SenatorReady_FAV_SB0517
Uploaded by: Senator Ready, Senator Ready
Position: FAV

JUSTIN READY
Legislative District 5
Carroll County

Judicial Proceedings Committee

James Senate Office Building
11 Bladen Street, Room 414
Annapolis, Maryland 21401
410-841-3683 · 301-858-3683
800-492-7122 *Ext.* 3683
Fax 410-841-3729 · 301-858-3729
Justin.Ready@senate.state.md.us

THE SENATE OF MARYLAND
ANNAPOLIS, MARYLAND 21401

March, 05

Senate Bill 517: General Provisions - Standard Time - Year-Round Daylight Saving Time

Chairman Pinsky, Vice Chair Kagan, members of the Committee, I am here today to present SB 517 which would signal Maryland's desire to remain on Daylight Saving Time year round. To date, forty-two states are entertaining or have passed legislation on the issue while two—Arizona and Hawaii—only observe their respective standard times.

Daylight Saving Time was initially implemented during World War I to save energy, but maintained unexpected popularity among Americans after the war, and was re-introduced year round during World War II for the same energy saving reasons.[1] However, with the technological advances we have realized today there is no significant energy saving associated with the time change process. What has not changed, on the other hand, is the continued popularity of Daylight Time among Americans and their desire to make it permanent.

The Federal Uniform Time Act of 1966—which codified Daylight Saving Time at the federal level—has been amended twice; both times extended the Daylight Saving period. The most recent change was a 2005 amendment which took effect in 2007. These changes to the original Act demonstrate the flexibility of time adjustment and offer precedent when considering changes at the state level. The Federal Uniform Time Act currently allows states to adopt the Standard Time of their current time zone, but not Daylight Time. The purpose of passing this bill would be to add our name to the list of states asking the federal government to amend the Act and allow us to adopt Daylight Time permanently.

Given both the sustained popularity of Daylight Saving Time since the first world war to the amending of the Uniform Time Act to today's nation-wide effort it is time Maryland joined the fight.

The problems often associated with Daylight Saving Time, most notably sleep deprivation and the lingering effects of it, are mostly due to the switch from Standard Time to Daylight Saving Time rather

[1] Steve P. Calandrillo and Dustin E Buehler, "Time Well Spent: An Economic Analysis of Daylight Saving Time Legislation," *Wake Forest Law Review*, 2008)

than the impact of a later sunset[2] as the body eventually readjusts. Staying on one time will alleviate these negative effects.

The reasons to choose Daylight Time over Standard Time include economic benefit, traffic safety, and crime reduction. Several studies show that many crime incidents are low during morning hours and peak during late afternoon and evening hours.[3] By adopting Daylight Saving Time permanently, workers will be able to be home before darkness falls. More daylight gives people the liberty of being outside after work, enjoying the daylight rather than going straight home. Anecdotally, we can think of walking down Main Street here in Annapolis at 5 during Daylight Saving Time with light for an extra hour versus during Standard Time when darkness coincides with getting off work. A State of Massachusetts study even found year-round Daylight Saving Time would lead to fewer traffic fatalities due to increased visibility during prime driving hours.[4]

Springing forward and staying there would benefit the State of Maryland, our economy, our roads, and put us in line with the rest of our country in recognizing this outdated policy. I respectfully request a favorable report.

[2] Jennifer L. Doleac and Nicholas J. Sanders, "Under the Cover of Darkness: How Ambient Light Influences Criminal Activity," *Review of Economics and Statistics* 97, no. 5 (2015): pp. 1093-1103, https://doi.org/10.1162/rest_a_00547)

[3] Buehler/Calandrillo; Doleac/Sanders

[4] "Report of the Special Commission on the Commonwealths Time Zone," Report of the Special Commission on the Commonwealths Time Zone § (n.d.))

SenatorReady_info_SB0517
Uploaded by: Senator Ready, Senator Ready
Position: FAV

UNDER THE COVER OF DARKNESS: HOW AMBIENT LIGHT INFLUENCES CRIMINAL ACTIVITY

Jennifer L. Doleac and Nicholas J. Sanders*

Abstract—We exploit daylight saving time (DST) as an exogenous shock to daylight, using both the discontinuous nature of the policy and the 2007 extension of DST, to consider the impact of light on criminal activity. Regression discontinuity estimates show a 7% decrease in robberies following the shift to DST. As expected, effects are largest during the hours directly affected by the shift in daylight. We discuss our findings within the context of criminal decision making and labor supply, and estimate that the 2007 DST extension resulted in $59 million in annual social cost savings from avoided robberies.

> Only the government would believe you could cut a foot off the top of a blanket, sew it to the bottom, and have a longer blanket.
>
> Unknown

I. Introduction

SOCIAL organization around a common understanding of time demonstrates the importance of the clock in daily life. Social norms assign the time one should wake up, attend work or school, eat lunch, return home, and sleep. Time coordination plays a major role in social interaction; Hamermesh, Myers, and Pocock (2008) show that even something as simple as television viewing schedules can influence time coordination among individuals. Though advancements in recordable television relaxed this particular restriction of time, the clock in many ways still dictates daily time use. Regardless of whether it is light or dark outside, or personal desires for different schedules, most follow the default instructions provided by the clock. This suggests we should pay attention to whether default schedules—or, equivalently, the clock itself—are set optimally.

One important question is whether clocks sync optimally with ambient daylight. Ambient light can have an impact on human behavior in a number of ways, such as quality of sleep and alertness during the day. For example, Wong (2012) and Carrell, Maghakian, and West (2011) show the impact of school schedules on student outcomes, including school day start and end times on academic performance. Could ambient light also affect individual safety? If criminals are less likely to offend in broad daylight, and schedules relative to clock time are mostly fixed (as for those with 9-to-5 jobs), the amount of ambient light at key hours could affect public safety, which suggests society could reduce the overall social costs of crime by simply shifting the clock.

Received for publication February 18, 2014. Revision accepted for publication January 21, 2015. Editor: Bryan S. Graham.

* Doleac: University of Virginia; Sanders: Cornell University.

We thank Ran Abramitzky, Alan Barreca, B. Douglas Bernheim, Nicholas Bloom, Caroline Hoxby, Maria Fitzpatrick, Melissa Kearney, Jonathan Meer, Alison Morantz, Amy Ellen Schwartz, Luke Stein, William Woolston, and several anonymous reviewers for helpful comments. We also thank seminar participants at Texas A&M University and the University of Virginia. J.D. appreciates the financial support of the Hawley-Shoven Fellowship.

A supplemental appendix is available online at http://www.mitpressjournals.org/doi/suppl/10.1162/REST_a_00547.

Criminal response to something as basic as outdoor environment is not without precedent. Research finds that, in general, the calendar affects criminal behavior, but researchers know less about the impact of ambient light on outdoor crime.[1] By increasing the likelihood of capture and the expected cost of criminal activity, light lowers the net expected wage from crime and could deter criminal behavior. Policymakers and law enforcement have long presumed this effect. Alternatively, increasing light might increase street crime if individuals stay out later, increasing the probability of interacting with a criminal and decreasing criminal search costs. The additional foot traffic could increase the "demand" for crime even as we expect the "supply" to decrease. The net effect is most relevant to policymakers but difficult to obtain without random assignment of ambient light. The exogenous shift of daylight caused by daylight saving time (DST) provides an opportunity to consider the role of light in street crime.

DST shifts an hour of available daylight from the morning to the evening each day in the spring and back to the morning in the fall. The U.S. Congress has extended the length of DST a number of times with the intent of decreasing energy consumption, but occasionally cites an additional benefit of a decrease in criminal activity. Most street crime occurs in the evening around common commuting hours of 5:00 to 8:00 p.m., and more ambient light during typical high-crime hours makes it easier for victims and passers-by to see potential threats and later identify wrongdoers (Calandrillo & Buehler, 2008). If people adhere to default schedules, shifting DST could have a meaningful effect on crime. But humans adapt, so it is not obvious that shifting daylight from one time of day to another would change the total amount of any activity. Criminals might adjust behavior to follow the darkness (or daylight).[2] It is ultimately an empirical question whether DST makes a difference in this context, and we are the first to rigorously analyze the impact of DST on crime rates. Such analysis is important; because the start and end dates of DST are arbitrary, there is often debate about whether timing is optimal. The social cost of violent crime is high, so even a small drop in crime rates due to an increase in evening daylight could make extending DST cost-effective.

We use both a regression discontinuity (RD) design and a difference-in-difference (DID) approach to test the impact of a change in ambient light on street crime, using the DST variation in sunset times as an exogenous shock to light. We

[1] See Heaton (2012) for evidence that liberalizing bans on Sunday liquor sales increased minor crime and alcohol-involved serious crime, and Jacob and Lefgren (2003) for evidence that juvenile delinquency increases when students are on summer vacation.

[2] Such behavioral adjustment seems to be the case for energy consumption, as we discuss in section II.

The Review of Economics and Statistics, December 2015, 97(5): 1093–1103

doi:10.1162/REST_a_00547

focus on two sources of variation for identification, as DST varies the amount of ambient light during high-crime hours of the day in two ways. First, under DST, in the spring (fall) of each year, the sun discontinuously rises and sets an hour later (earlier). Second, due to a legislated extension of DST, during a three-week (one-week) period in the spring (fall), the sun rises and sets an hour later during the same period in 2007 and 2008 than it did in 2005 and 2006. The legislation extending DST in 2007 provides an opportunity to directly control for time-of-year effects, which would otherwise be a concern since DST occurs simultaneously across 48 states (Arizona and Hawaii do not observe DST) and at approximately the same time each year.[3]

The RD model exploits the amount of daylight in key hours changing discontinuously from one day to the next, while other factors that affect crime outcomes are smoothly changing over the year. Our DID approach uses the three-week policy change the 2007 DST extension caused, combined with the within-day variation of the impact of DST on light. We hypothesize that DST has the strongest impact during the hours of light transition (sunrise and sunset); all other hours of the day remain either light or dark as before. We compare the shift in criminal activity during the two hours just after the pre-DST sunset time to the shift in criminal activity for all other hours.

RD results show that daily cases of robbery, a violent and socially costly street crime, decrease by approximately 7% in the weeks after DST begins, with a 19% drop in the probability of any robbery occurring. A 27% decrease in the robbery rate during the sunset hours drives much of this result. Our finding is highly robust to various RD specifications, and we find no such effects when rerunning the analyses using placebo dates to further test for general time trends. DID results similarly suggest a 20% decrease in the robbery rate during sunset hours. We also consider other violent crimes: rape, aggravated assault, and murder. We find no consistent impacts for aggravated assault, but suggestive evidence of impacts for rape and murder, though results are more sensitive to time-of-year controls than robbery. Using the social cost of crime, we estimate that the benefit of the 2007 shift of DST was a national decrease of $246 million in social crime costs per year, a nationwide social savings of $12 million per hour of additional ambient light during high-crime hours.[4]

As an additional consideration, we examine our results as a potential indication of criminal labor supply. By increasing the within-hour probability of capture, and thus the within-hour expected cost of crime, all else held constant, DST lowers the hourly net wage for robbery. Our hour-specific results suggest criminals are not reallocating robbery activity to alternate hours during the day, which, accompanied by the total drop in robberies, suggests criminals decrease their activity when the net wage decreases, at least in the short run. We further provide the first large-scale demonstration of how ambient light affects crime rates in the United States and evidence on the optimal timing of daylight with respect to public safety.[5]

The remainder of this paper proceeds as follows. Section II provides background on DST policy and the relevant changes used for identification. Section III describes a model for what factors might influence crime and how they relate to our analysis. Section IV describes the data. Section V details our empirical strategies. Section VI considers the results and explores the robustness of our findings. Section VII provides discussion of possible mechanisms and policy implications, including avoided social costs of crime.

II. Daylight Saving Time

DST shifts the relationship between clock time and sunset. At 2:00 a.m. on the first day of DST, clocks shift ahead one hour, removing a clock-recorded hour from that day and reallocating daylight from the early morning to the evening hours by pushing sunrise and sunset back one hour. Later in the year, at the end of DST, clocks shift from 3:00 a.m. back to 2:00 a.m., adding a clock-recorded hour to that day and reallocating daylight from the evening back to the morning. Anecdotal history suggests DST was first posed by Benjamin Franklin as a means to save money on candles by moving daylight from a time when few were working in the morning to a later, more work-intensive time. Despite the move from a wax-based lighting infrastructure, policymakers still cite DST as a means of energy conservation (Prerau, 2005). In reality, history credits George Vernon Hudson with the development of the more modern version of DST.

Energy savings have been the expressed goal of every recent change to DST policy. A congressional experiment in 1974 extended DST to last for a full year (clocks were not returned to their baseline time in the fall), with the goal of reducing energy consumption during a foreign oil embargo. In 1986, Congress permanently extended DST by one month to begin earlier in the spring (April), and in 2005, it voted to permanently extend DST (effective in 2007), citing the events of September 11, 2001, and ongoing wars in the Middle East as driving popular interest in reducing America's dependence on foreign oil. This most recent change moved the start of

[3] An additional interesting case is that of Indiana, where observance of DST varied across counties for a period of time. Kotchen and Grant (2011) use this variation, and the eventual shift to common-state observance, as a quasi-experiment to help identify the impacts of DST on energy use. Despite the intended purpose of DST as a source of energy savings, they find DST may have increased residential electricity demand.

[4] This assumes criminals do not shift avoided robberies to other times of year. We argue that consumption smoothing across more and less lucrative times of year is unlikely for this population, which typically does not have the financial resources (i.e., savings) or ability (i.e., bank accounts, discount rates) to go without income for long periods of time. Intertemporal shifts across hours are more likely than intertemporal shifts across months, and we consider the former in our analysis. However, this is ultimately a general equilibrium question that our empirical strategy cannot directly address.

[5] Van Koppen and Jansen (1999) tackle a similar topic using data from the Netherlands between 1988 and 1994, though their variation comes from daylight hours in summer versus winter (given the large differences in darkness in the Netherlands across seasons).

DST from the first Sunday in April to the second Sunday of March, and pushed the end back from the last Sunday of October to the first Sunday of November.[6] We focus on the impact of the beginning (spring shift) of DST, as the 2007 policy produced a larger change in the spring than in the fall (three weeks versus one week), and we are concerned that fall timing associated with Halloween is a confounder. We do, however, show that fall results largely agree with our spring findings.

Despite the intent of reducing energy and fuel use, empirical evidence suggests changes in DST did no such thing. Using variation in DST policy across the state of Indiana, Kotchen and Grant (2011) show DST resulted in an increase in energy consumption. Using changes in DST policy in Australia prompted by hosting the Olympics, Kellogg and Wolff (2008) find no energy savings. DST does, however, appear to have an impact on daily activity. Wolff and Makino (2012) find that the larger blocks of evening daylight produced by DST induce people to spend more time outdoors, with the positive health effect of burning an average of 10% more calories per day.

While no recorded changes in DST explicitly target criminal activity, an observational study of the 1974 yearlong DST experiment suggested violent crime fell 10% to 13% in Washington, DC, during the affected time of year (Calandrillo & Buehler, 2008). While this reduction is small in scope and isolated to a comparison of across-year crime rates, discussion of DST as a crime-reducing policy often cites this result. Our paper tests for this effect across the country using richer, more recent data and a cleaner natural experiment. Prior to examining these effects, however, we consider how DST might affect criminal behavior in a theoretical framework. We first pose the choice to engage in criminal behavior as a function of, among other things, ambient light and the probability of capture. We then consider how criminal labor supply might shift in response to the increased cost of criminal behavior associated with a higher probability of capture.

III. Factors in Criminal Deterrence

The classic Becker (1968) model of crime predicts a rational criminal will break the law if the expected benefit exceeds the expected cost. The expected cost of crime is a function increasing in the probability that someone will catch the criminal and the discounted punishment he or she would receive. Thus the number of crimes committed should fall if society does any of the following: incarcerates more likely offenders, increases the probability of apprehending offenders who commit new crimes, or makes punishments more severe.

Changes in crime come in two forms: an incapacitation effect and a deterrent effect. Incarcerating offenders has an incapacitation effect: individuals are physically prevented from committing crimes. But incarceration is extremely expensive, and the experience of prison could have negative long-term effects on the inmates and their families. Increasing punishment has a deterrent effect, in that it increases the expected cost of crime, making criminal activity less appealing to potential offenders and influencing the marginal criminal in their decision. But it is an open question whether potential criminals can be meaningfully deterred from offending by increasing the expected cost of crime.[7] Lengthy sentences have little to no deterrent effect, possibly because offenders highly discount the future (Lee & McCrary, 2005), and individuals who are impatient are unlikely to base today's decisions on a change that they feel only years from now.

It is a top policy priority to find more cost-effective ways to decrease crime, and focusing on how offenders respond to changes in the other parameter of the expected cost function—the likelihood of getting caught—might lead policymakers toward more promising interventions.[8] Indeed, all else held constant, the social planner prefers policies that increase the deterrence factor because they have a lower overall cost to society: the crime never occurs (saving victims) and incarceration is unnecessary.[9] However, legislators must be careful that policies are cost-effective and do not have unintended consequences that mitigate any deterrent effect.[10]

A. *Ambient Light and Its Effect on Crime*

We conduct our analysis in the framework of a simple model of criminal behavior, where criminals attempt a crime if the expected benefits are greater than the expected costs. More light means witnesses are more likely to spot criminals committing crimes and more likely to recognize and identify criminals apprehended later. Let the expected cost of crime be a function of the (discounted) length of sentence if captured (T) and probability of capture (P), which is a function of ambient light (L), as well as a large number of other factors (F) such as number of police. We treat criminal behavior as a labor decision; thus, we also include a disutility from labor factor (D), which includes search costs for potential victims, and thus depends on ambient light (L). An individual will commit a crime if

$$E[Benefit_{crime}] > E[Cost(T, P(L, F), D(L))_{crime}]. \quad (1)$$

In partial equilibrium, we expect $\partial P/\partial L$ and $\partial C/\partial P$ to be positive; greater amounts of light increase the probability of

[6] The week in the fall was reportedly due to lobbying by candy manufacturers to include Halloween (NPR, 2007).

[7] See Abrams (2012) for a review of the literature on the deterrent effect of longer sentences.

[8] See, for example, Cook and Ludwig (2011), Doleac (2012), and Kilmer et al. (2013).

[9] Increasing law enforcement employment is one way to deter criminal behavior via probability of capture. Prior evidence suggests this is effective, though police do more than simply arrest suspects, so the precise treatment is unclear (Levitt, 2004). Similarly, databases and registries that make it easier to identify suspects increase the probability of catching repeat offenders (Doleac, 2012). For instance, adding offenders to DNA databases appears to decrease crime rates due to a combination of deterrent and incapacitation effects.

[10] For instance, Prescott and Rockoff (2011) and Agan (2011) find no beneficial impact of sex offender registries on crime or recidivism.

capture, which increases the cost of crime and decreases the propensity to commit crime. In general equilibrium, the effect of additional light is ambiguous. If, for example, more light means individuals are more likely to remain outdoors longer, as Wolff and Makino (2012) suggested, this increases the number of potential victims for criminals, decreasing search costs ($\partial D/\partial L < 0$), which in turn decreases the expected cost of crime ($\partial C/\partial D > 0$). We are unable to directly separate these two effects; we interpret our results as the net effect of an increase in ambient light from DST.

Our analysis allows us to superficially consider the role of both the incapacitation and deterrence effects. We separately consider changes in total daily crime and crime within hours where DST directly affects light. Even with increased light, some criminals will still choose to offend and will face a higher probability of capture and incarceration. Once off the streets, they will be unable to commit additional crimes during any hour of the day. The incapacitation effect of DST on crime will be evident at all hours of the day, but any deterrent effect should be operative during the evening hours that were formerly dark but are now light.[11]

B. Investigating Daily Criminal Labor Supply

Labor supply models provide a framework to model criminal behavior. Without information on how victims adjust behavior as a product of DST, we are unable to consider whether criminal search costs increase or decrease. However, we can begin to address the issue of daily labor supply for criminals. Camerer et al. (1997) consider a similar question when they investigate how taxi drivers adjust daily labor supply when hourly wages vary with the effort required to find patrons, while Jacob, Lefgren, and Moretti (2007) consider criminal substitution across longer time periods when weather displaces criminal activity. Like cab drivers, criminals are "self-employed" and have the ability to choose the number of hours in which they engage in criminal activity. Our further analog here is one of criminals searching for "patrons": do criminals adjust their daily labor supply when the net hourly wage changes? We restrict our discussion here to robbery, the crime where discussion of a net wage is most comparable.

In a classic labor model, individuals work more hours when net wages are higher and, conversely, work fewer hours when net wages are lower (in favor of substituting away to leisure). We consider the net hourly wage of criminal behavior as the expected benefits of criminal activity minus the expected costs. The expected benefit for robbery is the financial return, while the expected costs are an increasing function of the probability of capture. DST should result in a lower net wage, and the classic model predicts fewer crimes, which would mean not just a reduction in crime during the hour of daylight shift but also for the day overall. This parallels the standard model of criminal deterrence. A behavioral model would suggest that lower net wages result in increased criminal hours in an attempt to obtain some set level of criminal income, and may result in a net daily impact of 0. We cannot observe the number of hours "worked" by criminals, but we do observe the number of crimes reported. We use this as a measure of the volume of criminal activity.

IV. Data

We obtain crime data from the National Incident-Based Reporting System (NIBRS) for the years 2005 to 2008. NIBRS data include detailed information on each reported crime, including the hour of occurrence, the type of committed offense, and whether there was an arrest. It classifies reporting areas as jurisdictions, which vary in size and geographic makeup. For example, a jurisdiction could be a county, a city government, or a combination of similar institutions. Though NIBRS reporting has gradually expanded over time, the geographic scope remains limited. As of 2007, jurisdictions reporting to NIBRS covered approximately 25% of the population and 25% of crimes reported in the Uniform Crime Reporting (UCR) system, and while some larger cities report, the data are disproportionately from smaller population centers. For example, though Texas reports data to NIBRS, reporting jurisdictions cover only around 20% of the state population, and only one reporting jurisdiction has a population over 1 million. How criminals make timing decisions might vary between highly urban areas and more rural zones, and we interpret our results with this in mind.[12] For our primary analysis, we restrict attention to jurisdictions that consistently reported for two years prior to the 2007 DST extension and two years after.[13] In the end, we have 558 jurisdictions covering a total population from 22 to 24 million persons, depending on the year. Data are predominantly in the eastern portion of the country. Figure 1 maps reporting regions, separated by time zone.

Our primary focus is on the crime of felony robbery. This is often a street crime in which the victim does not know the offender (muggings, for instance, would be classified as robberies), and thus should be particularly affected by ambient light. It also is one of the few financially motivated violent crimes, and thus responsive to changes in net wage.[14] We also consider additional violent crimes that might represent

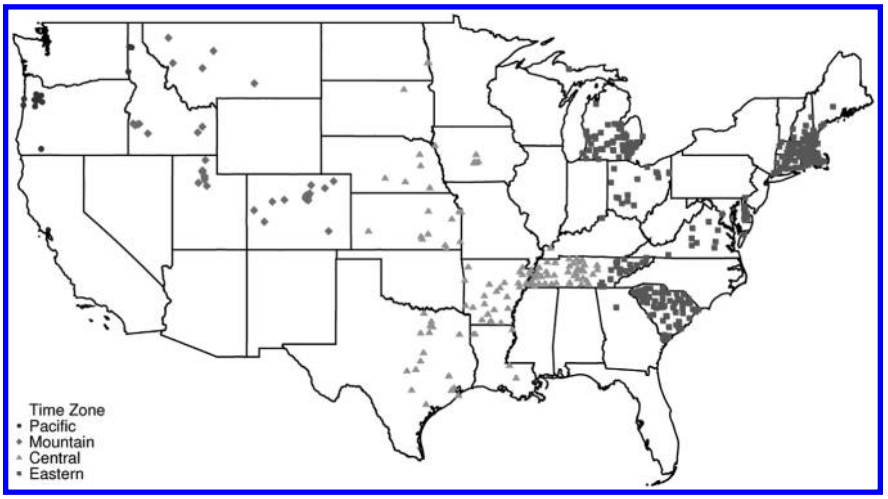
[11] DST shifts the hour of sunrise as well. We focus on sunset because most street crime occurs in the evenings. In prior versions of this paper, we specifically considered the hour of sunrise as well and saw no DST-related shift in behavior in the morning. Hourly results shown in the online appendix address this issue as well.

[12] For a detailed listing of which regions report by state and population coverage, see http://www.jrsa.org/ibrrc/background-status/nibrs_states.shtml.

[13] In a prior version of this paper, we found our general results were robust to using a nonbalanced panel (available on request).

[14] In earlier versions of this paper, we expanded our analysis to possible placebo crimes, such as forgery and swindling, that should be unaffected by darkness, and other property crimes (Doleac & Sanders, 2012). However, such crimes face the complication that the reported time of the crime is very noisy. For example, individuals discover a burglary upon returning home or a stolen car on the following morning, but they have no idea what time during the day the burglary occurred. Robbery remains our main focus, as the time of occurrence is likely well known.

FIGURE 1.—REPORTING REGIONS USED IN PRIMARY ANALYSIS



Latitude and longitude information are taken from the 2005 Law Enforcement Identifiers Crosswalk. Each point is one of the 558 reporting jurisdictions included in the main analysis, described in section IV.

robberies gone wrong: rape, aggravated assault, and murder. However, NIBRS data show victims are much more likely to know their offenders for these crimes, so we expect a substantially more muted impact.

If the classic labor model holds, then the largest effects should occur during the hours directly affected by DST (those just around sunset), where the net wage for robbery has decreased the most, and total criminal behavior should decrease. If ambient light is the relevant mechanism and criminals are not operating in a behavioral model, DST should not increase crime at 3:00 p.m., which is light both directly before and after DST, or 10:00 p.m., which is dark both directly before and after DST. If offenders are making up for lost time, however, criminals should increase activity in different hours.

To better measure the direct timing of the effect, we match reporting regions to sunset records. Using latitude and longitude data from NIBRS and daily sunrise and sunset times from the National Oceanic and Atmospheric Administration, we calculate the specific daily hour of sunset for each jurisdiction. Figure 2 is a frequency histogram of sunset times used in our analysis by year, using the recorded sunset time for the day directly before the beginning of DST in the spring. Times are earlier in 2007 and 2008, as sunset gradually occurs later as the year progresses and DST begins three weeks earlier in those years. We define the DST treatment variable of interest as a binary indicator that takes a value of 1 during DST and 0 at all other times. DST is "off" in the beginning of the year. It is "on" beginning April 3, 2005; April 2, 2006; March 11, 2007; and March 9, 2008. And it is "off" again beginning October 30, 2005; October 29, 2006; November 4, 2007; and November 2, 2008. Crime rates trend differently throughout the year, and RD estimates are most valid in the area of the discontinuity. We restrict the majority of our analysis within three weeks of the DST cutoff in each year, though in robustness checks, we expand our bandwidth to eight weeks on either side of the DST transition and allow for flexible time trends. We also investigate other times of year where we expect no shock to daylight as placebo tests.

Table 1 shows the raw, non-trend-adjusted average crime rate per 1 million persons for all crimes in our analysis, for the three weeks before and after the spring transition of DST. The first column shows averages across all weeks and all years. Columns 2 and 3 split the sample into pre- and post-DST but still show daily totals. Columns 4 and 5 focus on the same six-week framework but focus on crime in only the hours around sunset. The second panel shows the population, in millions, covered by these reports each year, as well as the number of reporting jurisdictions used (which is constant across years).

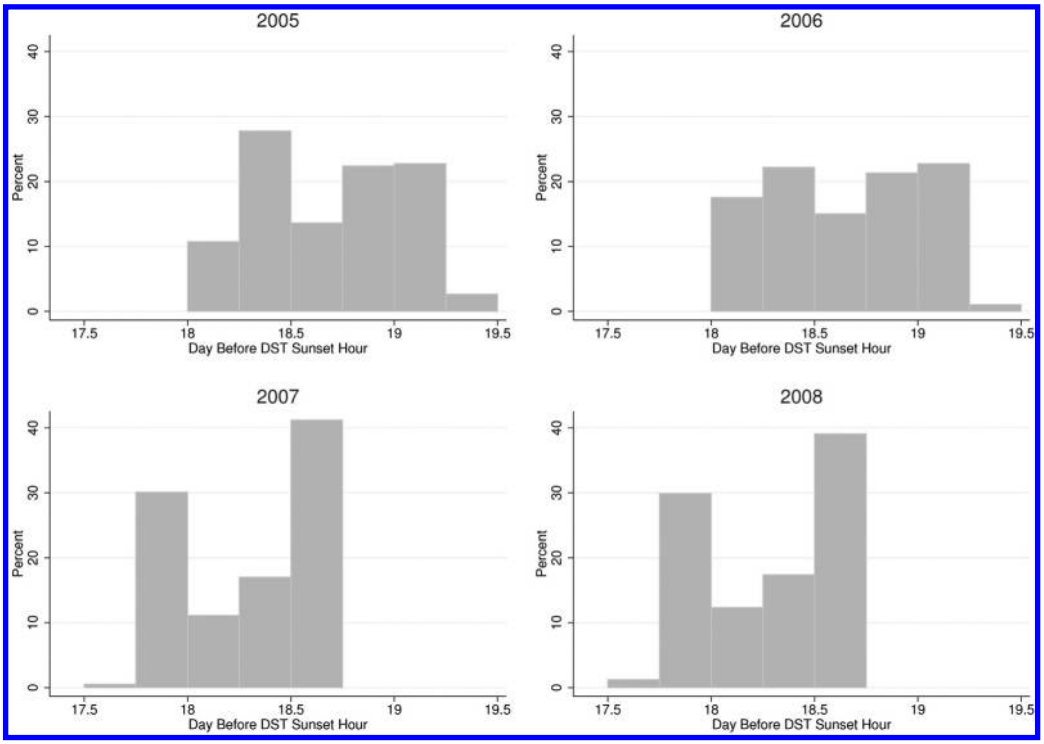
V. Empirical Strategy

We first consider the effect of DST on daily crime rates. This is the relevant policy question in determining the cost-effectiveness of DST. It also speaks to the question of criminal labor supply in that it addresses whether criminals reallocate activity across hours in the day to maintain a constant daily total or whether the relationship between daylight and clock time matters. Next, we consider impacts by hour of the day. If ambient light is important in the criminal activity decision, changes in daily crime rates will be strongest during the hours of light transition that, prior to DST, were dark but are now light.[15] This is the time that has the greatest relative increase in ambient light, making it the "treated" period.[16]

[15] We therefore expect that the criminal response should be largest during the "time since sunset" hours of 0 and 1, the periods covering sunset and dusk. Dusk is the time at which it becomes completely dark. It occurs, on average, about thirty minutes after sunset.

[16] We include more information on how we calculate time since sunset in the replication files. In prior versions, we conducted the same analysis using specific hour of day rather than hour relative to sunset. Results were similar and present only in the hours most frequently impacted by shifting sunset (6:00 and 7:00 p.m.). We demonstrate these results in the appendix.

FIGURE 2.—DISTRIBUTION OF SUNSET TIMES IN THE DAY BEFORE DST



Sunset times are taken from http://www.esrl.noaa.gov/gmd/grad/solcalc and are calculated as described in the Replication Files. The vertical axis represents the number of different sunset times used, where jurisdiction sunset time is determined by latitude and longitude. The horizontal axis shows the time of day using 24-hour time.

TABLE 1.—AVERAGE CRIMES PER MILLION POPULATION FOR THE THREE WEEKS BEFORE AND THREE WEEKS AFTER DAYLIGHT SAVING TIME

		All Day		Sunset Hour	
Crime Rate per Million	Total	Pre-DST	Post-DST	Pre-DST	Post-DST
Robbery	3.286	3.192	3.381	0.448	0.341
	(8.816)	(8.696)	(8.933)	(2.838)	(2.498)
Rape	1.046	1.036	1.056	0.093	0.081
	(5.222)	(5.251)	(5.192)	(1.478)	(2.776)
Aggravated assault	8.747	8.193	9.300	0.950	1.143
	(16.996)	(16.254)	(17.69)	(5.059)	(5.44)
Murder	0.141	0.142	0.140	0.016	0.011
	(1.631)	(1.634)	(1.628)	(0.648)	(0.451)
Year		2005	2006	2007	2008
Total population (1,000,000)	–	22.998	23.194	23.449	23.651
Total reporting Jurisdictions					558

Daily total is the average of total daily crimes, calculated by summing hourly data across all hours within the day. Sunset hour data are the average of total crimes occurring in the hour of sunset and the hour directly following sunset (dusk). Standard deviations are in parentheses. Population and crime data come from the National Incident-Based Reporting System (NIBRS). "Jurisdiction" refers to the region used for collecting crime data, and generally refers to a county, city, or similar municipality. We weight all means by jurisdiction population.

A. *Regression Discontinuity*

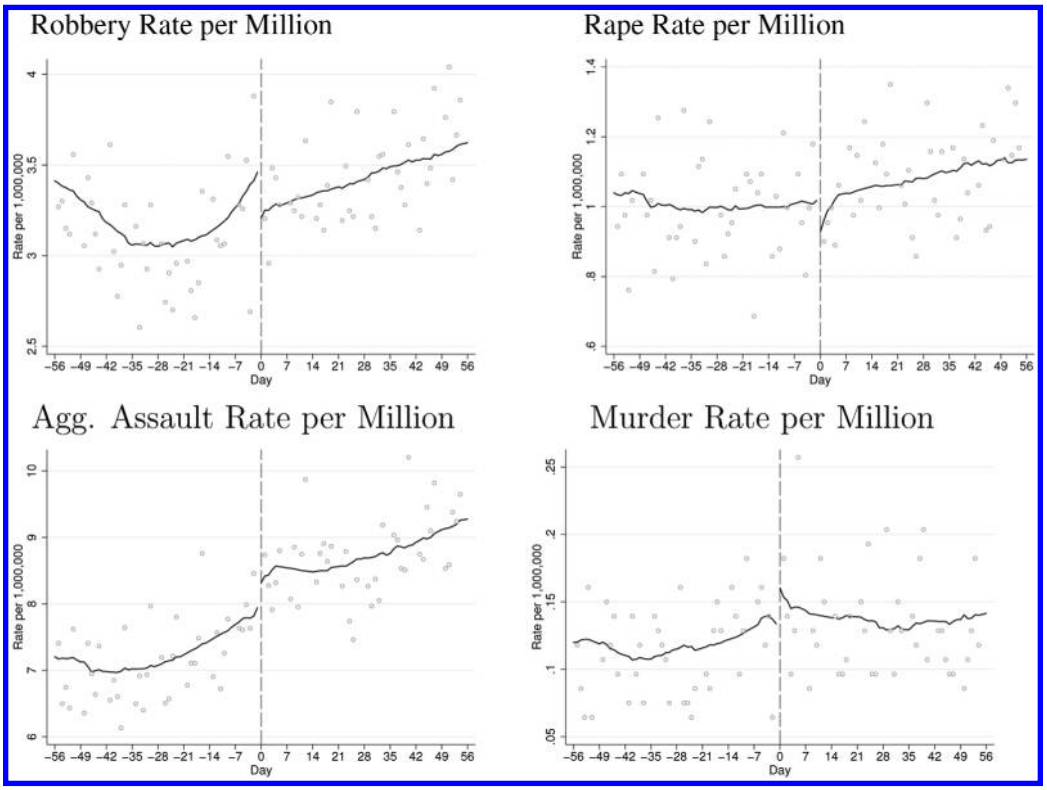
We begin with a regression discontinuity (RD) design, where the running variable is days before and after DST, scaled such that the running variable is equal to 0 at the first day of DST. This is not directly equivalent to using day-of-year as our running variable, as DST is determined not by a specific date but by a specific Sunday in the month independent of calendar date. We control for the running variable using a linear model with a varied slope on either side of the cutoff.

Despite the discontinuous nature of DST, the use of time as the running variable means that some assumptions of RD may fail. DST always begins on a Sunday, which has different crime patterns than other days. As a potential adjustment, we include day-of-week fixed effects. Given prior findings that weather can have an impact on criminal behavior (Jacob et al., 2007), we also control for daily county-level average temperature and rainfall.[17] Finally, we include jurisdiction-by-year fixed effects to allow for baseline differences in crime rates across reporting jurisdictions and years,

$$crime = \alpha + \beta_1 day + \beta_2 DST + \beta_3 DST * day + \omega W + \lambda_{jurisdictionXyear} + \gamma_{dow}, \quad (2)$$

[17] Weather data are from Schlenker and Roberts (2009).

FIGURE 3.—DAILY ESTIMATES OF LOCAL LINEAR REGRESSION RD IMPACT



Solid lines in all graphs are predicted outcome values based on a local linear regression as specified by equation (4). Outcome variable is crimes per million population, where individual panel titles indicate specific crimes. The horizontal axis variable, "Day," refers to days since the beginning of daylight saving time, which varies by year. The scatter plot is collapsed outcomes, by days since DST. Graphs do not include weekend data for display simplicity.

where W is a vector of weather variables and λ and γ are the noted fixed effects. We use two outcomes of interest: (a) crimes per million population, a continuous variable, and (b) an indicator function for whether a crime occurred in a given jurisdiction or time cell, which we estimate using a linear probability model. We do not control for population, as jurisdiction-by-year fixed effects indirectly contain this information. However, we do weight regressions by the jurisdiction population. We cluster all standard errors by jurisdiction to allow for common variation in crime rates. Our analysis is similar for both individual hours and daily results, where we sum all crimes to daily totals using the outcome of crimes per 1 million.

B. *Difference-in-Difference*

Our DID model uses both the variation in the timing of DST across years and the variation in the impact of DST across hours of the day. For this specification, we limit analysis to the time period that is standard time before the 2007 policy change but classified as DST from 2007 onward. The earlier beginning of DST is March 9 (2008), and the latest is April 3 (2006), so our analysis uses 25 days per year. We again use crimes per million and probability of any crime occurring as our outcomes of interest, and we collapse all data to the day-by-sunset level: the hour of sunset (hour 0) and just following sunset (hour 1) comprise one group, while all other hours of the day comprise the other. The relevant regression is

$$crime = \alpha + \beta_1 Post2007 + \beta_2 sunset + \beta_3 sunset^{*} Post2007. \quad (3)$$

Given the use of hours within the same day as a control group, we can omit all variables that do not vary by hour. We omit day-of-week and jurisdiction-by-year fixed effects, as they provide no additional identification for β_3, the coefficient of interest. As with RD estimates, we weight all regressions by population.

VI. Results

A. *Regression Discontinuity*

Figure 3 illustrates our local linear estimates for robbery, rape, aggravated assault, and murder rates before and after DST. We use a bandwidth of 21 days to estimate the shape of changes in crime rates over time to match our range choice in our regressions, and we weight all by population using the following estimation:

$$crime = \alpha + \beta_1 day + \beta_2 DST + \beta_3 DST^{*} day. \quad (4)$$

We use this regression to generate a predicted value for each day, which we then graph as a solid line. Scatter points are average true observed crime rates, collapsed to the daily level, though we omit weekends, which have much higher crime rates, for a more readable axis (note that weekends are included in the following regressions). The robbery figure

TABLE 2.—EFFECTS OF DST ON CRIME

	RD: Daily Totals		RD Sunset Hour		Diff-in-Diff: Sunset versus Other Hours	
	Crimes per 1,000,000	Probability of Crime Occurring	Crimes per 1,000,000	Probability of Crime Occurring	Crimes per 1,000,000	Probability of Crime Occurring
Robbery	−0.215*	−0.015**	−0.120**	−0.007*	−0.214***	−0.027***
	(0.122)	(0.008)	(0.041)	(0.004)	(0.081)	(0.008)
Share of pre-DST mean	−0.07	−0.19	−0.27	−0.10	−0.20	−0.22
Rape	−0.119*	−0.003	−0.35*	−0.004	0.058	0.006
	(0.069)	(0.007)	(0.019)	(0.003)	(0.052)	(0.008)
Share of pre-DST mean	−0.11	−0.06	−0.38	−0.32	0.17	0.14
Aggravated Assault	0.350	0.000	0.041	−0.008	−0.012	−0.011
	(0.213)	(0.008)	(0.070)	(0.006)	(0.212)	(0.007)
Share of pre-DST mean	0.04	0.00	0.04	−0.08	−0.00	−0.06
Murder	−0.010	0.005	−0.002	−0.002	−0.018	−0.007
	(0.035)	(0.010)	(0.007)	(0.002)	(0.015)	(0.007)
Share of pre-DST mean	−0.07	0.88	−0.89	−0.67	−0.37	−0.65

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Standard errors are clustered at the jurisdiction level. The outcome variable is either (a) crimes per million population or (b) the probability of at least one of the crimes occurring, as the column headers describe. Population-weighted coefficients show the change in the outcome variable due to the transition to DST. We calculate hours since sunset using data on the hour of sunset for each jurisdiction on the day prior to the beginning of DST. "Sunset Hour" refers to the hour of and just following sunset. All regression discontinuity models include day-of-week fixed effects, jurisdiction-by-year fixed effects, controls for weather (county average daily temperature and rainfall), and a running variable control for days since the beginning of DST, where we allow the slope of the running variable to vary before and after DST. Difference-in-difference regressions include data from March 9 through April 3 in all four years of the analysis. The first difference is whether the included weeks are classified as DST, which varies by year (not classified as DST in 2005–2006, classified as DST in 2007–2008). The second difference is whether the crime occurred in an hour classified as affected by sunset (hours 0 and 1, as calculated in section V). Regressions use 558 jurisdictions, with 94,744 day-by-hour-by-jurisdiction observations for the three weeks prior to and the three weeks following the beginning of DST (for the RD regressions) and 116,064 hour-group-by-day-by-jurisdiction observations (for the DID regressions). Population and crime data come from the National Incident-Based Reporting System.

shows a clear, large change in the pattern of daily total crimes. Graphs for other crimes are less suggestive, with little deviation from trend and no persistent effects.

The first two columns of table 2 show RD results from equation (2) using total daily crime rates for robbery, rape, aggravated assault, and murder as outcomes. Column 1 shows results using crimes per million. Aside from the addition of weather controls and time fixed effects, these regressions are the analog of figure 3 and show a similar pattern. We find an economically significant reduction in robbery, where DST results in a 7% drop in incidences per million, though the result is significant only at 10%. We also see effects for rape, which has a decrease of 11% and is again significant at 10%. No statistically significant results exist for aggravated assault or murder.

Column 2 repeats the analysis using a linear probability model (LPM) with the binary outcome of "did any incident of crime *X* occur in this jurisdiction on this day." This has the benefit of being less sensitive to outliers, such as an unusually large number of robberies on a single day.[18] Results are similar to the crimes per million outcomes. DST results in a 1.5 percentage point drop in the probability of any robbery occurring on a given day, a decrease of approximately 19%. We do not find statistically significant effects for any other crime, suggesting some outlier days may be responsible for the rape findings using crimes per million.

We next consider crimes reported in specific hours. Hourly data can suffer from issues such as flawed recording, incorrect victim recall, and other sources of measurement error, and we approach the following analysis with that in mind. However, in almost all cases, hourly analysis strongly supports that criminals engaging in robbery alter their behavior most drastically in the hours most affected by the DST policy, and they do not shift their behavior to other hours of the day in a consistent manner. We focus on the former point, and leave the latter for the online appendix.

Columns 3 and 4 of table 2 mirror those of columns 1 and 2, but focus on the hours most affected by daylight change (0 and 1 hours from calculated sunset). All regressions include weather controls as well as day-of-week and jurisdiction-by-year fixed effects. DST correlates with 0.12 fewer robberies per million during the hours following sunset (a decrease of 27% from pre-DST means, significant at the 1% level), or a decrease of 0.7 percentage points in the probability of any robbery occurring (a 10% decrease, significant at the 10% level). DST correlates with 0.35 fewer rapes per million during hours following sunset (a decrease of 38%, significant at the 10% level). Again, we find no statistically significant effects for any other crime.

B. RD Robustness Checks

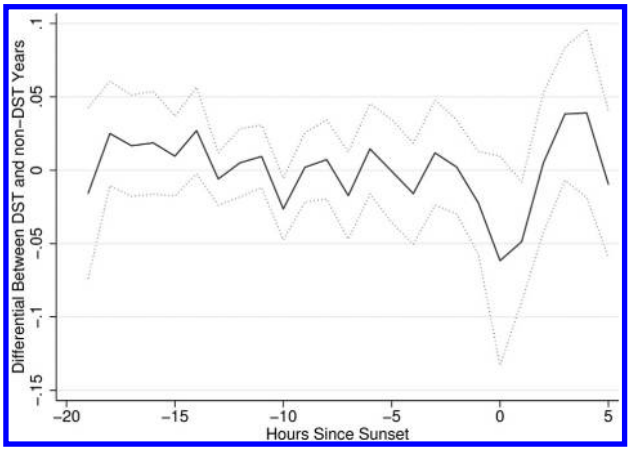
In the appendix, we discuss and present results of a wide variety of robustness checks, including using different bandwidths and polynomials, additional controls, and restricted samples. We also present results of placebo tests using fake DST dates and show results for all hours to test for reallocation of criminal activity across the day. Finally, we test for effects in the fall, and compare effects on weekdays (when commuters are more prevalent in the evening hours) with those on weekends. All appendix tests support our main findings.

C. Difference-in-Difference Results

Despite the discontinuous nature of DST, the use of time as the running variable can complicate the RD design. One

[18] For computational simplicity when using a large number of fixed effects, we prefer the LPM. We repeat the analysis using a logit and find similar results (available on request).

FIGURE 4.—DIFFERENCE IN ROBBERIES PER MILLION POPULATION ACROSS 2007 POLICY CHANGE BY HOURS SINCE SUNSET



Solid line indicates coefficients on an interaction between hours since sunset and whether the day was classified as daylight saving time, which varies by year. Estimates are done using equation (5). Data include only days in March and April that were classified as standard time in 2005–2006 but as DST in 2007–2008. The dotted line shows the 95% confidence interval for the estimates, where standard errors are clustered by jurisdiction.

identifying assumption of the RD model is the continuity of unobservable factors that determine outcomes (crime rates) with respect to the running variable (time). Given that DST always occurs on a Sunday, our data may violate this assumption. Controlling for day-of-week fixed effects can help reduce that particular issue, but other time factors, such as the timing of holidays, may further complicate identification. The 2007 policy change helps control for this concern, as DST occurs at a different time of year for the two years of our analysis. Additionally, the test for effects by hour is a check for such complications. There is no reason that potential confounders would systematically affect only the hours that are most sensitive to DST with regard to light shift. As an additional check for non-policy-related background trends, we repeat our analysis using a difference-in-difference model that does not depend on the same assumptions as the RD.

Our difference-in-difference results take advantage of the period in March that is standard time during 2005 and 2006 but DST during 2007 and 2008, along with the fact that the light impacts of DST appear to matter only during the hours of sunset. We thus collapse our crime rates to two observations per day: one during the hours of sunset and the other for all other hours. Columns 5 and 6 of table 2 show difference-in-difference results for all four crimes. As with RD, in the difference-in-difference model, only robbery shows a consistent, statistically significant decrease in crime. The DID estimate shows a drop of 0.21 robberies per million population, equivalent to a 20% decrease. This result is very similar to the RD estimate described above. Using the LPM, the DID interaction suggests a 2.7 percentage point drop in the probability of a robbery.

Figure 4 illustrates our robbery result graphically. We run the following regression:

$$crime = \beta_1 + \tau_{hours} + \beta_2 post2007 + \pi_{hoursXpost2007}. \quad (5)$$

The coefficients from the vector π represent the difference in crime rates, by hour, for the same time of year between the years 2005–2006, when the month of March was not DST, and 2007–2008, when it was. Figure 4 plots those coefficients, along with the 95% confidence interval, for each hour of the day. The hours of sunset are the only ones that see a systematic decrease in robbery after 2007.

VII. Discussion and Conclusion

We present the first rigorous empirical estimates of the effect of ambient light on violent crime. We find DST lowers robbery rates by 7%, with the largest results occurring during the hours most affected by the shift in daylight. This effect is large but not unreasonable relative to other interventions that operate primarily by increasing the probability of capture. For instance, Ayres and Levitt (1998) find that the availability of LoJack antitheft technology reduces auto theft by 10%, and Kilmer et al. (2013) find that requiring frequent tests for inebriation as a condition of community release or probation reduces DUI arrests by 12% and domestic violence arrests by 9%.

The impact of DST on robbery rates is the net effect of several factors, particularly if the prime time for crime is when most people are on their way home after work: (a) daylight itself could discourage offenders from committing crime because they are more visible and easier to identify; (b) DST might increase foot traffic at key times due to the later sunset, which might increase the number of potential witnesses in addition to increasing visibility, though this could also increase the number of potential victims; and (c) changes in offenders' schedules due to the later sunset (e.g., later family dinners or sports practices, substitution for their own leisure) might make them unavailable to commit crime until after most potential victims have gone home. The first two explanations imply DST has a deterrent effect on crime, while the third explanation implies an incapacitation effect that does not rely on incarceration. Regardless of the mechanism, it is clear the relationship between daylight and clock time matters when it comes to crime.

One must compare the benefits of avoided crimes, along with the potential health benefits found in Wolff and Makino (2012), with cost increases associated with DST. In addition to potentially increasing energy consumption, DST appears to have several other negative consequences. A 2012 poll by Rasmussen Reports found only 45% of Americans think DST is "worth the hassle," and remembering to change one's clocks—and occasionally being early or late for appointments—is inconvenient (Rasmussen, 2012). Groups consistently lobbying against DST extensions include the national Parent Teacher Association (PTA), which expressed concern that children are at risk of being

kidnapped while waiting in the dark for a schoolbus, and the airline industry, because changing flight schedules is costly.[19]

The growing literature on the effect of early school start times on academic performance suggests extending DST could have a negative effect on students by making classes earlier relative to sunrise (Wong, 2012).[20] Medical research on circadian rhythms suggests shifts in the sleep cycle can have negative impacts on response time and cognition, and on the Monday following DST, there is higher observed rate of traffic accidents, workplace injuries, and heart attacks (Coren, 1996; Varughese & Allen, 2001; Barnes & Wagner, 2009). Janszky and Ljung (2008) note that changing one's clocks "can disrupt chronobiologic rhythms and influence the duration and quality of sleep" for several days, and also hypothesize negative physical effects as a result of the policy. However, most of these costs are due to the switch from standard time to DST rather than the impact of a later sunset per se, and are likely small in comparison to the benefits of the substantial drop in violent crime.

There remains the specific valuation of the social benefits of the decreased crime seen as a result of DST. McCollister et al. (2010) estimate the social cost of a robbery at $42,310.[21] A back-of-the-envelope calculation implies the three-week extension of DST avoids $59.2 million nationally each year in avoided robberies.[22] If we include the suggested impacts on rape (with an estimated social cost per crime of $240,776), the total social cost savings come to $246 million. These savings are from the three-week period of DST extension. General equilibrium effect are likely to vary substantially across different seasons and geographic regions, so one should do out-of-sample prediction with caution, but assuming a linear effect in other months, the implied social savings from a permanent, yearlong change in ambient light would be almost twenty times higher.

[19] We find no evidence that ambient light affects kidnapping, but statistical power is low (results available on request). The Air Transport Association estimated that the 2007 extension would cost airlines $147 million (Koch, 2005).

[20] While Carrell et al. (2011) also consider how early classes affect school performance, their effect is independent of sunrise and thus should not be a long-term effect of DST. However, the deprivation of sleep schedules in the initial time shift may have its own effects.

[21] The social costs of crime include estimated tangible and intangible costs. McCollister et al. (2010) divide these into four categories: (a) direct economic losses suffered by the crime victim, including medical care costs, lost earnings, and property loss or damage; (b) local, state, and federal government funds spent on police protection, legal and adjudication services, and corrections programs, including incarceration; (c) opportunity costs associated with criminals' choice to engage in illegal rather than legal and productive activities; and (d) indirect losses suffered by crime victims, including pain and suffering, decreased quality of life, and psychological distress.

[22] We base these calculations on an estimated reduction in crimes per 1,000,000 residents per day, 21 days of DST, and a U.S. population of approximately 310 million. The number of robberies prevented each year is: $0.215 \times 21 \times (310{,}000{,}000/1{,}000{,}000) = 1{,}400$.

REFERENCES

Abrams, D. S., "Estimating the Deterrent Effect of Incarceration Using Sentencing Enhancements," *American Economic Journal: Applied Economics* 4:4 (2012), 32–56.

Agan, A. Y., "Sex Offender Registries: Fear without Function?" *Journal of Law and Economics* 54 (2011), 207–239.

Ayres, I., and S. D. Levitt, "Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lojack," *Quarterly Journal of Economics* 113 (1998), 43–77.

Barnes, C. M., and D. T. Wagner, "Changing to Daylight Saving Time Cuts into Sleep and Increases Workplace Injuries," *Journal of Applied Psychology* 94 (2002), 1305–1317.

Becker, G. S., "Crime and Punishment: An Economic Approach," *Journal of Political Economy* 76 (1968), 169–217.

Calandrillo, S., and D. E. Buehler, "Time Well Spent: An Economic Analysis of Daylight Saving Time Legislation," *Wake Forest Law Review* 43 (2008), 45–91.

Camerer, C., L. Babcock, G. Loewenstein, and R. Thaler, "Labor Supply of New York City Cabdrivers: One Day at a Time," *Quarterly Journal of Economics* 112 (1997), 407–441.

Carrell, S. E., T. Maghakian, and J. E. West, "A's from Zzzz's? The Causal Effect of School Start Time on the Academic Achievement of Adolescents," *American Economic Journal: Economic Policy* 3 (2011), 1–22.

Cook, P. J., and J. Ludwig, "Economical Crime Control," in Philip J. Cook, Jens Ludwig, and Justin McCrary, eds., *Controlling Crime: Strategies and Tradeoffs* (Chicago: University of Chicago Press, 2011).

Coren, S., "Daylight Savings Time and Traffic Accidents," *New England Journal of Medicine* 334 (1996), 924–925.

Doleac, J. L., "The Effects of DNA Databases on Crime," Batten working paper 2013-001 (2012).

Doleac, J. L., and N. J. Sanders, "Under the Cover of Darkness: Using Daylight Saving Time to Measure How Ambient Light Influences Criminal Behavior," SIEPR discussion paper 12-004 (2012).

Hamermesh, D. S., C. K. Myers, and M. L. Pocock, "Cues for Coordination: Light, Longitude and Letterman," *Journal of Labor Economics* 26 (2008), 223–246.

Heaton, P., "Sunday Liquor Laws and Crime," *Journal of Public Economics* 96:1–2 (2012), 42–52.

Jacob, B. A., and L. Lefgren, "Are Idle Hands the Devil's Workshop? Incapacitation, Concentration, and Juvenile Crime," *American Economic Review* 93 (2003), 1560–1577.

Jacob, B., L. Lefgren, and E. Moretti, "The Dynamics of Criminal Behavior Evidence from Weather Shocks," *Journal of Human Resources* 42 (2007), 489–527.

Janszky, I., and R. Ljung, "Shifts to and from Daylight Saving Time and Incidence of Myocardial Infarction," *New England Journal of Medicine* 359 (2008), 1966–1968.

Kellogg, R., and H. Wolff, "Daylight Time and Energy: Evidence from an Australian Experiment," *Journal of Environmental Economics and Management* 56 (2008), 207–220.

Kilmer, B., N. Nicosia, P. Heaton, and G. Midgette, "Efficacy of Frequent Monitoring with Swift, Certain, and Modest Sanctions for Violations: Insights from South Dakota's 24/7 Sobriety Project," *American Journal of Public Health* 103 (2013), e37–e43.

Koch, W., "Daylight-Saving Extension Draws Heat Over Safety, Cost," *USA Today*, July 22, 2005.

Kotchen, M. J., and L. E. Grant, "Does Daylight Saving Time Save Energy? Evidence from a Natural Experiment in Indiana," this REVIEW 93 (2011), 1172–1185.

Lee, D. S., and J. McCrary, "Crime, Punishment and Myopia," NBER working paper 11491 (2005).

Levitt, S. D., "Understanding Why Crime Fell in the 1990s: Four Factors That Explain the Decline and Six That Do Not," *Journal of Economic Perspectives* 18 (2004), 163–190.

McCollister, K. E., M. T. French, and H. Fang, "The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation," *Drug and Alcohol Dependence* 108 (2010), 98–109.

NPR, "The Reasoning behind Changing Daylight Saving," *All Things Considered*, March 8, 2007.

Prerau, D., *Seize the Daylight* (New York: Thunder's Mouth Press, 2005).
Prescott, J., and J. E. Rockoff, "Do Sex Offender Registration and Notification Laws Affect Criminal Behavior?" *Journal of Law and Economics* 54 (2011), 161–206.
Rasmussen, "34% See Daylight Saving Time as Energy Saver," *Rasmussen Reports*, March 10, 2012.
Schlenker, W., and M. Roberts, "Nonlinear Temperature Effects Indicate Severe Damages to U.S. Crop Yields under Climate Change," *Proceedings of the National Academy of Sciences* 106 (2009), 15594–15598.
Van Koppen, P. J., and R. W. J. Jansen, "The Time to Rob: Variations in Time of Number of Commercial Robberies," *Journal of Research in Crime and Delinquency* 36:1 (1999), 7–29.
Varughese, J., and R. P. Allen, "Fatal Accidents Following Changes in Daylight Savings Time: The American Experience," *Sleep Medicine* 2 (2001), 31–36.
Wolff, H., and M. Makino, "Extending Becker's Time Allocation Theory to Model Continuous Time Blocks: Evidence from Daylight Saving Time," IZA discussion paper 6787 (2012).
Wong, J., "Does School Start Too Early for Student Learning?" mimeograph (2012).

This article has been cited by:

1. Lawrence Jin, Nicolas R. Ziebarth. 2020. Sleep, health, and human capital: Evidence from daylight saving time. *Journal of Economic Behavior & Organization* **170**, 174-192. [Crossref]
2. Peter Kudela, Tomas Havranek, Dominik Herman, Zuzana Irsova. 2020. Does daylight saving time save electricity? Evidence from Slovakia. *Energy Policy* **137**, 111146. [Crossref]
3. Jerome Schafer, John B. Holbein. 2020. When Time Is of the Essence: A Natural Experiment on How Time Constraints Influence Elections. *The Journal of Politics* 000-000. [Crossref]
4. Jesse Burkhardt, Jude Bayham, Ander Wilson, Ellison Carter, Jesse D. Berman, Katelyn O'Dell, Bonne Ford, Emily V. Fischer, Jeffrey R. Pierce. 2019. The effect of pollution on crime: Evidence from data on particulate matter and ozone. *Journal of Environmental Economics and Management* **98**, 102267. [Crossref]
5. Aivo Jasevics, Laila Zemite, Mihails Gorobecs, Solvita Klavina-Makrecka. The Impact of Season-Dictated Daylight Saving Measures on Electricity Consumption 1-6. [Crossref]
6. Gregory DeAngelo, Kaj Gittings, Daniel S. Grossman, Umair Khalil. 2019. URBAN TRANSPORT AND CRIME: EVIDENCE FROM UNANTICIPATED MASS TRANSIT STRIKES. *Economic Inquiry* **57**:3, 1718-1737. [Crossref]
7. Jesse Burkhardt, Jude Bayham, Ander Wilson, Jesse D. Berman, Katelyn O'Dell, Bonne Ford, Emily V. Fischer, Jeffrey R. Pierce. 2019. The relationship between monthly air pollution and violent crime across the United States. *Journal of Environmental Economics and Policy* **101**, 1-18. [Crossref]
8. Osea Giuntella, Fabrizio Mazzonna. 2019. Sunset time and the economic effects of social jetlag: evidence from US time zone borders. *Journal of Health Economics* **65**, 210-226. [Crossref]
9. Carl Kitchens, Matthew Philip Makofske, Le Wang. 2019. "Crime" on the Field. *Southern Economic Journal* **85**:3, 821-864. [Crossref]
10. Jacob Kaplan. 2019. The Effect of Moonlight on Outdoor Nighttime Crime. *SSRN Electronic Journal* . [Crossref]
11. Paulo Arvate, Filipe Ortiz Falsete, Felipe Garcia Ribeiro, André Portela Souza. 2018. Lighting and Homicides: Evaluating the Effect of an Electrification Policy in Rural Brazil on Violent Crime Reduction. *Journal of Quantitative Criminology* **34**:4, 1047-1078. [Crossref]
12. Francis Petterini, Diogo Signor, Pedro Santos. 2018. O limítrofe do horário de verão: análises quase-experimentais do consumo de energia elétrica na Bahia e no Tocantins. *Nova Economia* **28**:3, 943-964. [Crossref]
13. Ignacio Munyo. 2018. Daylight saving time and crime: Does tiredness also affect criminal behavior?. *Journal of Applied Biobehavioral Research* **23**:3, e12115. [Crossref]
14. Ahmed W. A. Hammad, Ali Akbarnezhad. 2018. Sustainable Lighting Layout in Urban Areas: Maximizing Implicit Coverage and Minimizing Installation Cost. *Frontiers in Built Environment* **4**. . [Crossref]
15. Nicholas Rivers. 2018. Does Daylight Savings Time Save Energy? Evidence from Ontario. *Environmental and Resource Economics* **70**:2, 517-543. [Crossref]
16. Benjamin A. Jones. 2018. Spillover health effects of energy efficiency investments: Quasi-experimental evidence from the Los Angeles LED streetlight program. *Journal of Environmental Economics and Management* **88**, 283-299. [Crossref]
17. Rebecca Umbach, Adrian Raine, Greg Ridgeway. 2017. Aggression and sleep: a daylight saving time natural experiment on the effect of mild sleep loss and gain on assaults. *Journal of Experimental Criminology* **13**:4, 439-453. [Crossref]
18. Jeremy Grant Moulton. 2017. The Great Depression of Income: Historical Estimates of the Longer-Run Impact of Entering the Labor Market during a Recession. *The B.E. Journal of Economic Analysis & Policy* **17**:4. . [Crossref]
19. Osea Giuntella, Wei Han, Fabrizio Mazzonna. 2017. Circadian Rhythms, Sleep, and Cognitive Skills: Evidence From an Unsleeping Giant. *Demography* **54**:5, 1715-1742. [Crossref]
20. Jennifer L. Doleac. 2017. The Effects of DNA Databases on Crime. *American Economic Journal: Applied Economics* **9**:1, 165-201. [Crossref]
21. Patricio Dommnguez, Kenzo Asahi. 2017. Crime Time: How Ambient Light Affect Criminal Activity. *SSRN Electronic Journal* . [Crossref]
22. John Paul Wilson, Michael J. Bernstein, Kurt Hugenberg. A Synthetic Perspective on the Own-Race Bias in Eyewitness Identification 241-270. [Crossref]
23. Weily Toro, Robson Tigre, Breno Sampaio. 2015. Daylight Saving Time and incidence of myocardial infarction: Evidence from a regression discontinuity design. *Economics Letters* **136**, 1-4. [Crossref]
24. Jennifer L. Doleac. 2015. The Effects of DNA Databases on Crime. *SSRN Electronic Journal* . [Crossref]
25. Weily Toro, Robson Tigre, Breno Sampaio. 2015. Daylight Saving Time and Incidence of Myocardial Infarction: Evidence from a Regression Discontinuity Design. *SSRN Electronic Journal* . [Crossref]

SenatorReady_info_SB0517
Uploaded by: Senator Ready, Senator Ready
Position: FAV

43 Wake Forest L. Rev. 45

Wake Forest Law Review
Spring 2008

Articles

Steve P. Calandrillo [a1] Dustin E. Buehler [aa1]

TIME WELL SPENT: AN ECONOMIC ANALYSIS OF DAYLIGHT SAVING TIME LEGISLATION

Several nations implemented daylight saving time legislation in the last century, including the United States. The United States briefly experimented with year-round daylight saving time twice--during World War II and the energy crises in the 1970s. Agency studies and congressional hearings from the 1970s show several benefits of year-round daylight saving time, along with potential disadvantages. These studies are dated, and much has changed in the last thirty years. While congressional efforts to extend daylight saving time in 2007 have again focused on the energy savings this legislation would produce, far more meaningful benefits have been largely ignored. This Article collects and analyzes modern research on daylight saving time, concluding that year-round daylight saving time would save hundreds of lives annually by decreasing motor vehicle and pedestrian fatalities. Furthermore, extra light in the evening hours reduces criminal activity and results in energy savings from decreased peak electricity demand. Finally, year-round daylight saving time would eliminate the negative effects caused by the current spring and fall time changes. These advantages significantly outweigh the potential costs of daylight saving during winter months. The time has come for Congress to enact year-round ***46** daylight saving time legislation--each year we wait costs hundreds of American lives and millions of dollars.

TABLE OF CONTENTS

***47 The very best way to lengthen the day**

Is to steal a few hours from the night.

Sir Henry Norman [1]

Introduction

Americans do not like it when Congress messes with their clocks. [2] Early Sunday morning, March 11, 2007, the United States shifted its clocks forward an hour to daylight saving time, three weeks earlier than usual. [3] Many individuals immediately cried foul. One Texan panned the change because she would "spend the next three weeks feeling late, rushed and sleepy." [4] A Chicago CEO lamented a critical mass of "sleepy workers, computer glitches and March Madness," and said "it will be a miracle if any actual work gets done." [5] In Indiana, a candidate jumped into a gubernatorial race in which Democrats had accused incumbent Governor Mitch Daniels of being "out of sync with Hoosiers" [6] because he forced the state to finally observe daylight saving time. [7]

The rant against daylight saving time was not unanimous, however, and many Americans voiced support. "Moving up daylight-saving time has the effect of moving up spring," claimed one New Yorker. [8] Others expressed gratitude for "extra hours of evening light" [9] and more "quality family time in the evening." [10] One ***48** individual even suggested that Congress should extend daylight saving time year round, since problems associated with the time shift "have everything to do with the biannual change and nothing at all to do with the relative timing of darkness and daylight." [11]

When Congress recently extended daylight saving time by three weeks in the spring and one week in the fall, [12] it once again waded into one of the world's great controversies. [13] For hundreds of years, the idea of shifting clocks has been praised and ridiculed, advocated and demonized. Even public leaders have weighed in on the debate. Benjamin Franklin lampooned the idea of daylight saving time. [14] Winston Churchill fought for it on the floor of Parliament. [15] Mahatma Gandhi refused to observe it. [16] And Richard Nixon advocated year-round daylight saving time in an address to the nation. [17]

Over the last hundred years, Congress held numerous hearings, collected reports, and received testimony attesting to the benefits and drawbacks of shifting clocks. [18] However, there are two significant problems in the existing literature on daylight saving time. First, many of the key studies and reports on the effects of extended and year-round daylight saving time are outdated. [19] As a ***49** result, policymakers are placed in the untenable position of making decisions based on research produced decades ago. Second, debates on daylight saving time in Congress and other public forums have been dominated far too frequently by catch phrases, questionable assumptions, and anecdotal evidence. [20] Now more than ever, the debate needs a new analysis of the advantages and disadvantages of daylight saving time--especially given that Congress recently asked Americans to "spring

forward" three weeks early. In other words, one of the most controversial and long-standing debates of the twentieth century needs to be recast and reanalyzed with twenty-first century evidence.

This Article provides the bridge for that gap. Part I examines the history of daylight saving time, from its origins as satirical fodder to the debates of the present day. This history shows that the United States has had an inconsistent (and not always rational) experience with daylight saving time. The nation oscillated between periods of uniform time observance and local time observance.[21] It has twice experimented with year-round daylight saving time.[22] If nothing else, the current summer observance of daylight saving time in the United States constitutes a middle point between the extremes of the past.

Part II of this Article examines empirical results, focusing in particular on studies and research from the United States' 1974 experiment with year-round daylight saving time during the energy crises. Agency studies and congressional hearings from the 1970s highlight several advantages and disadvantages of extended daylight saving. This portion of the Article also stresses that these dated studies should inform our analysis of the issue, but they should not dictate our conclusions--much has changed in the last thirty years.

Finally, Part III examines current studies and research using cost-benefit analysis and argues that Congress should implement year-round daylight saving time. Studies show that year-round daylight saving time has several significant advantages, including a decrease in motor vehicle and pedestrian fatalities, energy savings ***50** from reduced peak electricity demands, and a potential decrease in crime.[23] Additionally, year-round daylight saving time avoids negative effects caused by the current spring and fall time changes. Finally, year-round daylight saving time does not endanger school children, and its benefits outweigh other notable disadvantages. Thus, on balance, the benefits of extending daylight saving time dramatically outweigh its costs, and Congress should step up to adopt year-round daylight saving time legislation before hundreds of additional lives are sacrificed by those who seek nothing better than the status quo.

I. History of Daylight Saving Time

Without a doubt, daylight saving time is "one of the most persistent political controversies of the last century."[24] Benjamin Franklin's satirical wit and William Willett's tireless advocacy birthed the concept of shifting clocks.[25] Several nations, including the United States, first implemented summer daylight saving time during World War I.[26] The United States also experimented with year-round daylight saving time during World War II and the oil embargos of the 1970s.[27] Ultimately, the country settled into uniform summer observance of daylight saving time,[28] and most recently extended the period of observance in 2007.[29]

A. Springing Forward from Satire and Horseback Rides: Benjamin Franklin and William Willett Introduce Daylight Saving Time

Like many great ideas, daylight saving time started as satirical fodder. On April 26, 1784, the Journal de Paris published a whimsical letter titled An Economical Project, signed by a "Subscriber" later unmasked as Benjamin Franklin.[30] Franklin, a ***51** man known for staying up all night to play chess,[31] went to bed one night in Paris several hours after midnight.[32] According to Franklin, an "accidental sudden noise" woke him at 6:00 the next morning, and he was surprised to find his room "filled with light" because his servant had neglected to close the shutters the night before.[33] To confirm this shocking discovery, he "repeated this observation the three following mornings."[34] Tongue in cheek,[35] Franklin wrote to the Journal, "[y]our readers, who with me have never seen any signs of sunshine before noon . . . will be as much astonished as I was, when they hear of his rising so early; and especially when I assure them, that he gives light as soon as he rises."[36]

From his observations, Franklin concluded that shifting sleeping patterns to coincide with sunlight would save money on candles.[37] He calculated the amount he would save on candles by waking up (and going to bed) six hours earlier, and then multiplied these savings by the estimated number of families in Paris.[38] Franklin's tedious calculations indicated that Paris residents would save more than ninety-six million livres tournois each year simply by adjusting their schedules to rise with the sun[39] --a sum equivalent to approximately $200 million today.[40]

***52** Given the "immense sum" that Paris could save, Franklin whimsically proposed a series of government regulations to force residents to rise with the sun, including (1) "a tax . . . on every window that is provided with shutters to keep out the light of the sun"; (2) "guards . . . placed in the shops of the wax and tallow chandlers" so no family could purchase more than one pound of candles each week; (3) guards "posted to stop all the coaches [on] the streets after sun-set, except those of physicians, surgeons, and midwives"; and (4) the ringing of all church bells at sunrise, and "if that is not sufficient, let cannon be fired in every street, to wake the sluggards effectually, and make them open their eyes to see their true interest."[41]

The Journal published Franklin's satirical proposal, but another century passed before others seriously considered the idea of shifting clocks to save daylight. On a summer morning in 1905, wealthy architect and businessman William Willett awoke early in the village of Chislehurst, England, for his usual horseback ride before breakfast.[42] He noticed that "practically no one was up except an occasional labourer going to work, postmen, milkmen, and sweeps."[43] Also mindful that his afternoon golf games frequently ended abruptly due to the onset of darkness, Willett came up with the idea of shifting Britain's clocks forward.[44]

Two years later, Willett authored and distributed The Waste of Daylight, in which he advocated shifting clocks eighty minutes forward during summer months.[45] Willett proposed that "at 2 a.m. on each of four Sunday mornings in April, standard time shall advance 20 minutes; and on each of four Sundays in September, shall recede 20 minutes."[46] Willett argued that the extra daylight during summer evenings "makes for health and strength of body and mind" because "[t]he brief period of daylight now at our disposal is frequently insufficient for most forms of outdoor recreation."[47] Echoing the arguments of Benjamin Franklin's Economical Project,[48] Willett noted that everyone, "rich and poor alike, will find their ordinary expenditure on electric light, gas, oil and candles considerably reduced for nearly six months in every year."[49] The ***53** idea of shifting daylight was born.

B. Ridicule, Adoption, and Retreat: The Onset of World War I Prompts Temporary Adoption of Daylight Saving Time

Ideas are fickle, and daylight saving time is no exception. The concept went from national joke to the law of the land in less than a decade. British society initially responded to Willett's proposal "with ridicule and derision."[50] In 1908, a "Daylight Saving Bill" was introduced on the floor of the House of Commons "amid laughter and ironical cheers."[51] Most criticism of the legislation centered on Willett's proposal for shifting time gradually over four weeks each spring and fall.[52] In light of this criticism, a parliamentary committee recommended simplifying Willett's original proposal so that clocks would be "put forward an hour on the third Sunday in April, and put back an hour on the third Sunday in September."[53] Although the daylight saving bill received substantial support[54] and raised several debates in Parliament,[55] the legislation failed to ***54** pass.[56]

Despite these early setbacks, the implementation of "summer time" in Germany during World War I rejuvenated the daylight saving movement in Britain.[57] Immediately after Germany implemented summer daylight saving time on April 30, 1916, the Frankfurter Zeitung boldly stated that "it is characteristic of England that she could not rouse herself to a decision."[58] Roused into action, Sir Henry Norman moved for the adoption of daylight saving time on the floor of the House of Commons, with the backing of the government[59] and most of Britain's Chambers of Commerce.[60] Support for daylight saving time had shifted drastically, and the resolution passed with only two members of the House of Commons opposed.[61]

Britain's experiment with daylight saving time was an instant success. Immediately after the switch to "summer time," the London Times reported that "a week of perfect evenings has proved so emphatically the charm of an added hour of daylight . . . and in succeeding years the coming of Summer Time will be looked forward to with as much eagerness as the coming of the summer season." [62] Workers expressed "hope that daylight saving will be put into operation every year." [63] When Britain ended "summer time" on October 1, 1916 by moving the hands of three million clocks back an hour, observers considered the experiment a "success," [64] and they noted that "even the farmers, who at first objected to it, [have] become reconciled to the innovation." [65]

The United States soon followed Britain's lead. Many prominent organizations and individuals lined up behind daylight saving time, ***55** including President Woodrow Wilson, [66] the American Railway Association, [67] the National Chamber of Commerce, [68] and the president of baseball's National League. [69] Advocates of summer daylight saving time in the United States argued that it would save oil, gas, and electrical power; increase manufacturing production; stimulate outdoor recreation; and improve military training conditions. [70] Proponents claimed that daylight saving legislation would conserve more than 1,500,000 tons of coal each year [71] and millions of dollars in fuel costs. [72]

Congress found these arguments persuasive. In March 1918, an overwhelming majority of both the House and Senate passed legislation establishing seven months of daylight saving time, extending from the last Sunday in March until the last Sunday in October. [73] President Wilson signed the bill into law, [74] and the United States began observing daylight saving time early Sunday morning, March 31, 1918. [75] The nation's initial response to daylight saving time was favorable, with praise for savings in electricity, gas, and coal, and another hour of trading time between the New York and London stock exchanges. [76]

***56** Early enthusiasm did not sustain daylight saving time, and the United States' experiment with advanced clocks did not outlast the war. Although several national leaders and organizations urged retention of daylight saving time, [77] agricultural interests successfully lobbied Congress for repeal of the law. [78] In June 1919, Congress passed a rider as part of the annual agricultural appropriation bill that repealed daylight saving time when clocks shifted back in October. [79] President Wilson vetoed the appropriations bill, objecting specifically to the repeal of daylight saving time. [80] Although Congress failed to override the President's veto of the appropriations bill, [81] it quickly passed a stand-alone bill repealing daylight saving time. [82] The President once again vetoed the legislation, [83] but this time Congress overrode his veto. [84] The United States' war-time experiment with daylight saving time ended less than two years after its implementation.

C. Local Standards Yield to "War Time": The United States Implements Year-Round Daylight Saving Time During World War II

Congress's repeal of national daylight saving time following World War I did not keep Americans from advancing their clocks during summer months. The debate shifted to local communities, [85] ***57** and several states and municipalities immediately enacted daylight saving time. [86] When the New York Stock Exchange decided it too would observe daylight saving during summer months, [87] stock exchanges in Baltimore, Boston, Chicago, Detroit, Philadelphia, and Pittsburgh quickly followed suit. [88] Several railroads "capitulated to the demands of their commuters" and published revised daylight saving time schedules. [89] By 1925, Americans observed daylight saving throughout Rhode Island and Massachusetts, and in 280 cities in twelve other states. [90] Six years later, the number of cities observing daylight saving time grew to 483. [91] As a result, daylight saving time observance became "an almost unsolvable puzzle." [92]

Once again, it took a war to provoke national observance of daylight saving time in the United States. After the start of World War II, several countries implemented daylight saving time to assist their war effort. [93] Organizations started lobbying Congress for daylight saving time as a means of furthering national defense interests. [94] In July 1941, President Franklin Roosevelt sent a ***58** message to Congress in support of daylight saving time. [95] He argued that the nation faced a serious power shortage [96] and that daylight saving time would contribute meaningfully to the national defense effort. [97] Citing statistics provided by the Federal Power Commission, Roosevelt claimed that year-round daylight saving time would reduce annual electricity consumption by more than 736 million kilowatt-hours. [98] Noting that "it is also important that such a program have sufficient flexibility to meet varying regional conditions," [99] the President asked Congress to empower him to alter regional time standards through executive orders. [100]

Congress did not act immediately, [101] perhaps reflecting national polls showing only thirty-eight percent of Americans in favor of year-round daylight saving time in June 1941. [102] However, public sentiment shifted following the United States' entry into World War II. [103] In January 1942, a Gallup poll showed that fifty-seven percent of Americans supported year-round daylight saving time. [104] Although members of Congress from rural districts objected to daylight saving time, [105] the House and Senate passed legislation advancing the nation's clocks by one hour. [106] The act specified that ***59** daylight saving time would expire six months after the end of the war. [107] President Roosevelt signed the legislation, and the nation converted to year-round daylight saving time on February 9, 1942. [108] The new year-round daylight saving scheme became known as "War Time." [109]

Despite studies showing that War Time conserved energy, [110] the end of the war brought renewed calls for an end to daylight saving time. [111] Opponents of War Time argued that it had deprived Americans of millions of hours of sleep, subjected school children to morning darkness, forced farm workers to wait an extra hour for dew to evaporate from fields, increased factory worker absenteeism, and even contributed to increased juvenile delinquency. [112] Both the House and Senate unanimously passed legislation ending War Time, [113] and the United States turned back its clocks to standard time on September 30, 1945. [114]

D. Congress Enacts the Uniform Time Act After Failed Experiments with Local Observance of Daylight Saving Time

After congressional repeal of War Time in September 1945, the drive for daylight saving time once again shifted to states and municipalities. [115] By 1965, local action had produced a "clock ***60** scramble chaotic enough to confound Father Time, himself." [116] During the 1950s, "Iowa had 24 systems for starting and ending daylight time." [117] In Minnesota, St. Paul observed daylight saving time while neighboring Minneapolis did not. [118] During the summer of 1965, St. Paul police officers wore two watches because the police and fire departments used separate measures of time. [119] Travelers on the thirty-five minute bus ride from Steubenville, Ohio, to Moundsville, West Virginia had to change their watches seven times. [120] "One airline reported 4,000 calls a day from customers asking what time it would be in their destination cities." [121] A time scientist at the U.S. Naval Observatory dubbed the United States "the worst timekeeper in the world." [122]

In response to this widespread confusion, Congress once again considered daylight saving time. [123] Legislation introduced in the House mandated uniform national observance of daylight saving time during summer months, unless entire states opted to remain on standard time. [124] Most importantly, the bill prohibited cities and localities from enacting separate local time standards. [125] After years of confusion, the discussion on daylight saving time had a different tone. Farmers supported efforts to impose time uniformity, [126] and ***61** "[n]o one argued that time should be keyed to the cows' milking schedule." [127] Instead, opponents criticized daylight saving as "the golfer's delight," and argued that it would endanger young children by forcing them

to walk to school in the dark. [128] Despite this criticism, the bill easily passed in the House. [129] Days later, the Senate passed the legislation, [130] and President Lyndon Johnson signed the bill into law. [131]

The new Uniform Time Act of 1966 [132] required all states to uniformly advance clocks by one hour from the last Sunday of April until the last Sunday in October. [133] The Act superseded all local daylight saving laws and ordinances, [134] and a state could exempt itself from observing daylight saving time only if the entire state remained on standard time. [135] Observance of daylight saving time remained optional for 1966, but the Act mandated the start of national daylight saving time in April 1967. [136]

On April 30, 1967, national daylight saving time went into effect. [137] Clocks shifted forward an hour in all but a few states. [138] In 1968, only Hawaii and Arizona chose to remain on standard time ***62** during summer months. [139] After oscillating on exemption, Michigan decided to shun daylight saving time, starting in 1969. [140] In the early 1970s, Indiana took advantage of an amendment to the Uniform Time Act, allowing states straddling time zones to exempt portions of the state from observing daylight saving time. [141] Other than these few exceptions, the United States uniformly advanced its clocks one hour during summer months.

E. Oil Embargos and Energy Crises: The United States Returns to Year-Round Daylight Saving Time

In 1973, the United States encountered a "prolonged peace-time energy shortage," caused by an oil embargo by the Organization of Petroleum Exporting Countries ("OPEC"). [142] The energy crisis prompted efforts to extend daylight saving time to winter months as an energy conservation measure. [143] Senators Claiborne Pell and John O. Pastore introduced a bill requiring year-round daylight saving time, arguing that the legislation would "reduce crime, cut traffic accidents and lessen demands on electric power." [144] State legislatures began considering implementation of year-round daylight saving time. [145] An editorial in the New York Times cited a study by Consolidated Edison showing that year-round daylight saving time would reduce peak-hour loads by five percent, and concluded that "nationwide reduction in fuel consumption would evidently be significant." [146]

***63** On November 7, 1973, President Richard Nixon addressed the nation and advocated a series of policies to address the energy crisis. [147] President Nixon claimed that the winter supply of petroleum could fall short of anticipated demands by as much as seventeen percent and bluntly stated that the United States was "heading toward the most acute shortages of energy since World War II." [148] The President asked Congress to develop an emergency energy act, with a provision for "immediate return to daylight saving time on a year-round basis." [149]

Congress acted quickly. The Senate Commerce Committee immediately held hearings on legislation establishing year-round daylight saving time. [150] Year-round daylight saving legislation passed overwhelmingly in both the House and Senate. [151] Advocates claimed that the bill would save the equivalent of three percent of the nation's energy shortage. [152] Opponents of year-round daylight saving time called the legislation nothing more than "gimmickry" that would do little to save energy and would force children to wait in darkness for early morning school buses. [153] However, the urgent atmosphere of the national energy crisis reframed the debate over daylight saving, and the legislation "whisked through both houses by voice vote with little debate." [154] On December 15, 1973, President Nixon signed the year-round daylight saving bill into law, claiming that it would reduce fuel consumption by the equivalent of 150,000 barrels of oil each day during winter months. [155]

The new law provided for daylight saving time on a year-round ***64** basis for a trial period, starting in January 1974 and expiring in April 1975. [156] The act also required the Secretary of Transportation to study the effects of year-round daylight

saving time on "the use of energy in the United States, traffic safety, including the safety of children traveling to and from school, and the effect on school hours," and submit a report to Congress. [157]

The nation's experiment with daylight saving time started on January 6, 1974. [158] The jolt to daylight saving time in the middle of winter caught many off guard, and the New York Times reported that "[c]ommuter trains from New Jersey were delayed, many school children missed their free breakfasts, some workers walked to subways and buses with trepidation, and many people felt strange yesterday as the day began an hour earlier for most in an eerie darkness." [159] However, preliminary statistics showed a reduction in nationwide consumption of electricity. [160] The Senate Commerce Committee later estimated that daylight saving time saved approximately 100,300 barrels of oil daily from January through April 1974. [161]

Advocates for a return to standard time focused in particular on the danger to school children caused by another hour of morning darkness. [162] In January 1974, accidents in Florida killed eight school-age children, a noticeable increase from the two children that had been killed during the same period the year before. [163]

Responding to national concerns about winter daylight saving, ***65** Congress passed legislation returning the nation to standard time from late October until late February. [164] Lamenting this retreat, a New York Times editorial emphasized the benefits of daylight saving during winter months, particularly "the reduction in auto accidents yielded by an additional hour of daylight for weary home-bound motorists in the evening traffic rush" and an estimated five percent reduction in peak-hour electricity loads. [165] Although it noted that parents of school children are "understandably concerned" by morning darkness, the New York Times reasoned that "for those very few weeks the schools could surely move their schedules up an hour." [166]

Upon expiration of the Emergency Daylight Saving Time Energy Conservation Act on April 27, 1975, the Uniform Time Act of 1966 once again went into effect. [167] After experimenting briefly with year-round daylight saving time, the United States returned to its observance of daylight saving from the last Sunday in April to the last Sunday of October. [168]

F. 2007 Extension of Daylight Saving: Congress Extends Daylight Saving Time Observance in the United States

Although members of Congress from rural areas blocked ***66** attempts to extend daylight saving time in the early 1980s, [169] Congress subsequently extended daylight saving observation twice. In 1986, Congress passed legislation moving the start of daylight saving time from the last Sunday of April to the first Sunday of April. [170] The Department of Transportation estimated that another month of daylight saving time would save $28 million in costs associated with traffic accidents and would prevent more than 1500 injuries and twenty deaths. [171]

Most recently, Congress also extended daylight saving time by four weeks as part of the Energy Policy Act of 2005, the provisions of which took effect in the spring of 2007. [172] Under the act, Americans advance clocks on the second Sunday of March rather than the first Sunday of April, and the nation falls back on the first Sunday of November, rather than the last Sunday in October. [173] Supporters claim that small energy savings will add up over the years. [174] For example, the American Council for an Energy-Efficient Economy estimates that expanded daylight saving time will save $4.4 billion and will reduce carbon emissions by 10.8 million metric tons by 2020. [175] Unlike prior years, opposition from agricultural interests was not a major factor in the debate. [176] Instead, the airline industry, schools, and religious groups unsuccessfully opposed the extension of daylight saving time. [177]

***67** In sum, daylight saving time history is long and convoluted. The United States and other nations first experimented with the idea of daylight saving time during World War I. Although Congress repealed the act at the end of the war, local observance

by states and municipalities kept daylight saving time alive. The United States experimented with year-round daylight saving time twice, during World War II and the oil embargos of the 1970s. Unfortunately, the nation's experiments with year-round daylight saving time did not last, largely due to concern that school children were at risk during early morning hours. Congress has more recently extended summer daylight saving twice, but has not revisited the idea of year-round daylight saving time.

II. Empirical Results from Year-Round Daylight Saving Time in the United States

In evaluating whether Congress should restore year-round daylight saving time, it is crucial to weigh the costs and benefits of such a plan. Fortunately, year-round daylight saving time is not a new concept, and the issue has been studied carefully--especially during the United States' brief experiment with year-round daylight saving time in 1974. First, agency studies from the 1970s show substantial benefits of extended daylight saving. [178] On the other hand, several congressional hearings have discerned potential drawbacks of winter daylight saving time. [179] Finally, experts emphasize that these studies should inform our modern analysis of the issue but should not dictate our conclusion--after all, much has changed in the last thirty years. [180]

A. Studies Demonstrated the Benefits of Year-Round Daylight Saving Time Following the 1974 Experiment in the United States

As Congress debated various daylight saving proposals over the last century, agencies and other researchers produced several studies highlighting the benefits from daylight saving time. Most notably, researchers found that year-round daylight saving time decreased fatal motor vehicle and pedestrian accidents, saved energy, and reduced crime.

First and most importantly, studies of the 1974 year-round daylight saving time experiment showed a decrease in motor vehicle ***68** and pedestrian fatalities. [181] The Department of Transportation ("DOT") studied the effect of winter daylight saving time on fatal accidents. It compared March and April 1974 (when daylight saving time was in effect) with March and April 1973 (when no daylight saving time was in effect). Adjusting for other effects, including seasonal trends and a reduced speed limit, the DOT demonstrated that daylight saving time reduced traffic fatalities by 0.7%. [182] At the time, Department analysts also believed that "further study may reveal that daylight saving time actually reduces fatalities on the order of 1.5 to 2 percent." [183] While 1 to 2% may not sound like much at first blush, that translates into hundreds of American lives annually. [184]

Second, studies from the mid-1970s show that year-round daylight saving time saves energy. Prior to the year-round daylight saving time experiment in 1974, the American Public Power Association ("APPA") conducted an informal survey of several of its member utilities and estimated that year-round daylight saving time would reduce energy demands by approximately one to two percent, measured in kilowatt-hour sales. [185] The DOT examined Federal Power Commission data for the four daylight saving time transitions during the 1974 year-round daylight saving time experiment [186] and affirmed the APPA's estimates. [187] The DOT concluded that extended daylight saving time likely reduces electricity consumption by one percent in March and April, representing approximately 100,000 barrels of oil per day during those two months. [188] The report found minimal savings in home ***69** heating fuel consumption, and no measurable effect on gasoline use. [189] Based on the DOT's findings, APPA estimated that a one percent energy saving would have reduced system demands by two billion kilowatt-hours in 1973, which at the time was the equivalent of saving 3.8 million barrels of oil each year. [190]

However, there is some disagreement as to whether this decrease in energy consumption is attributable to daylight saving time. Because the data sample for the DOT study was limited, the DOT deemed its energy savings findings "probable" rather than conclusive. [191] The National Bureau of Standards ("NBS") later examined the same data from the DOT study and concluded that there was "no conclusive evidence for decreased production of electrical energy during Daylight Saving Time." [192] However, DOT officials disagreed with the NBS evaluation, and reiterated their conclusion that "[t]he magnitude of the DST saving is

about 1 percent." [193] Ultimately, even if one study from the mid-1970s is not "conclusive," all available studies do show that there are potential energy savings from year-round daylight saving time.

Third, an often ignored benefit of daylight is the salutary effect it has on stopping criminals in their tracks. In theory (and in practice), the percentage of violent crimes committed outdoors is higher during dark evening hours than during morning hours, and shifting an hour of sunlight from morning to evening decreases exposure of individuals to violent outdoor crime. [194] Indeed, limited statistics from the 1970s show that year-round daylight saving time ***70** reduces crime. [195] Hence, after the nation's experiment with year-round daylight saving time during the Nixon Administration, daylight saving advocates argued that shifting an hour of light from morning to evening reduced overall crime rates and should therefore be continued. [196]

The sole empirical study from the 1970s supports the concept that year-round daylight saving time can reduce crime. The Law Enforcement Assistance Administration ("LEAA") of the Department of Justice conducted a limited study during the 1974 year-round daylight saving time experiment, examining the effect of daylight saving on crime in Washington, D.C. and Los Angeles. [197] The results showed a ten to thirteen percent reduction in violent crime for daylight saving time periods in Washington, D.C., but were inconclusive as to the effect in Los Angeles. [198] DOT officials cautioned that the study should not be viewed as conclusive evidence that daylight saving time reduced crime, especially given both the limited time and limited sample area. [199]

Finally, advocates have claimed that year-round daylight saving time incurs additional advantages--from additional sunlight for after-work shopping, [200] to the economic benefit from cities in the eastern United States sharing three hours overlap in the working ***71** day with western European cities (rather than two hours under standard time). [201] Proponents argued that year-round daylight saving time would serve as an effective method for boosting retail sales and recreation [202] and that it would end the confusion associated with changing clocks twice a year (a practice that Congressman Craig Hosmer labeled the "Mickey Mouse Factor"). [203] Thus, studies and analysis from the 1970s demonstrate that the United States' experiment with year-round daylight saving time in 1974 produced several notable benefits.

B. Congressional Hearings Have Identified Potential Disadvantages of Year-Round Daylight Saving Time

Despite several benefits of extended daylight saving, opponents persuaded Congress to abandon year-round daylight saving time. Congressional hearings on the matter identified a number of disadvantages, including fatal accidents involving school-age children, opposition among farmers, and sign-on time problems for AM radio stations.

First, school officials and parents argued forcefully that morning darkness jeopardized the lives of school-age children commuting to school. [204] They pointed to a noticeable increase in deaths of school children in Florida during the early months of the 1974 winter daylight saving time experiment. [205] In addition to concerns arising out of the deaths in Florida, Britain's experiment with year-round daylight saving time indicated that "the accident rate for children going to school in the morning in the dark increased despite the fact that many more parents took their children to school"--leading to "a slight increase in road casualties among children." [206]

Second, year-round daylight saving time presents problems for ***72** farmers and the agricultural sector. A representative of the Kentucky Farm Bureau Federation testified before the Senate Committee on Commerce in 1975 that in winter months it is often 10:00 in the morning before farmers can work in a hay field, due to dew on the crops during dark morning hours. [207] Additionally, many farm workers commute from populated towns and urban centers and desire working hours that are similar to those of urban employees. [208] Farm employers dislike winter daylight saving time because the additional hour of morning darkness forces farm employees to "sit around and kill time" while waiting for morning dew to evaporate. [209]

Third, extended daylight saving time in the 1970s was problematic for radio broadcast stations. The physical characteristics of the broadcast spectrum allow much greater range for radio broadcast during darkness than during daylight.[210] Recognizing this limitation, the Federal Communications Commission ("FCC") licenses some stations as full-time stations, and others only as daytime stations.[211] When daylight saving time pushes back the time of sunrise, it delays the time when daytime stations can sign on for broadcast, and some daytime radio stations lose a portion of their audience.[212] Although part of this audience loss from dark morning hours is offset by an evening commute during daylight, the FCC reported that radio stations suffered a net loss in audience and revenue during the 1974 daylight saving time experiment.[213] Daytime AM radio stations experienced a 2.5% decrease in their audience during the winter months of 1974.[214] ***73** With a one-hour delay in sunrise during the winter, many stations could not come on the air "until after the businessman has already driven to work, until after the farmer has already completed his chores around the house," allowing lucrative advertising time to slip away.[215] The tendency of morning radio listeners to prefer television during the evening exacerbated the problem.[216]

Thus, the United States' experiment with year-round daylight saving time in 1974 highlighted several negative effects of daylight saving during winter months and framed the tradeoffs of year-round daylight saving time.

C. Studies from the 1974 Year-Round Daylight Saving Time Experiment Are Informative, but Not Conclusive

As policymakers evaluate proposals to extend daylight saving time, they certainly should consider the previously mentioned results from the United States' experiment with year-round daylight saving time in the 1970s. Even so, a sound policy choice on this issue cannot be based on those studies alone. The Department of Transportation itself has admitted that the relevant studies are dated and analyzed only a limited set of data.[217] Patterns of energy use in the United States have changed considerably since the mid-1970s.[218] Officials caution that the LEAA crime study should not be viewed as conclusive evidence that daylight saving time reduced crime, especially given both the limited time and limited sample area.[219]

In sum, for those advocating a return to year-round daylight saving time, dated studies on the effect of the 1974 experiment are informative but not conclusive. This Article attempts to bridge the gap by collecting and analyzing modern research and studies. The following analysis shows that the benefits of year-round daylight saving time outweigh its costs.

*74 III. Congress Should Enact Year-Round Daylight Saving Time Legislation

Congress should enact legislation to return the United States to year-round daylight saving time. Although the previously mentioned studies on daylight saving time are dated, new studies and analysis continue to show that year-round daylight saving time would be advantageous for the United States. Daylight saving time involves tradeoffs, and in evaluating these tradeoffs, we should use a cost-benefit analysis. Extension of daylight saving to winter months undoubtedly will produce some adverse effects from additional darkness during morning hours. However, the benefits resulting from another hour of light during late afternoon and early evening (when far more people are awake and can benefit from daylight) will outweigh these costs. Ultimately, although we all would prefer a daylight saving policy that accrues benefits without costs, there are only so many hours of sunlight in a given day. The question before us, then, is how to make the best possible use of the hours we have.

Year-round daylight saving time would be advantageous to the current piecemeal system for several reasons. First, it would save lives by reducing overall fatalities among pedestrians and motor vehicle occupants.[220] Second, extending daylight saving to winter months will likely save energy by reducing peak electricity demand.[221] Third, year-round daylight saving time likely will reduce some types of criminal activity by providing another hour of afternoon light.[222] Fourth, year-round daylight saving time will eliminate negative effects caused by the current spring and fall time changes.[223] Finally, contrary to conventional

wisdom, the evidence shows that winter daylight saving time does not endanger school children [224] and does not irreparably harm farmers and radio stations. [225] Thus, on balance, the benefits of extending daylight saving time outweigh its costs. [226]

***75 A. Year-Round Daylight Saving Time Saves Lives by Reducing Pedestrian and Motor Vehicle Fatalities**

It is somewhat disappointing that the majority of congressional debate in 2005 centered on the ability of daylight saving time to reduce oil consumption when Congress had a far more noble argument it could have made: hundreds of lives per year are currently being sacrificed by critics of daylight saving. Year-round daylight saving time would result in a significant net decrease in fatal accidents involving pedestrians and motor vehicle occupants. Darkness increases the risk of fatal accidents and is most problematic during the irregular evening commute. [227] Several studies show that winter daylight saving time would decrease accidents in the evening while increasing accidents in the morning. [228] Because individuals are more accident prone during the evening rush hour (and more individuals are on the road during evening than morning), hundreds of American lives would be saved on balance. [229]

First, "darkness increases the risk of motor vehicle crashes" that are fatal to pedestrians and motorists. [230] A study by researchers at the University of Michigan Transportation Research Institute examined eleven years of national crash data across the United States. It found that "fatal pedestrian crashes are three to four times more likely in darkness than they are during the daytime," and fatal motorist crashes are "marginally more likely in darkness." [231] Another study sponsored by the Insurance Institute ***76** for Highway Safety analyzed five years of crash data in the contiguous United States and found a similar effect, estimating that a change from daylight to twilight causes a 300% increase in fatal pedestrian crashes. [232] The negative effect of darkness in the United States is confirmed by the experience of other countries. For example, a three-year study in Britain found that accidents are about 50% more likely in darkness, and that fatal and serious accidents are about 100% more likely. [233]

Second, it would be better to allocate daylight in the evening because fatal accidents are more likely to occur during afternoon and evening hours than during morning hours. [234] A variety of factors lead to more accidents during the afternoon and evening:

> The morning rush hour is shorter than the afternoon rush hour. Children and traffic follow a highly regimented routine in the morning and drivers are rested. Contrast that with the afternoon. Many children are riding bicycles and enjoying unsupervised outdoor play. More drivers will have alcohol in their bloodstream, the rush hour is long and more irregular in the afternoon, and drivers are tired and in a hurry to get home. [235]

In the United States, there are more than twice as many fatal accidents during evening hours than during morning hours. [236] In Britain, there are 50% more fatal and serious road accident injuries among adults during the hours between 4:00 p.m. and 7:00 p.m. than the period between 7:00 a.m. and 10:00 a.m. [237]

Extending daylight saving time to winter months would save hundreds of lives by shifting an hour of daylight from morning to evening. [238] A recent study by researchers at Rutgers University [239] ***77** demonstrates that year-round daylight saving time would save hundreds of lives. The researchers examined Fatality Analysis Reporting System data for every county in the United States for both 1998 and 1999. [240] They concluded that year-round daylight saving time would cause a one-third reduction in evening pedestrian fatalities and a one-third increase in morning fatalities. [241] Because pedestrian activity is greater in the evening than morning, year-round daylight saving time would have reduced pedestrian fatalities by 343 lives during 1998 and 1999, a net decrease of thirteen percent of all pedestrian fatalities. [242] Additionally, the study concluded that year-round daylight saving time would have decreased motor vehicle occupant fatalities by 390 over the same two-year period, representing a three-

percent decrease in motor vehicle occupant fatalities.[243] Thus, year-round daylight saving time would have saved nearly 370 lives each year in the United States had it been in effect in the late 1990s.[244]

The Rutgers findings mirror the conclusions of other studies. A study of fatal crash data for the contiguous United States estimated that 901 lives would have been saved from 1987 through 1991 if year-round daylight saving time had been in effect--an average savings of approximately 180 lives per year.[245] Results from a British study were even more dramatic. A recent analysis of Britain's three year experiment with year-round daylight saving ***78** time between 1968 and 1971 concluded that approximately 2500 fewer people had been killed or seriously injured during the experiment's first two winters.[246]

Sunrise and sunset times demonstrate why year-round daylight saving time saves lives. During January, the average standard time sunrise in Los Angeles is 6:57 a.m., and the average sunset is 5:08 p.m.[247] Assuming that the average workday starts at 8:00 a.m. and ends at 5:00 p.m., most of the morning commute is in daylight while nearly all of the evening commute is in darkness. If clocks were shifted forward an hour during winter months, however, the average January sunrise in Los Angeles would be 7:57 a.m., and the average sunset would be 6:08 p.m.[248] Thus, year-round daylight saving time would give Los Angeles commuters another hour of daylight during the evening commute. Because drivers generally are more alert in the morning and more accident prone during the evening commute,[249] year-round daylight saving time will save lives.

Lives would be saved in northern cities as well. For example, the average January standard time sunrise in Minneapolis is 7:46 a.m., and the average sunset is 4:59 p.m.[250] If one again assumes that the average workday starts at 8:00 a.m. and ends at 5:00 p.m., most Minneapolis residents travel to work in the dark during both morning and evening commutes. Under year-round daylight saving time, however, the morning commute would still be in darkness but there would be light for the evening commute--since the sun would not set until 5:59 p.m.[251] Although nobody likes waking up to darkness, one commute in daylight is better than none.

In sum, year-round daylight saving time will save hundreds of lives by shifting an hour of daylight to the afternoon. The lives saved during the evening commute will more than offset any increase in morning fatalities. It is well past time for Congress to step up and recognize this most worthy advantage of permanently turning our clocks forward.

*79 B. Year-Round Daylight Saving Time Saves Energy by Reducing Evening Peak Electricity Loads

Although daylight saving time's energy saving effect is more difficult to quantify than its effect on pedestrian and motor vehicle occupant fatalities, it is likely that year-round daylight saving time would at least marginally reduce evening peak electricity loads. A recent study by the California Energy Commission demonstrates that year-round daylight saving time would produce a net decrease in electricity consumption.[252] Even a marginal savings in electricity could have a drastic effect.

Two factors produce peaks in evening electricity use. First, electricity demand spikes in the early evening because of the time of day. In the early evening many individuals arrive home from work and turn on appliances and heat, but workplaces are still using energy to complete their day of operations.[253] Second, electricity demand also increases due to sunset and falling temperatures. When sunset occurs, individuals are more likely to be indoors, they turn on lights at home, heaters operate more often, and streetlights turn on.[254]

Daylight saving time should reduce evening peak electricity loads because it allows the peak in electricity use associated with time of day to precede the increase in electricity use caused by sunset and falling temperatures.[255] By contrast, under winter standard time, these two electricity use factors coincide with one another, producing an unnecessarily pronounced evening peak load.[256]

In 2001, the California Energy Commission concluded that year-round daylight saving time produces a net decrease in overall electricity use during winter months of about 3.4%.[257] This net decrease results from a significant reduction in evening peak load, which outweighs a smaller increase in the early-morning load.[258] As a result, year-round daylight saving time would save approximately 3400 MegaWatt hours of electricity per day in California during winter, amounting to approximately one-half of one percent of the ***80** state's winter electricity use.[259] The Commission estimated that Californians would save between $100 million and $350 million during winter months with year-round daylight saving time, depending on electricity prices.[260]

Although critics may question the significance of a small net savings in electricity, even a modest effect--especially on peak electricity demand-- could have drastic implications. For example, the rolling blackouts in California only a few years ago resulted from electricity demand exceeding supply by only one or two percent.[261] Thus, year-round daylight saving time not only reallocates sunlight; its marginal effect on peak electricity use has the potential to literally keep individuals out of the dark.

C. Year-Round Daylight Saving Time Reduces Criminal Activity by Providing Another Hour of Afternoon Light

Extending daylight saving to winter months likely will decrease crime. On balance, several American and British studies show that improved street lighting reduces crime. Additionally, many crime rates are low during morning hours and peak during late afternoon ***81** and evening hours. By shifting an hour of sunlight from morning to evening during winter months, year-round daylight saving time has the potential to significantly reduce crime.

First, improved street lighting appears to decrease crime. For decades, studies debated whether street lighting had any actual effect on crime rates,[262] and the effect of light appeared inconclusive.[263] However, recent analysis of these studies indicates that street lighting does play a key role in reducing many criminal incidents.[264] In 2002, researchers at Britain's Home Office gathered and screened all available American and British studies on the effects of improved lighting on crime.[265] Conducting a systematic analysis,[266] the researchers only relied on studies that included ***82** before and after measures of crime in both experimental and control areas.[267] A meta-analysis of eight American and five British studies that met these criteria showed a twenty percent decrease in crime in experimental areas (with improved street lighting) compared with control areas --" a significant effect of improved lighting."[268]

Second, studies show that many crime incidents are low during morning hours and peak during late afternoon and evening hours.[269] In essence, time of day is one of the most important factors in crime rate.[270] For example, one study compiled statistics for hourly ***83** robbery patterns in thirteen American cities for 2000 and 2001.[271] The researchers selected 5:00 a.m. as the starting point for each day (meaning that a particular "crime day" ended at 4:59 a.m. the next morning).[272] To demonstrate the hourly distribution of crime, the study calculated "quartile minutes" for robbery for each city--in other words, the average minute of the day when twenty-five percent of all robberies have occurred, as well as the minutes when fifty percent and seventy-five percent of all robberies have occurred.[273]

The results were telling. In ten of the cities, more than ten hours pass in the morning and early afternoon before the first twenty-five percent of robberies occur (meaning that the first quartile minute arrives sometime after 3:00 p.m.).[274] By comparison, in all thirteen cities the next twenty-five percent of robberies occurred in less than six hours during the late afternoon and evening.[275] These findings demonstrate that individuals are more likely to be victims of robbery during the late afternoon and evening, rather than during the morning.[276] Several studies also show that other crimes--including assault, larceny, motor vehicle theft, and juvenile crime--are sparse during morning hours and peak during late afternoon and evening hours.[277] For many crimes, Americans face a greater risk during the evening.

Whatever the reason that criminals are apparently late to rise ***84** and late to bed, Congress should take advantage of it by enacting year-round daylight saving time. Doing so would reduce crime by shifting an hour of light to the time of day when it is needed most. Daylight saving during winter months would add an hour of light to the late afternoon and evening--the peak time of day for many crimes, including assault, larceny, motor vehicle theft, and juvenile crime.[278] An additional hour of darkness in the morning is an acceptable tradeoff, since most crime rates are low during morning hours.[279] Thus, year-round daylight saving time maximizes the effect of daylight on crime rates.

D. Year-Round Daylight Saving Time Will Eliminate Negative Effects Caused by Spring and Fall Time Changes

In addition to the benefits associated with an additional hour of evening light during winter months, year-round daylight saving time presents another significant advantage--eliminating the need to "spring forward" and "fall back." The small change in time twice a year leads to significant consequences, and year-round daylight saving time would avoid the subtle interruption of sleep patterns caused by a twice-yearly time change. Our society has been labeled "chronically sleep-deprived,"[280] and it is plagued with a host of problems resulting from insufficient sleep and disrupted circadian rhythms.[281] Because American society is already chronically sleep deprived, even small changes in sleep schedules can have drastic ***85** effects.[282]

Most notably, studies show a significant increase in traffic accident fatalities for the week following the spring daylight saving time change, when individuals lose an hour of sleep. For example, psychologist Stanley Coren analyzed United States traffic fatalities for the weeks preceding and following both the spring and fall daylight saving time changes.[283] He found that accidents during the week of the spring daylight saving time change increased by 6.5% compared with the week before.[284] Dr. Coren also concluded that the difference in accidents during the fall daylight saving time change was statistically insignificant.[285]

Some studies have concluded that accidents increase after both spring and fall daylight saving time changes simply because people's schedules have been thrown off their normal pattern.[286] For example, researchers at Stanford and Johns Hopkins analyzed twenty-one years of vehicle crash data and concluded in 2001 that accidents increase the week following both spring and fall time changes.[287] Similarly, researchers at San Jose State University studied traffic accidents in California from 1976 to 1978 and concluded that "there is a significant increase in traffic accidents during the week following the DST change which occurs regardless of the season."[288] Comparing the daily number of accidents for the week before and week following the spring and fall time changes, ***86** the study found a 3.6% increase in accidents on Monday alone (compared with the Monday before the time change).[289] The researchers warned that "[w]hen one considers that the numbers presented . . . represent several deaths, hundreds of injuries, and the loss of millions of dollars in lost work and damages to property, the social costs of our annual DST change ritual may be unacceptably high."[290]

Additionally, several researchers have noted other unsettling behavioral habits that occur immediately after the spring and fall daylight saving time changes. A study of New Mexico accident reports during the period from 1989 to 1992 found that fatal alcohol-related accidents during the week following the spring and fall daylight saving time changes represented 71.2% of all traffic accidents, up significantly from 53.7% for the prior week.[291] A study of international financial markets even suggested a correlation between the spring and fall daylight saving time changes and large negative returns on financial market indices. On Mondays following the time changes, the United States apparently has averaged a "one-day loss of $31 billion on the NYSE, AMEX, and NASDAQ exchanges."[292]

Thus, in addition to the many benefits from evening daylight during winter months, year-round daylight saving time would also avoid complications associated with the twice-yearly time change.[293]

*87 E. Contrary to Critics' Claims, Year-Round Daylight Saving Time Will Not Endanger School Children

For decades, school officials and parents have fought attempts to extend daylight saving time, arguing that increased morning darkness will jeopardize the safety of children commuting to school. [294] Parents point to a noticeable increase in school-age children deaths in Florida during the early months of the 1974 winter daylight saving time experiment. [295] Although daylight saving time advocates argue that schools should adjust accordingly by shifting back the start of the school day, opponents claim that such a shift is not practical "when you have working parents and those going to and from work, having to meet work commitments." [296]

These are serious concerns. However, the correlation between extended daylight saving time and school children fatalities does not withstand scrutiny. First, the evidence shows that year-round daylight saving time does not pose a serious threat to the safety of school children and confirms that the disturbing deaths in Florida thirty years ago are not indicative of a nationwide trend. One month after the United States started observing winter daylight saving time in January 1974, no state other than California and Florida had reported a significant increase in accidents involving school-age children. [297] The National Safety Council ("NSC") later surveyed forty-two states and the District of Columbia and ***88** concluded that winter daylight saving time had "little or no effect on the number of early-morning traffic fatalities among school children." [298] Other studies confirmed NSC's results, including the previously mentioned study by researchers at Rutgers University. [299] The Rutgers study examined accident data for every county in the United States for 1998 and 1999, and found no increased risk to school children from year-round daylight saving time. [300]

Second, if there is any overall effect of daylight saving time on school children, it is likely a net positive effect after factoring in lives saved during sunlit evening hours. The DOT's study on the effects of winter daylight saving time showed a nationwide increase of ten school children fatalities during the morning hours during the winter of 1974, but this number was offset by the sixty fewer afternoon school children fatalities during the same period. [301]

Third, there are ways to mitigate any problems associated with morning darkness. Past experience demonstrates that school districts will adjust to year-round daylight saving time by delaying the start of the school day during winter months. [302] For example, ***89** during the 1974 winter daylight saving time experiment, 44% of school districts in the United States--serving 47% of the nation's students--quickly shifted school hours to later times. [303] Additionally, there are other viable solutions to early morning darkness, including increased funding for school crossing guard services and pedestrian safety training for school children. [304]

Although policymakers should seriously consider the concerns of school officials and parents, they should not allow tragic newspaper accounts to interfere with a rational policy choice. As the founder of the Daylight Saving Time Coalition explained to members of Congress in 2001:

> If a child is killed in the morning hours, there will be finger-pointing at the bus driver, the school principal, the superintendent, and at YOU for having voted for this change. However, the fatal accident that is avoided because of more afternoon daylight will never be reported. The child whose life is saved because a driver slammed on the brakes in the nick of time will never see his photo in the news. [305]

In sum, winter daylight saving time either has no effect on school children fatalities or a net positive effect. Regardless, parents and school officials should implement other methods for ensuring the safety of school-age children during morning hours, allowing the rest of society as a whole to benefit from year-round daylight saving time.

F. Other Problems Associated with Year-Round Daylight Saving Do Not Outweigh Its Benefits

Two other potential drawbacks of year-round daylight saving time must be addressed--disadvantages to farmers and radio stations. Fortunately, the evidence shows that these disadvantages are minimal, and are easily outweighed by the significant ***90** advantages of daylight saving during winter months.

First, year-round daylight saving time does not irreparably affect the agricultural community. After the 1974 experiment with year-round daylight saving time, the Department of Agriculture reported that the experiment did not significantly affect agricultural activities or productivity. [306] The agricultural community now appears to accept that daylight saving time has marginal effect on farmers. Although the agricultural sector vigorously lobbied against daylight saving legislation in the early twentieth century, [307] farmers have not actively opposed extensions of daylight saving time in recent years. [308]

Second, year-round daylight saving time would have minimal effect on radio stations. The problem posed to AM radio stations (noted above) [309] appears to be resolving itself over time. Some claim that the dramatic growth in FM band for local radio over the last thirty years--not to mention the increased use of internet broadcasting technology--has made daylight saving time concerns regarding AM radio sign-on times "a non-issue." [310] Additionally, net losses by daytime radio stations have always been small when measured against total AM broadcast revenues. [311] Thus, policymakers can enact year-round daylight saving time without irreparably harming the agricultural sector and radio stations.

Conclusion

Daylight saving time has a long, storied history in the United States, and the topic continues to elicit surprisingly strong opinions today. Despite these intense views, Congress should rationally assess the benefits and drawbacks of extended daylight saving time, using modern studies and analysis. In doing so, it should resist the urge to be swayed by unsubstantiated claims and powerful interests--both of which have led our country astray on this issue more than once in the past.

A rational cost-benefit analysis of existing research ***91** demonstrates numerous reasons why Congress should adopt year-round daylight saving time. The benefits of such a plan clearly outweigh the disadvantages: hundreds of lives would be saved each year, and rolling power blackouts could be avoided. Crime would decrease. Americans would stop losing sleep after adjusting their clocks. Another hour of morning darkness during winter months is a small price to pay for the far greater advantages of extended evening daylight. Ultimately, the evidence shows that it is past time for Americans--and Congress--to shift their thinking permanently forward on daylight saving time.

Footnotes

a1 Professor of Law and Washington Law Foundation Scholar, Univ. of Washington School of Law, stevecal@u.washington.edu. J.D., Harvard Law School; B.A., Univ. of California at Berkeley.

aa1 Law Clerk to Judge Alfred Goodwin, U.S. Court of Appeals for the Ninth Circuit, dbuehler@myuw.net. J.D., Univ. of Washington School of Law; B.A., Willamette Univ.

The authors wish to thank U.S. Congressmen Edward Markey (D-Mass.) and Fred Upton (R-Mich.) for bringing this topic to the forefront of Congress's attention. Our gratitude as well to Ninth Circuit Judge Alfred Goodwin, Chryssa Deliganis, Mary Lynn Veden, Jonathan Moskow, Irwin Yoon, and Alyse Merritt for their encouragement and thoughts on prior drafts, as well as to the Washington Law School Foundation for its generous financial support.

1 See Parliament, Times (London), Mar. 6, 1909, at 4; see also Cabinet and Secrecy, Times (London), May 9, 1916, at 7 (describing the debate on Sir Henry Norman's resolution for daylight saving time).

2 After the spring daylight saving time clock change in 2007, one newspaper columnist counted herself "among millions annoyed by fiddling with time, which seems wrong at its core, like calling a rock a marshmallow or declaring Christmas in July." Susan Ager, Standards Are for Changing, Detroit Free Press, Mar. 13, 2007, Features Section, at 1.

3 Tom Abate, Easy Start for Early Daylight Time; So Far, No Time Warp, No Digital Meltdowns Accompany March Shift, S.F. Chron., Mar. 12, 2007, at A2; Change Your Clocks, Sunday Oregonian, Mar. 11, 2007, at A1.

4 Jacquielynn Floyd, Local News Online, Dallas Morning News, Mar. 12, 2007, at 2B.

5 Mike Penner, Morning Briefing: From Crazy to Lazy, Like Clockwork, L.A. Times, Mar. 13, 2007, at D2.

6 Mary Beth Schneider, 2nd Democrat Declares He'll Run for Governor, Indianapolis Star, Mar. 20, 2007, Local: Metro & State Section, at 1.

7 Chris Cillizza, Second Democrat Looks to Limit Indiana Governor to Single Term, Wash. Post, Mar. 20, 2007, at A6; Lesley Stedman Weidenbener, Daniels' Legislative Agenda Is in Trouble, Courier-J. (Louisville, Ky.), Mar. 18, 2007, at 1A.

8 Keith Grubman, Letter to the Editor, Adjusting Clocks Moves Up Spring, Newsday (N.Y.), Mar. 17, 2007, at A16.

9 David Hendrickson, Letter to the Editor, DST Complainers Need to Get Out in the Sunshine, Indianapolis Star, Mar. 14, 2007, Editorial Section, at 9.

10 Karen Simonson Smith, Letter to the Editor, Evening Daylight Helps Build Stronger Families, Indianapolis Star, Mar. 14, 2007, Editorial Section, at 9.

11 Catherine Kemp, Letter to the Editor, Let's Save Daylight All Year Long, N.Y. Times, Mar. 18, 2007, § 14, at 13. Similarly, a Maryland resident suggested "switching one-half hour into daylight saving time and never changing back" in order to "end this semiannual nuisance once and for all." Mary J. Wendehack, Letter to the Editor, Same Time All Year, Wash. Post, Mar. 14, 2007, at A14.

12 Energy Policy Act of 2005, Pub. L. No. 109-058, § 110, 119 Stat. 615 (codified as amended at 15 U.S.C. § 260a (Supp. V 2007)); Richard Simon, Daylight Saving Time Advances, L.A. Times, July 22, 2005, at A12 (noting the weeks of the change).

13 See Michael Downing, Our Perplexing Rite of Spring (and Fall), Wash. Post, May 1, 2005, at B2.

14 Michael Downing, Spring Forward: The Annual Madness of Daylight Saving 3 (2005).

15 Mr. Churchill and the Daylight Saving Bill, Times (London), Jan. 21, 1911, at 10.

16 Herbert L. Matthews, Gandhi, Fast Over, Is Happy but Weak, N.Y. Times, Mar. 4, 1943, at 4 ("Gandhi,... like most old-fashioned Indians, does not observe the government's daylight saving.").

17 Linda Charlton, 'Energy Crisis' May Begin at Home Soon, N.Y. Times, Nov. 8, 1973, at 32 (reporting on proposals in Nixon's address to the nation).

18 E.g., Energy Conservation Potential of Extended and Double Daylight Saving Time Before the Subcomm. on Energy of the H. Comm. on Science, 107th Cong. (2001) [hereinafter Hearing on H.R. 704 and 1647] (regarding H.R. 704 and H.R. 1647); Daylight Saving Time Act of 1975: Hearing on S. 980 and S. 2566 Before the S. Comm. on Commerce, 94th Cong. [hereinafter Hearing on S. 980 and S. 2566]; Daylight Saving Time: Hearings on S. 385, S. 1260, S. 2568, and S. 2602 Before the S. Comm. on Commerce, 93d Cong. (1973) [hereinafter Hearings on S. 385, S. 1260, S. 2568, and S. 2602].

19 See, e.g., Hearing on H.R. 704 and 1647, supra note 18, at 27 (statement of Linda Lawson, Acting Deputy Assistant Secretary for Policy, U.S. Department of Transportation) (noting that the Department of Transportation's 1975 study on the effects of year-round daylight saving time "is very old and it was also for a very limited time"); see also infra notes 217-19 and accompanying text.

20 See, e.g., Marjorie Hunter, House Sets Rules on Daylight Time, N.Y. Times, Mar. 17, 1966, at 41 (noting that opponents criticized daylight saving as "the golfer's delight" and argued without evidence that it would endanger young children by forcing them to walk to school in the dark); Andy Soltis, Senators OK Bill for Sunnier Days, N.Y. Post, July 30, 2005, at 2 (noting that Rep. Edward Markey,

the main congressional proponent of the 2005 legislation extending daylight saving time, argued that "[t]he beauty of **daylight savings time** is that it just makes everyone feel sunnier.").

21 See infra notes 115-41 and accompanying text.

22 See infra notes 108-09, 155-56 and accompanying text.

23 See infra notes 181-84, 255-56, 278-79 and accompanying text.

24 Downing, supra note 13.

25 See David Prerau, DST: Take a Look Back in Time to Examine Its Origins, Indianapolis Star, Mar. 28, 2006, at 7A.

26 Daylight Saving Which Begins Today, N.Y. Times, Mar. 31, 1918, at X14.

27 Harold M. Schmeck, Jr., Daylight Time Begins, N.Y. Times, Jan. 6, 1974, at 1; Clocks to be Advanced an Hour February 9 Throughout Nation, Wall St. J., Jan. 21, 1942, at 3; Roosevelt Signs Daylight Time Act, N.Y. Times, Jan. 21, 1942, at 19.

28 David Prerau, Seize the Daylight: The Curious and Contentious Story of Daylight Saving Time 204-06 (2005).

29 Energy Policy Act of 2005, Pub. L. No. 109-058, § 110, 119 Stat. 615, 615 (codified as amended at 15 U.S.C. § 260a (Supp. V 2007)). Although the Act was passed in 2005, its provisions took effect in 2007. Id.; see also Simon, supra note 12.

30 Benjamin Franklin, Letter to the Editor, An Economical Project, J. de Paris (Apr. 26, 1784), reprinted in Benjamin Franklin, Autobiography, Poor Richard, and Later Writings 244-48 (J.A. Leo Lamay ed., Literary Classics of the United States, Inc., 4th prtg. 1997), available at http:// webexhibits.org/daylightsaving/franklin3.html. Several biographies of Franklin contain a historical account of this letter. See generally Alfred Owen Aldridge, Benjamin Franklin: Philosopher & Man 358-59 (1965); Alfred Owen Aldridge, Franklin and His French Contemporaries 177-80 (1957); H.W. Brands, The First American: The Life and Times of Benjamin Franklin 640-42 (2000).

31 Aldridge, Franklin & His French Contemporaries, supra note 30, at 178.

32 Franklin, supra note 30, at 244.

33 Id .; Prerau, supra note 25.

34 Franklin, supra note 30, at 245.

35 Historians recognize that Franklin was enjoying one of his many satirical moments. See Aldridge, Franklin & His French Contemporaries, supra note 30, at 178 ("The mild satire of this combined literary parody and moral parable resembles [Jonathan] Swift's writings in a mellow mood."); Downing, supra note 14, at 3 ("[E]ven [daylight saving time's] most ardent advocates believe that when Ben Franklin took pen in hand and wrote the first detailed proposal to save daylight... he had his tongue in his cheek.").

36 Franklin, supra note 30, at 244-45.

37 Id. at 245-46; Prerau, supra note 28, at xii.

38 Franklin, supra note 30, at 246. Franklin assumed that the average family in Paris burned candles for seven hours during each of the 183 days between March 20th and September 20th, and multiplied the total number of hours for this six month period (1281) by 100,000 (the estimated number of families in Paris), giving him 128,100,000 total hours "spent at Paris by candle-light." Id. He then multiplied this figure by the estimated cost of candles "at half a pound of wax and tallow per hour." Id.

39 Id.; see also Brands, supra note 30, at 641 (summarizing Franklin's findings).

40 Prerau, supra note 28, at xiii.

41 Franklin, supra note 30, at 246-47.

42 Prerau, supra note 25; see generally Prerau, supra note 28, at 1-9 (describing William Willett's contribution to the development of daylight saving time).

43 Parliamentary Committees, Times (London), May 8, 1908, at 23.

44 See Terry Oberg, Seeing the Light, Courier-Mail (Brisbane, Austl.), Dec. 31, 2005, at M06.

45 William Willett, The Waste of Daylight (1907), reprinted in Donald de Carle, British Time 152 (1947), available at http://webexhibits.org/daylightsaving/willett.html.

46 Id.

47 Id. at 153.

48 See Franklin, supra note 30, at 244-48.

49 Willett, supra note 45, at 154. Indeed, much like the calculations in Franklin's Economical Project, Willett's calculated savings stated that "[a]ssuming the cost of artificial light, for each unit of the population, averages only, one-tenth of a penny per head, per hour, the figures with which I conclude this paper show that 210 additional available hours of daylight can be gained and at least 2,500,000 a year can be saved." Id.

50 Suzanne McGonagle, Remember to Put Your Clock Back Winter Time Begins: The History of the Gained Hour That Marks the Onset of Winter, Irish News (Belfast), Oct. 29, 2005, at 3; see also Parliamentary Committees, Times (London), May 20, 1908, at 9 (discussing a member of Parliament who "had met hundreds of thinking men... opposing what they called this 'wild-cat' scheme" of daylight saving time). The United States observed Britain's consideration of daylight saving time with amusement. See Daylight Bill Gaining, N.Y. Times, Mar. 7, 1909, at C2 ("The House of Commons closed the legislative week by wasting a day over the Daylight Saving bill....").

51 Parliamentary Debate, Times (London), Mar. 27, 1908, at 11. Willett also wrote letters to every member of Congress, urging the adoption of daylight saving time in the United States. Would Add an Hour to Our Summer Day, N.Y. Times, Feb. 7, 1909, at C3.

52 See Parliamentary Committees, Times (London), May 20, 1908, at 9; see also David Gill, Letter to the Editor, The Daylight Saving Bill, Times (London), May 12, 1908, at 3 ("It is one thing to change the origin of time once for all, it is quite another to chop and change it about in the manner proposed by the Bill.").

53 Political Notes, Times (London), July 2, 1908, at 12.

54 Daylight Saving, Times (London), May 5, 1911, at 9 ("It is not to be disputed that the movement in favour of what is known as daylight saving... is steadily advancing in public favour."); Mr. Churchill and the Daylight Saving Bill, Times (London), Jan. 21, 1911, at 10 (noting that William Willett claimed that "163 corporations, town councils, &c., nearly 50 trade unions, besides 45 Chambers of Commerce (including the Associated Chambers), 54 clubs, and 64 associations and societies" had passed resolutions in favor of daylight saving, and Winston Churchill assured Willett that "as many as 230 members of the present House of Commons had expressed themselves favourable to the principle of the Bill").

55 See, e.g., Parliament, Times (London), Mar. 6, 1909, at 4 (recalling an account of a House of Commons debate on the Daylight Saving Bill).

56 Daylight Saving, Times (London), Apr. 22, 1916, at 2.

57 Id. (noting that only days after Germany announced that it would be shifting its clocks forward an hour, "it was stated by the Home Secretary in the House of Commons that the question of taking the same step here was receiving the attention of the Government").

58 Through German Eyes, Times (London), May 6, 1916, at 5 (internal quotation marks omitted).

59 Daylight-Saving Plan in Britain, N.Y. Times, May 3, 1916, at 13.

60 Daylight Plan Spreads, N.Y. Times, May 10, 1916, at 24.

61 Cabinet and Secrecy, Times (London), May 9, 1916, at 7.

62 Summer Time, Times (London), May 29, 1916, at 10.

63 Id.

64 See Indorses Daylight Saving, N.Y. Times, Jan. 14, 1917, at 7. The New York Times later published an in-depth article containing several statistical benefits from global observance of daylight saving time, including a nine percent average savings in consumption of gas in Britain and savings of about 442,500 tons of coal in France. See Daylight Saving Which Begins Today, supra note 26, at X14.

65 British Clocks Set Back, N.Y. Times, Oct. 1, 1916, at 4. In addition to Germany and Britain, several other countries implemented daylight saving time, including Australia, Austria, Belgium, Denmark, France, Holland, Iceland, Italy, Norway, Portugal, Sweden, and parts of Canada. See Daylight Saving Which Begins Today, supra note 26.

66 President Favors Saving of Daylight, N.Y. Times, Feb. 1, 1917, at 7.

67 For Daylight Saving, N.Y. Times, Jan. 29, 1917, at 17.

68 Plea for Daylight Saving, N.Y. Times, Mar. 3, 1918, at 6.

69 Foster for Longer Day, N.Y. Times, Jan. 7, 1917, Section 8, at 1. Despite wide support, not everyone favored daylight saving time. For example, some observed that "[t]he setting back or forward of all clocks an hour on two days in each year will involve inconvenience and annoyance." Split on Daylight Saving, N.Y. Times, Jan. 1, 1917, at 7. Not surprisingly, Harvard students voted 689 to 393 against a university daylight saving proposal, rejecting the idea of holding classes an hour earlier. See Harvard Rejects Daylight Saving, N.Y. Times, Jan. 23, 1918, at 18.

70 See Daylight Saving Bill Signed by President, N.Y. Times, Mar. 20, 1918, at 14.

71 See Plea for Daylight Saving, supra note 68.

72 See 7 Months' Saving of Daylight Voted, N.Y. Times, Mar. 16, 1918, at 1.

73 Act of Mar. 19, 1918, ch. 24, § 3, 40 Stat. 450, 451 (repealed 1919); see also 7 Months' Saving of Daylight Voted, supra note 72 (reporting that the House passed the daylight saving bill by a vote of 252 to 40); Daylight Saving Plan Approved by Senate, N.Y. Times, Mar. 17, 1918, at 8 (reporting that the Senate concurred in the House amendments to the daylight saving bill without a roll call vote).

74 Daylight Saving Bill Signed by President, N.Y. Times, Mar. 20, 1918, at 14.

75 Move Clocks Ahead at Patriotic Rally, N.Y. Times, Mar. 31, 1918, at 13. Many cities held celebrations commemorating the event. For example, in New York City, "a patriotic meeting was held in Madison Square Park" in which "after the parade by the Boy Scouts, headed by the Police Department Band, several thousand spectators listened to addresses on behalf of the forthcoming Liberty Loan and the sale of war savings stamps." Id.

76 See Report Big Success in Daylight Saving, N.Y. Times, Apr. 2, 1918, at 13; Wants Clocks Kept Ahead, N.Y. Times, Oct. 8, 1918, at 10. For example, proponents of extending daylight saving time heralded statistics showing that residents in the District of Columbia saved $60,000 in their gas bills and that 17.5 tons of coal were saved for every thousand residents in St. Louis. See Counting the Gains of Daylight Saving, N.Y. Times, Oct. 13, 1918, at 13.

77 See, e.g., For Daylight Saving Law, N.Y. Times, June 18, 1919, at 6 (reporting the views of the National Tuberculosis Association); Labor for Daylight Saving, N.Y. Times, June 9, 1919, at 12 (reporting the views of the Vice President of the American Federation of Labor); Uphold Light-Saving Law, N.Y. Times, May 28, 1919, at 25 (reporting the views of the Merchants' Association).

78 Congress for Repeal of Daylight Saving, N.Y. Times, June 19, 1919, at 15.

79 Id.; Cuts Out Daylight Saving, N.Y. Times, Feb. 21, 1919, at 5.

80 Wilson Rejects Agricultural and Sundry Civil Bill, N.Y. Times, July 13, 1919, at 1. Wilson stated that repeal of daylight saving time would "involve a serious economic loss" and that "the overwhelming testimony of its value which has come to me convinces me that I should not be justified in acquiescing in its repeal." Id.

81 Daylight Law Repeal Beaten in the House, N.Y. Times, July 15, 1919, at 17. Congress passed the agricultural appropriations bill without the rider repealing daylight saving time, and the President signed the bill into law. Passes Agricultural Bill, N.Y. Times, July 24, 1919, at 15; Signs Bill with Daylight Rider Out, N.Y. Times, July 26, 1919, at 13.

82 Act of Aug. 20, 1919, ch. 51, 41 Stat. 280; see also Daylight Issue up Again, N.Y. Times, Aug. 2, 1919, at 14.

83 President Vetoes Daylight Repeal, N.Y. Times, Aug. 16, 1919, at 7; President Vetoes Daylight Savings Repeal Bill, Wall St. J., Aug. 16, 1919, at 4.

84 Daylight Saving Act Now Stands Repealed, N.Y. Times, Aug. 21, 1919, at 1; House Kills Veto of Daylight Law, N.Y. Times, Aug. 20, 1919, at 17.

85 See Plan Local Action to Save Daylight, N.Y. Times, Aug. 23, 1919, at 11 ("The [National Daylight Saving Association] will urge upon Boards of Aldermen, City Councils, State Legislatures, and other authoritative bodies that legislation be enacted to have the clock officially set forward in order to conserve daylight.").

86 See, e.g., Chattanooga for Daylight Saving, N.Y. Times, Dec. 26, 1919, at 4 (reporting that Chattanooga, Tennessee adopted daylight saving time); Chicago Moves up Clocks, N.Y. Times, June 13, 1920, at 17 (reporting that Chicago adopted daylight saving time); City and Suburbs Set Clocks Ahead, N.Y. Times, Mar. 28, 1920, at 1 (noting that several cities adopted daylight saving time); Jersey City Adopts Daylight Saving, N.Y. Times, Jan. 15, 1920, at 2 (reporting that Jersey City, New Jersey adopted daylight saving time); Set the Clock Back One Hour Tonight, N.Y. Times, Oct. 25, 1919, at 11 (reporting that New York City adopted daylight saving time).

87 Stock Exchange to Save Daylight, N.Y. Times, Mar. 25, 1920, at 17.

88 Adopt Wall Street Time, N.Y. Times, Mar. 26, 1920, at 17; City and Suburbs Set Clocks Ahead, supra note 86.

89 Daylight Saving Gaining Ground, N.Y. Times, Mar. 26, 1920, at 17; see also Jersey Suburbs Adopting New Time, N.Y. Times, Mar. 27, 1920, at 12.

90 14 States Observe Daylight Saving, N.Y. Times, June 30, 1925, at 9.

91 Daylight Saving Returns; 483 Cities Turn Clocks Ahead, N.Y. Times, Apr. 26, 1931, at 1.

92 Daylight Saving Puts Europe in a Muddle, N.Y. Times, Apr. 17, 1923, at 2. Global observance of daylight saving time was mixed as well. In 1922, the German government announced that it had "received so many petitions against [daylight saving time] that it has been decided to leave German clocks alone this Summer." No Daylight Saving for Germany, N.Y. Times, Mar. 25, 1922, at 1. However, other countries adopted and maintained daylight saving time. By 1932, Belgium, Britain, Canada, France, Holland, and Portugal observed daylight saving. See 7 Nations to Go on Daylight Saving, N.Y. Times, Apr. 15, 1932, at 13.

93 For example, Germany, France, and Italy implemented daylight saving time. Merchant Group Urges Daylight Saving Law of World War Re-enacted for U.S. Defense, N.Y. Times, Mar. 2, 1941, at 19. Britain implemented year-round daylight saving time and shifted its clocks ahead an additional hour during summer months. British Daylight Saving to be 2 Hours in Summer, N.Y. Times, Mar. 5, 1941, at 8.

94 See, e.g., Merchant Group Urges Daylight Saving Law of World War Re-enacted for U.S. Defense, supra note 93.

95 President Favors Law to Cut Power Use by Extension of Daylight Time, Wall St. J., July 16, 1941, at 3; Proposal on Daylight Time, N.Y. Times, July 16, 1941, at 10.

96 This claim would later be supported by Federal Power Commission Chairman Leland Olds, who testified before a congressional committee that the nation would experience a shortage of fifty-five million kilowatt-hours of electricity in 1943 as a result of the nation's accelerated national defense program. National Daylight Saving Urged by FPC Chairman, Wall St. J., Aug. 6, 1941, at 2.

97 See President Pushes Saving Daylight, N.Y. Times, July 16, 1941, at 10; Proposal on Daylight Time, supra note 95.

98 See Proposal on Daylight Time, supra note 95.

99 Id.

100 President Pushes Saving Daylight, supra note 97. Roosevelt asked Congress for authority to order the nation to advance its clocks up to two hours ahead of standard time for the whole year or any part of the year. Id.

101 See Wheeler Offers a Bill for Daylight Saving, N.Y. Times, Dec. 31, 1941, at 11 ("[T]he President asked Congress six months ago for authority [to implement daylight saving time], but no action was taken.").

102 George Gallup, Change to Daylight Time All Year 'Round Found Favored by Majority in Gallup Poll, N.Y. Times, Jan. 4, 1942, at 41.

103 See id.

104 Id. Polling of individual demographics showed strong support for daylight saving time in urban areas and significant opposition among farmers. For example, in cities with a population of more than 100,000, 72% supported year-round daylight saving time; among farmers, only 36% supported year-round daylight saving time, and 45% opposed. See id.

105 See, e.g., House Passes Bill for Daylight Time All Over Country, N.Y. Times, Jan. 10, 1942, at 1.

106 Act of Jan. 20, 1942, ch. 7, 56 Stat. 9, 9 (repealed 1945); see also House Daylight Bill is Passed by Senate, N.Y. Times, Jan. 15, 1942, at 1. The Senate had previously passed legislation giving President Roosevelt the power to implement daylight saving time, but later opted for the House version of the bill, which advanced the nation's clocks uniformly by one hour. See id.

107 Act of Jan. 20, 1942, ch. 7, § 2, 56 Stat. 9 (repealed 1945).

108 Clocks to be Advanced an Hour February 9 Throughout Nation, Wall St. J., Jan. 21, 1942, at 3; Roosevelt Signs Daylight Time Act, N.Y. Times, Jan. 21, 1942, at 19.

109 See, e.g., Topics of The Times, N.Y. Times, Feb. 7, 1942, at 16; War Time to Begin in Nation Tomorrow, N.Y. Times, Feb. 8, 1942, at 1.

110 The War Production Board estimated in 1945 that year-round daylight saving time had saved nearly 5 billion kilowatt-hours of electricity during the war. See Farmers Demand 'Sun Time' Again, N.Y. Times, July 15, 1945, at E8. A study published by the Association of Edison Illuminating Companies found a net electric utility fuel savings of 4.60% in December 1942. See Daylight Saving Time: Hearings on S. 385, S. 1260, S. 2568 and S. 2602 Before the S. Comm. on Commerce, 93d Cong. 131 (1974).

111 See Ask Congress Repeal of 'Daylight Time,' N.Y. Times, Feb. 24, 1945, at 26; Farmers Demand 'Sun Time' Again, supra note 110.

112 Congress Leaders Promise to End Daylight Saving Time by Sept. 30, N.Y. Times, Sept. 9, 1945, at 1.

113 Act of Sept. 25, 1945, ch. 388, 59 Stat. 537 (1945); see also House Votes Standard Time, N.Y. Times, Sept. 13, 1945, at 14 ("The House... passed without opposition a resolution to return the country to standard time...."); What's News, Wall St. J., Sept. 21, 1945, at 1 ("The Senate unanimously approved... a measure ending daylight saving time....").

114 Turn Back Clocks One Hour Tonight, N.Y. Times, Sept. 29, 1945, at 1.

115 See, e.g., Daylight Saving Ends at 2 a.m. Tomorrow, N.Y. Times, Sept. 28, 1946, at 1 (reporting that "Connecticut, New Jersey, Massachusetts, and New Hampshire, observed [daylight saving time] under State laws," and cities in fifteen other states observed daylight saving time under local laws); Most of State to Shift Clocks, N.Y. Times, Apr. 3, 1946, at 17 (reporting that a majority of cities in New York State implemented daylight saving time).

116 Felix Belair, Jr., Uniform Daylight Saving Time Sought, N.Y. Times, Mar. 7, 1965, at 24.

117 Mike Toner, Daylight Saving Once Ticked People Off, Atlanta J.-Const., Apr. 3, 2005, at B1.

118 Hearing on H.R. 704 and 1647, supra note 18 (statement of Linda Lawson, Acting Deputy Assistant Secretary for Policy, United States Department of Transportation).

119 Toner, supra note 117. Minnesotans bore the brunt of daylight saving confusion. During a particular part of the year, parts of the state observed central standard time, daylight saving time, and extended daylight saving time at once, leading Minnesotans to joke that "convicts do time; soldiers do double time; Minnesotans do triple time." Uniform Time Bill to Ease Confusion, N.Y. Times, Apr. 3, 1966, at 68 (internal quotation marks omitted).

120 Belair, supra note 116. Indeed, if bus passengers on this route wanted to keep the correct local time at all stops, they had to change their watches an average of once every five miles. Id.

121 Michael Downing, Endless Summer, N.Y. Times, Aug. 9, 2005, at A19.

122 Belair, supra note 116 (quoting Dr. William Markowitz).

123 See Bill Offered on Uniformity in Daylight Saving Time, N.Y. Times, Mar. 9, 1965, at 37; Daylight Time Hearing Set, N.Y. Times, Mar. 31, 1965, at 43.

124 Marjorie Hunter, House Sets Rules on Daylight Time, N.Y. Times, Mar. 17, 1966, at 41.

125 Id.

126 Belair, supra note 116. Although it is possible that the confusion created by erratic local time observance created support for uniform daylight saving time among farmers, it is also possible that farmers took a pragmatic stance in response to declining clout in Congress. See Uniform Time Bill Sent to President, N.Y. Times, Mar. 31, 1966, at 41 ("[T]he advance of state and Federal reapportionment giving greater political weight to urban areas has diminished the political voice of the farmer and will reduce the chances of states remaining off daylight time in the future.").

127 Hunter, supra note 124.

128 Id.

129 Id. (reporting that the House passed the Uniform Time Bill by a vote of 291 to 93).

130 Uniform Time Bill Passed by Senate, N.Y. Times, Mar. 23, 1966, at 17. The Senate amended the bill to permit state legislatures to exempt either an entire state or a "single contiguous part" of a state from daylight saving time. See Uniform Time Bill Sent to President, N.Y. Times, Mar. 31, 1966, at 41. However, a House-Senate conference committee subsequently eliminated this amendment, and the resulting bill only allowed entire states to opt out of daylight saving time. See Daylight Time Bill Approved by Senate, N.Y. Times, Mar. 30, 1966, at 32.

131 Uniform Time Bill Signed by Johnson, N.Y. Times, Apr. 15, 1966, at 37.

132 Uniform Time Act of 1966, Pub. L. No. 89-387, 80 Stat. 107 (1966) (codified as amended at 15 U.S.C. §§ 260-63, 266-67 (2000)).

133 Uniform Time Act § 3(a).

134 Id. § 3(b).

135 Id. § 3(a).

136 Id. § 6. Although observance was optional during 1966, states could not deviate from the Act's prescribed start and end times for daylight saving time. See id.

137 Clocks Set Ahead for Daylight Time, N.Y. Times, Apr. 30, 1967, at 1.

138 Id. The Hawaii and Michigan legislatures passed laws exempting the states from daylight saving time. 46 States Will Observe Daylight Time April 30, N.Y. Times, Apr. 23, 1967, at 57. Additionally, the Department of Transportation, the agency charged with the responsibility of administering the Uniform Time Act, granted dispensations to three states with exceptional circumstances. Douglas E. Kneeland, Most States Act on Uniform Time, N.Y. Times, Apr. 30, 1967, at 33. The Department granted a temporary reprieve to Kentucky because its legislature was not scheduled to come into session until the following year. Id. The Secretary of Transportation

also delayed implementation of daylight saving time in Indiana and Alaska because these states were contemplating changes in time zones. Id.

139 Clocks Set Ahead for Daylight Time, supra note 137.

140 After the Michigan legislature exempted the state from daylight saving time in 1967, the state's citizens pressed for a referendum on the matter. Single Time Act Going into Effect, N.Y. Times, Apr. 1, 1967, at 34. State officials offered a compromise in which "[t]he Upper Peninsula will go on Central Daylight (which is, of course, the same as Eastern Standard); the rest of the state will stay on Eastern Daylight." Referendum Row, Time, July 7, 1967, at 47, available at http:// www.time.com/time/magazine/article/0,9171,899572,00.html. Although Michigan observed daylight saving time in 1968, voters opted to return to standard time in a statewide referendum. Drive to Begin to Restore Daylight Saving in Michigan, N.Y. Times, Nov. 16, 1969, at 47.

141 Daylight Saving Time Will Start Tomorrow, N.Y. Times, Apr. 28, 1973, at 35; Daylight Time Begins at 2 a.m. Tomorrow, N.Y. Times, Apr. 24, 1971, at 31.

142 1 Office of the Assistant Sec'y for Policy, Plans & Int'l Affairs, U.S. Dep't of Transp., Final Report on the Operation and Effects of Daylight Saving Time 23 (1975) [hereinafter Final Daylight Saving Report].

143 See Editorial, Energy-Saving Time, N.Y. Times, Oct. 28, 1973, at E14.

144 Year-Round D.S.T. Urged, N.Y. Times, Mar. 16, 1973, at 54.

145 See, e.g., All-Year Use Asked on Daylight Saving, N.Y. Times, Oct. 25, 1973, at 53 (reporting that a proposal for year-round daylight saving time was introduced in New York Assembly); Total Daylight Saving Urged, N.Y. Times, Nov. 2, 1973, at 6 (reporting that the Massachusetts House of Representatives voted to extend daylight saving time to the entire year).

146 Energy-Saving Time, supra note 143. The editorial also cited preliminary figures from a Rand Corporation study, showing energy savings from year-round daylight saving time equal to one-half of the projected three percent energy shortage for 1973. Id.

147 Richard Nixon, Address to the Nation About Policies to Deal With the Energy Shortages, 1973 Pub. Papers 323 (Nov. 7, 1973), available at http:// www.nixonfoundation.org/clientuploads/directory/archive/1973_pdf_files/1973_ 0323.pdf [hereinafter Nixon's Address]; see also Linda Charlton, 'Energy Crisis' May Begin at Home Soon, N.Y. Times, Nov. 8, 1973, at 32 (reporting on proposals in Nixon's address to the nation).

148 Nixon's Address, supra note 147, at 916.

149 Id. at 918.

150 Richard L. Madden, Senate Panel Speeds Bill to Meet Energy Shortage, N.Y. Times, Nov. 10, 1973, at 69.

151 Richard L. Madden, Daylight Saving All Year 'Round Voted by Senate, N.Y. Times, Dec. 5, 1973, at 1 (noting that the Senate approved year-round daylight saving time by vote of 67 to 10); Richard L. Madden, Daylight Saving for Next 2 Years Is Voted by House, N.Y. Times, Nov. 28, 1973, at 1 (reporting that the House approved year-round daylight saving time by vote of 311 to 88).

152 Madden, Daylight Saving for Next 2 Years Is Voted by House, supra note 151.

153 Id. (internal quotation marks omitted).

154 Richard L. Madden, Congress Votes Daylight Saving for Two Years to Save Energy, N.Y. Times, Dec. 15, 1973, at 17.

155 Richard Nixon, Statement on Signing the Emergency Daylight Saving Time Energy Conservation Act of 1973, 1973 Pub. Papers 359 (Dec. 15, 1973); see also John D. Morris, President Urges Congress to Act on Energy Bills, N.Y. Times, Dec. 16, 1973, at 1.

156 Emergency Daylight Saving Time Energy Conservation Act of 1973, Pub. L. No. 93-182, §7, 87 Stat. 707, 709. Exemptions from the act could be made by law by "any State with parts thereof in more than one time zone, and any State that lies entirely within one time zone and is not contiguous to any other State." Id. § 3(a). Additionally, the President had the power to grant exemptions upon a proclamation by a state's governor that the law would cause "undue hardship." Id. § 3(b).

157 Id. § 4(a).

158 Harold M. Schmeck, Jr., Daylight Time Begins, N.Y. Times, Jan. 6, 1974, at 1.

159 Mary Breasted, Daylight Saving Puts Most in Dark as Week Opens, N.Y. Times, Jan. 8, 1974, at 20.

160 Gene Smith, Power Use Down by as Much as 10%, N.Y. Times, Jan. 17, 1974, at 1 (reporting that Edison Electric Institute released statistics showing that production of electricity during the first week of daylight saving time was 4.1% less than the same week a year earlier and attributed this reduction to the combination of voltage reductions, daylight saving time, and voluntary conservation programs).

161 Anthony Ripley, Senate Votes Return to Standard Time for Four Months and Sends Bill to Ford, N.Y. Times, Oct. 1, 1974, at 81.

162 See B. Drummond Ayres, Jr., Benefits of Daylight Saving in Winter Widely Doubted, N.Y. Times, Feb. 3, 1974, at 40; House Unit Asks Hiatus in Daylight-Saving Time, N.Y. Times, Aug. 13, 1974, at 22.

163 Evan Jenkins, Schools Ask End to Daylight Time, N.Y. Times, Jan. 31, 1974, at 17. A Florida state education department spokesperson claimed that "six of the deaths were clearly attributable to the fact that children were going off to school in darkness." Id.

164 Act of Oct. 5, 1974, Pub. L. No. 93-434, 88 Stat. 1209 (amending the Emergency Daylight Saving Time Energy Conservation Act of 1973, Pub. L. No. 93-182, §7, 87 Stat. 707, 709 to provide for uniform standard time from the last Sunday in October 1974 through the last Sunday in February 1975); see also House Votes for a Return To Standard Time In '74, N.Y. Times, Aug. 20, 1974, at 16 (reporting that the House of Representatives voted 381 to 16 to return to standard time during winter months); Ripley, supra note 161. Congressional action against year-round daylight saving time is not surprising, since public support for winter daylight saving had dropped dramatically. A study by the National Opinion Research Center showed that only 42% favored winter daylight saving time in February 1974, down from 79% in December 1973. Anthony Ripley, Senate Votes Return to Standard Time for Four Months and Sends Bill to Ford, N.Y. Times, Oct. 1, 1974, at 81. Public opinion polls in 1974 also revealed that 38% of respondents were concerned about the safety of school children during year-round daylight saving time. See Hearing on H.R. 704 and 1647, supra note 18, at 16 (2001) (statement of Linda Lawson, Acting Deputy Assistant Secretary for Policy, United States Department of Transportation); see also Toner, supra note 117 ("A rash of early morning traffic deaths among school children in Florida in 1974 prompted Congress to lift DST during the winter months.").

165 Editorial, SOS for DST, N.Y. Times, Sept. 20, 1974, at 38.

166 Id.

167 Final Daylight Saving Report, supra note 142, at 30; Emergency Daylight Saving Time Energy Conservation Act of 1973, Pub. L. No. 93-182, § 7, 87 Stat. 707, 709 ("This Act... shall terminate at 2 o'clock antemeridian on the last Sunday of April 1975.").

168 Uniform Time Act of 1966, Pub. L. No. 89-387, § 3(a), 80 Stat. 107, 107; Daylight Saving Time Ends at 2 A.M. Sunday, N.Y. Times, Oct. 28, 1976, at 35; Daylight Saving Time to Begin Tomorrow, N.Y. Times, Apr. 24, 1976, at 26.

169 See, e.g., House Defeats Move on Daylight Savings, N.Y. Times, July 16, 1983, at 48 ("House of Representatives, bowing to rural lawmakers, has defeated legislation to extend daylight saving time."); Marjorie Hunter, Debate on Daylight Saving Time Leads to Talk of Thermometers, N.Y. Times, June 30, 1983, at B6 ("Scarcely anything so stirs the oratorical flights of fancy of farm state Congressmen as proposals for expanding daylight saving time.").

170 Act of July 8, 1986, Pub. L. No. 99-359, § 2(b), 100 Stat. 764, 764; Jonathan Fuerbringer, An Early-April Start for Daylight Saving Is Backed by Senate, N.Y. Times, May 21, 1986, at A1; Measure to Extend U.S. Daylight Time Is Sent to President, N.Y. Times, June 25, 1986, at A18.

171 Bill Signed to Advance Start of Daylight Time, N.Y. Times, July 9, 1986, at A12. The extension was also "backed by more than 8,000 fast-food outlets, sporting goods manufacturers and garden centers that all saw more daylight as a key to more sales." Toner, supra note 117.

172 Energy Policy Act of 2005, Pub. L. No. 109-058, § 110, 119 Stat. 594, 615 (codified as amended at 15 U.S.C. § 260a (Supp. V 2007)). President George W. Bush signed the bill into law on August 8, 2005. Edwin Chen, Bush Signs Overhaul of U.S. Energy Policy, L.A. Times, Aug. 9, 2005, at A10.

173 Energy Policy Act § 110; Richard Simon, Daylight Saving Time Advances, L.A. Times, July 22, 2005, at A12.

174 See Steve Lohr, Time Change a "Mini-Y2K" in Tech Terms, N.Y. Times, Mar. 5, 2007, at C1.

175 Id.

176 Indeed, one daylight saving time critic claimed that the extension of daylight saving time was inevitable, since "the number of Americans living on golf courses is greater than the number living on farms." Downing, supra note 13.

177 Richard Simon, Daylight Plan Not Greeted as Sunny News, L.A. Times, July 21, 2005, at A12. The airline industry claimed that "putting the United States 'out of sync with most of the world's clocks"' would disrupt airline schedules. School groups expressed concern that children would be forced to "wait for morning buses or walk to school in the dark." And Agudath Israel of America, a nationwide Orthodox Jewish organization, claimed that delayed sunrise would force observant Jews to choose between morning prayer and punctuality at work. Id.

178 See infra Part II.A.

179 See infra Part II.B.

180 See infra Part II.C.

181 Hearing on S. 980 and S. 2566, supra note 18 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, and International Affairs, Department of Transportation).

182 See id.

183 Id.

184 See Ezio C. Cerrelli, Nat'l Highway Traffic Safety Admin., Trends in Daily Traffic Fatalities, 1975-1995, at 1-2 (1996), available at http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/RNotes/1996/day_note.pdf.

185 Hearing on S. 980 and S. 2566, supra note 18, at 74 (statement of the APPA).

186 Hearing on H.R. 704 and 1647, supra note 18, at 18 (statement of Linda Lawson, Acting Deputy Assistant Secretary for Policy, U.S. Dep't of Transp.).

187 Final Daylight Saving Report, supra note 142, at 88 ("It is apparent that electricity usage is consistently less during the DST period at each transition by an average amount of about 1%.... The evidence is thus very strong that electricity savings are associated with DST at winter, spring and fall transitions.").

188 See Hearing on S. 980 and S. 2566, supra note 18, at 15 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans and International Affairs, Department of Transportation). But see id. at 37 (statement of Marvin H. Kahn, Senior Economist, Energy, Resources, and Environmental Systems Analysis Department, Mitre Corp.) (noting that the Department of Transportation study's comparison of total load electricity demands during years with and without winter daylight saving time could be affected by seasonal weather variations).

189 Id., at 15 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, and International Affairs, Department of Transportation).

190 Id. at 75 (statement of the APPA).

191 Hearing on H.R. 704 and 1647, supra note 18, at 18 (statement of Linda Lawson, Acting Deputy Assistant Secretary for Policy, United States Department of Transportation).

192 National Bureau of Standards, Review and Technical Evaluation of the DoT Daylight Saving Time Study E-3 (1976) (emphasis added); see also Staff of H. Comm. on Interstate & Foreign Commerce, 94th Cong., The Uniform Time Act of 1966 and Other Related Acts and Background Information for Committee Consideration of H.R. 13089 and Similar Bills Relating to Daylight Saving Time 24-25 (Comm. Print 1976) ("NBS warn[ed] that... [g]ross electricity production data, without detailed corrections for known influencing factors and trends (temperature, sky cover, etc.) are not sufficient for assessing size or direction of a possible DST-related effect on electricity consumption.").

193 Staff of H. Comm. on Interstate & Foreign Commerce, 94th Cong., supra note 192, at 24.

194 See, e.g., Daylight Saving Time: Hearings on S. 385, S. 1260, S. 2568 and S. 2602 Before the S. Comm. on Commerce, 93d Cong. 25 (1974) (statement of Sen. Claiborne Pell) ("With the extra hour of daylight saving time at a time when most of the work force is enroute home, criminals would be less apt to threaten individuals returning to their families.").

195 See Hearing on S. 980 and S. 2566, supra note 18, at 17 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, and International Affairs, Department of Transportation).

196 See, e.g., Hearing on H.R. 704 and 1647, supra note 18, at 9 (statement of Rep. Brad Sherman) ("Because people get home from work and school earlier and complete more errands and chores in daylight, daylight saving time seems to reduce people's exposure to various crimes, which are more common in darkness than in light."); WebExhibits, Daylight Saving Time: Incidents and Anecdotes, http://webexhibits.org/daylightsaving/k.html (last visited Dec. 28, 2007) ("It is clear that for most crimes where darkness is a factor, such as muggings, there are many more incidents after dusk than before dawn, so light in the evening is most welcome.").

197 Hearing on S. 980 and S. 2566, supra note 18, at 17 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, and International Affairs, Department of Transportation).

198 Id.; Final Daylight Saving Report, supra note 142, at 93-94 (indicating that Washington, D.C. crime statistics in one-hour intervals showed a decrease in crime attributable to daylight saving time; Los Angeles crime statistics were only available in two-hour intervals, yielding data that "proved to be too coarse in resolution to reveal a DST effect if there was one").

199 Hearing on S. 980 and S. 2566, supra note 18, at 17 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans and International Affairs, Department of Transportation); Final Daylight Saving Report, supra note 142, at 93 (reporting results for two locations over the course of about two years).

200 See Daylight Saving Time: Hearings on S. 385, S. 1260, S. 2568 and S. 2602 Before the S. Comm. on Commerce, 93d Cong. 26 (1974) (statement of Rep. Craig Hosmer) ("People do not shop between 6 and 9 in the morning, but in the evening. Year-round Daylight Saving Time... would also make after work shopping more attractive because of the added hour of daylight.").

201 See id. at 84 (letter from New York Economic Development Administration) ("The economic effects of making daylight savings a year-round practice would be nothing less than profound.... Because national investment decisions are so dependent on an intimate, timely knowledge of international commerce, American business in general would inevitably benefit from an additional hour's daily contact with Europe.").

202 See id. ("Retail prosperity would certainly be promoted by such a policy.... The leisure industry, a dynamic growth sector in our currently haphazard economy, prospers while the sun shines.").

203 Id. at 26 (statement of Rep. Craig Hosmer).

204 See, e.g., Ayres, supra note 162 ("Many parents say their children must start off to school in darkness, easy prey for drowsy motorists.").

205 Accidents in Florida killed eight school-age children in January 1974 (immediately after the implementation of the Emergency Daylight Saving Time Energy Conservation Act of 1973), a noticeable increase from the two children killed during January 1973. See Jenkins, supra note 163.

206 Hearings on S. 385, S. 1260, S. 2568, and S. 2602, supra note 18, at 45 (memorandum from Deputy Assistant Director for Research, Department of the Interior).

207 Hearing on S. 980 and S. 2566, supra note 18, at 59 (statement of John Koon, Exec. Secretary, Kentucky Farm Bureau Federation).

208 Id.

209 Id. at 60.

210 Hearing on S. 980 and S. 2566, supra note 18, at 75-76 (statement of the National Association of Broadcasters) ("[M]ore broadcast stations can be operated in daylight hours with little or no interference to other full time broadcasters while the same operations at night would impair signal quality of the same full time broadcasters."); Final Daylight Saving Report, supra note 142, at 106 ("[M]ore stations can broadcast from different locations on a single channel without interference during the day than at night.").

211 Final Daylight Saving Report, supra note 142, at 106; Hearings on S. 385, S. 1260, S. 2568 and S. 2602, supra note 18, at 82 (statement of Sen. Marlow Cook) ("[T]here are literally thousands of small radio stations in the United States whose only authority is to go on the air from sunrise to sunset....").

212 Final Daylight Saving Report, supra note 142, at 106.

213 Hearing on S. 980 and S. 2566, supra note 18, at 17 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, & International Affairs, Department of Transportation); Final Daylight Saving Report, supra note 142, at 106-07 ("[A] detailed examination by the FCC of revenue changes in January - April 1974 and March - April 1975 shows that a net loss of revenue is experienced (especially in the winter) at many locations.").

214 Hearing on S. 980 and S. 2566, supra note 18, at 17 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, & International Affairs, Department of Transportation). Additionally, five hundred of the twenty-three hundred AM daytime stations experienced revenue losses (averaging $1,500 for that winter) because they were operating on Mexican and Canadian clear channels and were prevented by international treaties from making presunrise time adjustments for signing on. Id. at 17, 25-26.

215 Id. at 64 (statement of J.B. Crawley, President, Radio Station WMSK, Morganfield, Ky.).

216 See id.

217 Hearing on H.R. 704 and 1647, supra note 18, at 27 (statement of Linda Lawson, Acting Deputy Assistant Secretary for Policy, U.S. Department of Transportation) ("[I]t is very old and it was also for a very limited time.").

218 See, e.g., id. at 3 (statement of Rep. Roscoe G. Bartlett, Chairman, Subcomm. on Energy) ("It is important to recognize that our patterns of energy use have changed considerably since [the 1970s], so that it is not a foregone conclusion that significant energy savings will result from extended Daylight Savings today.").

219 Final Daylight Saving Report, supra note 142, at 93-94.

220 See infra Part III.A.

221 See infra Part III.B.

222 See infra Part III.C.

223 See infra Part III.D.

224 See infra Part III.E.

225 See infra Part III.F.

226 At this point, it is worth noting briefly that it is not our intention to weigh every possible advantage or disadvantage of daylight saving time in this Article. Certainly, there are hundreds of other advantages and disadvantages--beyond those mentioned here--that policymakers could consider. By weighing the primary advantages and disadvantages of year-round daylight saving time, we hope to contribute significantly to existing literature on the subject. We encourage others to contribute meaningfully to the debate by weighing additional policy advantages and disadvantages of year-round daylight saving time.

227 See, e.g., Douglas Coate & Sara Markowitz, Pedestrian Fatalities, Motor Vehicle Occupant Fatalities, and Daylight Saving Time 7 (2002), http:// www.cornwall.rutgers.edu/pdf/Daylight%20Saving%20Time-Report.pdf.

228 See, e.g., id. at 7; Susan A. Ferguson et al., Daylight Saving Time and Motor Vehicle Crashes: The Reduction in Pedestrian and Vehicle Occupant Fatalities, 85 Am. J. Pub. Health 92, 95 (1995).

229 See, e.g., Hearing on H.R. 704 and 1647, supra note 18, at 26 (statement of James C. Benfield, Bracy Williams & Co.); Coate & Markowitz, supra note 227, at 7; Ferguson et al., supra note 228, at 92; John M. Sullivan & Michael J. Flannagan, The Role of Ambient Light Level in Fatal Crashes: Inferences from Daylight Saving Time Transitions, 34 Accident Analysis & Prevention 487, 493 (2002).

230 Ferguson et al., supra note 228, at 92; see also Coate & Markowitz, supra note 227, at 7 ("Daylight is an important determinant of morning and evening pedestrian fatalities in the U.S."); Hilary Green, Some Effects on Accidents of Changes in Light Conditions at the Beginning and End of British Summer Time 4 (1980) ("[D]arker conditions increase accident frequency and the effect is more pronounced for fatal and serious accidents than for those less severe."); Sullivan & Flannagan, supra note 229, at 493.

231 Sullivan & Flannagan, supra note 229, at 493. The study examined crash data from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System from 1987 to 1997, focusing in particular on fatal pedestrian crashes at intersections, fatal pedestrian crashes on dark rural roads, and fatal single-vehicle run-off-road crashes on dark, curved roads. Id. at 488-89. Data were compared for time periods that "straddled the daylight saving time changeover periods in time windows that abruptly changed from dark to light (or light to dark) across the time change." Id. at 489.

232 Ferguson et al., supra note 228, at 95. The study found that the negative effects of darkness "are far more pronounced for pedestrians than for vehicle occupants," attributing this to vehicle headlights, since pedestrians "rarely carry a flashlight during periods of darkness and do not often wear reflective material." Id.

233 Green, supra note 230, at 4.

234 E.g., Coate & Markowitz, supra note 227, at 7 ("[P]edestrian activity is greater in the evening period than in the morning period."); Ferguson et al., supra note 228, at 92 ("[T]here is typically more traffic during the affected evening hours than during the morning."); Sullivan & Flannagan, supra note 229, at 493 ("[M]ore crashes occur in the evening.").

235 Hearing on H.R. 704 and 1647, supra note 18, at 26 (statement of James C. Benfield, Bracy Williams & Co.).

236 See Sullivan & Flannagan, supra note 229, at 493 figs.9 & 10.

237 Mayer Hillman, Time for Change: Setting Clocks Forward by One Hour Throughout the Year 6 (1993). There also are three times as many accidents among children in Britain during the period between 3:00 p.m. and 6:00 p.m. than the period between 7:00 a.m. and 10:00 a.m. Id.

238 Coate & Markowitz, supra note 227, at 7-8.

239 Id. at title page. The study was conducted by two Department of Economics faculty members through a research grant from the Cornwall Center for Metropolitan Studies at Rutgers-Newark. Id. The researchers later published their findings in Accident Analysis and Prevention. Douglas Coate & Sara Markowitz, The Effects of Daylight and Daylight Saving Time on US Pedestrian Fatalities and Motor Vehicle Occupant Fatalities, 36 Accident Analysis & Prevention 351 (2004).

240 Coate & Markowitz, supra note 227, at 1, 4. The only counties the researchers did not examine as part of the study were counties in Alaska and Hawaii. Id. To ensure the accuracy of its findings, the study took into account variables such as miles traveled, weather, income per capita, local speed limits, seat belt and motor vehicle inspection regulations, and alcohol control policies. Id. at 5.

241 Id. at 6.

242 Id. at 7.

243 Id. The study attributed the smaller savings in motor vehicle occupant lives to "the presence of vehicle lights, which make vehicles visible to other drivers during darkness." Id. at 7-8.

244 This conclusion represents the sum of the net pedestrian lives that would have been saved during 1998 and 1999 (343) and the net motor vehicle occupant lives saved during the same two-year period (390), divided by two in order to approximate annual savings. See id. (providing a summary of lives that would have been saved during 1998 and 1999 through year-round daylight saving time).

245 Ferguson et al., supra note 228, at 95. The study found far greater benefit for pedestrians than for vehicle occupants. The estimated 901 lives that would be saved through year-round daylight saving time consisted of 727 fewer fatal pedestrian crashes and 174 fewer crashes fatal to vehicle occupants. Id.

246 The study found that Britain's experiment with year-round daylight saving time "had resulted in an 11% reduction in casualties during the hours affected by the time change in England and Wales and a 17% reduction in Scotland" and noted that "[a]lthough casualties in the morning had increased, the decrease in casualties in the evening far outweighed this." Royal Society for the Prevention of Accidents, Single/Double Summer Time Policy Paper 8 (2003), http://www.rospa.com/roadsafety/info/summertime_paper2006v2.pdf.

247 Hearing on H.R. 704 and 1647, supra note 18, at 11 (statement of Rep. Brad Sherman).

248 Id.

249 See, e.g., Hearing on H.R. 704 and 1647, supra note 18, at 26 (statement of James C. Benfield, Bracy Williams & Co.); Coate & Markowitz, supra note 227, at 7; Ferguson et al., supra note 228, at 92; Sullivan & Flannagan, supra note 229, at 493.

250 Hearing on H.R. 704 and 1647, supra note 18, at 12 (statement of Rep. Brad Sherman).

251 See id.

252 Cal. Energy Comm'n, Effects of Daylight Saving Time on California Electricity Use 3 (2001), available at http://www.energy.ca.gov/reports/2001-05-23_400-01-013.PDF.

253 Id. at 8.

254 Id.

255 Id.

256 Id.

257 Id. at 3.

258 Id. at 7. Morning peak load is always less than evening peak load because many people do not wake up until after sunrise (thus, demands associated with darkness and cold temperatures are less pronounced), while others "wake up in the dark but spend less than an hour at home before leaving for work." Id. at 8.

259 Id. at 3.

260 Id. at 16. In January 2007, two researchers at the University of California released a working paper questioning studies that show a net savings in energy from daylight saving time. See Ryan Kellogg & Hendrik Wolff, Does Extending Daylight Saving Time Save Energy? Evidence From an Australian Experiment 2-4 (Univ. of Cal. Energy Inst., Working Paper No. 163, 2007), available at http://www.ucei.berkeley.edu/PDF/csemwp163.pdf. The study examined data from Australia's brief two-month daylight saving time extension in 2000 (enacted to facilitate the Olympic Games in Sydney) and concluded that "the extension failed to conserve electricity." Id. at 3-4. Although this University of California study adds meaningful analysis to the daylight saving time debate, it should not be read as disproving the California Energy Commission's findings. The study examined an extremely limited period of time, did not analyze the effects of year-round daylight saving time, and, as the authors themselves admit, "we cannot directly apply our results to other countries without adjustment for behavioral and climatic differences." Id. at 4. As the California Energy Commission stated in a follow-up report released in May 2007, "it is important to understand that the absence of statistical confidence does not mean there is no effect. It is entirely possible that early DST saved electricity as people used less light and heat in the evenings." Cal. Energy Comm'n, The Effect of Early Daylight Saving Time on California Electricity Consumption: A Statistical Analysis 5 (2007), available at http://www.energy.ca.gov/2007publications/CEC-200-2007-004/CEC-200-2007-004.PDF. See also Justin Lahart, Daylight Saving Wastes Energy, Wall St. J., Feb. 27, 2008, at D1 (noting that a recent study conducted by Mathew

Kotchen and Laura Grant showed a slight increase in electricval consumption in Indana due to increased air conditiong use after the switch to daylight saving time). Although more studies are needed to conclusively wuanitfy the net effect of dalight saving time, the great majority of the reserch performed to date verifies energy savings.

261 Hearing on H.R. 704 and 1647, supra note 18, at 6 (statement of Rep. Brad Sherman).

262 Compare, e.g., Kate Painter, The Influence of Street Lighting Improvements on Crime, Fear and Pedestrian Street Use, After Dark, 35 Landscape & Urb. Plan. 193, 193 (1996) (arguing that study results "provide convincing evidence that sensitively deployed street lighting can lead to reductions in crime and fear of crime, and increase pedestrian street use after dark"), and Kate Painter & David P. Farrington, Street Lighting and Crime: Diffusion of Benefits in the Stoke-on-Trent Project, 10 Crime Prevention Studies 77, 94 (1999) ("For all crime categories except burglary, prevalence decreased significantly in the experimental area after the street lighting was improved."), available at http://popcenter.org/Library/CrimePrevention/Volume% 2010/04-PainterFarrington.pdf, with Stephen Atkins et al., Home Office (London), Crime Prevention Unit Paper No. 28, The Influence of Street Lighting on Crime and Fear of Crime 20 (1991) ("[N]o evidence could be found to support the hypothesis that improved street lighting reduces reported crime."), available at http://www.homeoffice.gov.uk/rds/prgpdfs/fcpu28.pdf, and David Herbert & Norman Davidson, Modifying the Built Environment: The Impact of Improved Street Lighting, 25 Geoforum 339, 341 (1994) ("There is clearly no necessary relationship between lighting and crime."), and Malcolm Ramsay, Home Office (London), Crime Prevention Unit Paper No. 29, The Effect of Better Street Lighting on Crime and Fear: A Review 24 (1991) ("Better lighting by itself has very little effect on crime."), available at http:// www.homeoffice.gov.uk/rds/prgpdfs/fcpu29.pdf.

263 See Lawrence W. Sherman et al., Univ. of Md., Preventing Crime: What Works, What Doesn't, What's Promising: A Report to the United States Congress 203 (1997) (noting that the effect of lighting on crime is inconclusive in part "due to the lack of research on lighting, particularly in the United States" and in part because "the limited research on lighting continues to use weak designs (typically without control areas) which fail to substantially reduce our uncertainty about the effect of lighting on crime").

264 David P. Farrington & Brandon C. Welsh, Home Office (London), Research Study No. 251, Effects of Improved Street Lighting on Crime: A Systematic Review 2 (2002) (noting that although initial research questioned the effect of street lighting on crime, "as further evidence accumulated, there were more signs that improved street lighting could have an effect in reducing crime"), available at http://www.homeoffice.gov.uk/rds/pdfs2/hors251.pdf.

265 Id. at 8 ("The main aim of this report is to present the findings of a systematic review of the available research evidence on the effects of improved lighting on crime."); see also David P. Farrington & Brandon C. Welsh, Improved Street Lighting and Crime Prevention, 19 Just. Q. 313, 313 (2002) (publishing the findings of Farrington & Welsh's systematic review).

266 "Systematic analysis" refers to the use of "rigorous methods for locating, appraising and synthesizing evidence from prior evaluation studies." Farrington & Welsh, supra note 264, at 7.

267 Id. at 9.

268 Id. at 34. Farrington and Welsh's systematic analysis later was criticized for "ignor[ing] the large variation (known as 'overdispersion') in the data and implicitly assum[ing] that crimes are independent events." P. R. Marchant, Research Note, A Demonstration that the Claim that Brighter Lighting Reduces Crime Is Unfounded, 44 Brit. J. Criminology 441, 441 (2004). However, this criticism does not invalidate the conclusions of Farrington and Welsh's systematic analysis:

Dr Marchant's critique has drawn attention to our disciplines [sic] lack of knowledge about key criminology issues.... Contrary to Dr Marchant's arguments, however, we contend that the [studies] did provide evidence that improved lighting caused a decrease in crime.... Even if we assume that the variance of the total number of crimes greatly exceeds the mean, the conclusions of our meta-analysis hold up: namely that existing evaluations of the highest methodological quality, when analysed together, show that improved lighting, on average, causes a significant 20 per cent decrease in crime in experimental areas compared with comparable control areas.

David P. Farrington & Brandon C. Welsh, Measuring the Effects of Improved Street Lighting on Crime: A Reply to Dr Marchant, 44 Brit. J. Criminology 448, 465-66 (2004).

269 See, e.g., Mich. Metro. Info. Ctr., Wayne State Univ., Reality vs. Perceptions: An Analysis of Crime and Safety in Downtown Detroit 7-8 (2005), available at http://www.tedconline.com/uploads/Downtown_Detroit_Crime_Study_ 2006.pdf; Marcus Felson & Erika Poulsen, Simple Indicators of Crime by Time of Day, 19 Int'l J. Forecasting 595, 598 (2003). Violent crime rates in particular are higher per hour during the late afternoon and evening than during morning and early afternoon hours. According to the U.S. Department of Justice, 52.6% of violent crimes in 2005 occurred between 6:00 a.m. and 6:00 p.m. (an average hourly rate of 4.4%), while 34.5%

of violent crimes occurred between 6:00 p.m. and midnight (an average hourly rate of 5.8%). Bureau of Justice Statistics, U.S. Dep't of Justice, Criminal Victimization in the United States, 2005 Statistical Tables tbl.59 (2005), available at http:// www.ojp.usdoj.gov/bjs/pub/pdf/cvus05.pdf.

270 See, e.g., Mich. Metro. Info. Ctr., Wayne State Univ., Reality vs. Perceptions: An Updated Analysis of Crime and Safety in Downtown Detroit 7 (2006) ("Criminal acts by nature do not remain constant over time. Rather, crime incidents vary by month, day of week and time of day."); Ellen G. Cohn & James Rotton, Weather, Seasonal Trends and Property Crimes in Minneapolis, 1987-1988: A Moderator-Variable Time-Series Analysis of Routine Activities, 20 J. Envtl. Psychol. 257, 266 (2000) ("[T]he primary determinants of criminal behavior are time of day and day of the week."); Felson & Poulsen, supra note 269, at 595 ("Crime varies more by hour of day than by any other predictor we know.").

271 Felson & Poulsen, supra note 269, at 599. The thirteen cities included Albany, N.Y.; Akron, Ohio; Cincinnati, Ohio; Evansville, Ind.; Fort Wayne, Ind.; Hartford, Conn.; Lincoln, Neb.; Lowell, Mass.; Plano, Tex.; Rockford, Ill.; South Bend, Ind.; Springfield, Ill; and Tampa, Fla. Id.

272 Id. at 596.

273 Id. at 597, 599.

274 See id. at 599.

275 See id.

276 See id. at 598 (noting that only 8.9% of all robberies in Albany, New York occur between 6:00 and 11:00 a.m.; in comparison, 29.1% of all robberies occur between 6:00 and 11:00 p.m.).

277 See, e.g., Bureau of Justice Statistics, U.S. Dep't of Justice, supra note 269 tbl.59 (recording that robbery, assault, motor vehicle theft, rape and sexual assault incidents during 2005 were, on average, higher per hour between 6:00 p.m. and midnight than between 6:00 a.m. and 6:00 p.m.); Mich. Metro. Info. Ctr., supra note 270, at 8 (noting that most criminal incidents of robbery, felonious assault, larceny and motor vehicle theft in downtown Detroit occurred during evening hours; morning incidents constituted less than twenty percent of those occurring during the evening); Office of Juvenile Justice and Delinquency Program, U.S. Dep't of Justice, Juveniles as Offenders: Time of Day, http://ojjdp.ncjrs.org/ojstatbb/offenders/qa03301.asp (last visited Dec. 29, 2007) ("Juvenile violence peaks in the afterschool hours on school days and in the evenings on nonschool days."); Statistical Analysis Center, Office of Justice Assistance (Wisconsin), Incident-Based Reporting, Data Examples 224 graph 11, http://oja.state.wi.us/docview.asp?docid=4045&locid=97 (last visited Dec. 29, 2007) (noting that approximately 13.3% of Wisconsin robberies occur between 6:00 a.m. and 12:00 noon; in comparison, 42.4% of robberies occur between 6:00 p.m. and 12:00 midnight).

278 See, e.g., Mich. Metro. Info. Ctr., supra note 270, at 8 (recording that robbery, felonious assault, larceny and motor vehicle theft in downtown Detroit peak during evening hours); Office of Juvenile Justice and Delinquency Program, supra note 277; Bureau of Justice Statistics, U.S. Dep't of Justice, supra note 269 tbl.59 (noting that robbery, assault, motor vehicle theft, rape, and sexual assault incidents during 2005 were, on average, higher per hour between 6:00 p.m. and midnight than between 6:00 a.m. and 6:00 p.m.).

279 See, e.g., Bureau of Justice Statistics, U.S. Dep't of Justice, supra note 269 tbl.59; Mich. Metro. Info. Ctr., supra note 270, at 8 (morning crime incidents constitute less than twenty percent of those occurring during the evening); Statistical Analysis Center, Office of Justice Assistance (Wisconsin), supra note 277.

280 Stanley Coren, Correspondence, **Daylight Savings Time** and Traffic Accidents, 334 New Eng. J. Med. 924, 924 (1996).

281 See, e.g., id. (claiming that the cost of sleep-related accidents in 1988 "exceeded $56 billion and included 24,318 deaths and 2,474,430 disabling injuries"); Damien Leger, The Cost of Sleep-Related Accidents: A Report for the National Commission on Sleep Disorders Research, 17 Sleep 84, 91 (1994) ("The total economic cost of sleepiness related to accidents, including motor-vehicle, work-related, home-based, and public accidents, is estimated to have been between 43 and 56 billion dollars in 1988."); Timothy H. Monk & Simon Folkard, Letter, Adjusting to the Changes to and from Daylight Saving Time, 261 Nature 688, 689 (1976) ("[A]djustment to the time changes associated with DST is not instantaneous, and that significant disruptions in behaviour may occur during adaptation to the new cycle.").

282 See Sharon Bernstein, Time Change May Put Sleepier Drivers on Road, L.A. Times, Mar. 31, 2005, at B2 ("[E]ven the loss of a small amount of sleep can affect driving"); Coren, supra note 280, at 924 ("Although one hour's change may seem like a minor disruption in the cycle of sleep and wakefulness, measurable changes in sleep pattern persist for up to five days after each time shift."); Dawn Fallik, Body Clocks Don't Just Spring Ahead, Boston Globe, Mar. 12, 2007, at C1 ("Studies have shown that the Monday after daylight saving time, car accidents increase 10 percent on the highways.... You're taking a sleep-deprived nation and cutting another hour off the board, not simply shifting the circadian rhythm." (quoting Dr. Charles A. Czeisler, chief of sleep medicine at Brigham and Women's Hospital)). But see Neeraj Sood & Arkadipta Ghosh, The Short and Long Run Effects of Daylight Saving Time on Fatal Automobile Crashes, 7 Berkeley Elec. J. Econ. Analysis & Pol'y, Art. 11, at 15 (2007) (finding no increase in automobile crashes resulting from the short-term sleep disruption associated with daylight saving time changes, but admitting that this result "mostly contradicts findings in the existing literature").

283 Stanley Coren, Accidental Death and the Shift to **Daylight Savings Time**, 83 Perceptual & Motor Skills 921, 921 (1996).

284 Id.

285 Id. at 922.

286 See Sharon Bernstein, supra note 282; Robert A. Hicks et al., Daylight Saving-Time Changes Increase Traffic Accidents, 56 Perceptual & Motor Skills 64, 65 (1983).

287 Sharon Bernstein, supra note 282 (reporting findings of study by Jason Varughese of Stanford University and Richard P. Allen of Johns Hopkins University).

288 Hicks et al., supra note 286, at 65 (emphasis added).

289 Id. at 66.

290 Id. at 66. It is worth noting that studies on the effect of the daylight saving time changes are not in complete agreement. Compare, e.g., Coren, supra note 280, at 924 (claiming that the spring shift to daylight saving time results in an eight percent increase in traffic accidents, and the fall shift results in a decrease in accidents of the same percentage), with Mats Lambe & Peter Cummings, The Shift to and from **Daylight Savings Time** and Motor Vehicle Crashes, 32 Accident Analysis & Prevention 609, 609-11 (2000) (analyzing the effect of the shift to and from daylight saving time on motor vehicle crashes in Sweden and concluding that the shift had no measurable effects on crash incidence), and Alex Vincent, Correspondence, Effects of **Daylight Savings Time** on Collision Rates, 339 New Eng. J. Med. 1167-68 (1998) (questioning Dr. Coren's findings). However, most studies show a net effect on lives that is at least marginally (and frequently significantly) negative, and no study shows a net savings in lives as a result of both spring and fall daylight saving time changes combined.

291 Gregory J. Hicks et al., Fatal Alcohol-Related Traffic Crashes Increase Subsequent to Changes to and from **Daylight Savings Time**, 86 Perceptual & Motor Skills 879, 880 (1998).

292 Mark J. Kamastra et al., Losing Sleep at the Market: The Daylight Saving Anomaly, 90 Am. Econ. Rev. 1005, 1010 (2000).

293 As a counterargument, one should note that critics of year-round daylight saving contend that the switch in time during fall and spring is actually positive because it reminds Americans to change the batteries in their smoke detectors. See Josh Brown, Points of Contention, Dallas Morning News, July 27, 2005, at 2A (stating that "firefighters who've used the 'change your clock, change your battery' slogan worry about dead smoke detectors" from extended daylight saving time); Kevin Duggan, Has Time Run Out on Daylight Saving?, Fort Collins Coloradoan, Apr. 3, 2004, at B1 ("Fire officials say daylight-saving time is a good way to remember to change the batteries in smoke detectors."). While this may be true, it seems curious to the authors why changing from daylight saving time to standard time should be the one and only impetus for Americans to think about fire safety. Why not choose July 4th or Christmas or Halloween or create national "Smokey the Bear Day" to address this concern?

294 See, e.g., Ayres, supra note 162 ("Many parents say their children must start off to school in darkness, easy prey for drowsy motorists."); Editorial, Don't Mess with Time, Atlanta J. Const., Apr. 3, 1993, at A19 ("The worst thing about daylight-saving time is that darkness still lingers when some children are going to school."); Dianne Stallings, Parents Worry About Bus Stops in the Dark, St. Petersburg Times (Fla.), Oct. 1, 1987, at 1 (reporting that school and parent-teacher associations propose reducing daylight saving time observance to decrease risk of children waiting for school buses in the dark); Suzanne Wilder, More Sun for Some Will Leave

Others in Dark, Columbus Dispatch (Ohio), Aug. 20, 2005, at A1 (reporting that the National Parent Teacher Association initially opposed the proposal to extend daylight saving time for eight weeks).

295 As noted above, accidents in Florida killed eight school-age children in January 1974 (immediately after the implementation of the Emergency Daylight Saving Time Energy Conservation Act of 1973), a noticeable increase from the two children killed during January 1973. See Jenkins, supra note 163.

296 Hearing on S. 980 and S. 2566, supra note 18, at 12 (statement of James E. Baker, Superintendent, Middlesboro Schools, Middlesboro, Ky.).

297 Ayres, supra note 162.

298 School Deaths Not Tied to Shift in Time, N.Y. Times, Feb. 21, 1974, at 20; see also Hearing on S. 980 and S. 2566, supra note 18, at 50-51 (statement of Robert Currie, Director of the National Safety Council's Office of External Relations; Accompanied by Harry Rosenfield, General Counsel).

299 See, e.g., Final Daylight Saving Report, supra note 142, at 77-83 (concluding that daylight saving time does not "have a significant effect on the number of children killed going to and from school"); Coate & Markowitz, supra note 227, at 10 n.11 (finding "no increased risk to school children" from year-round daylight saving time and concluding that "sunrise is not an important variable" in fatalities of school-age children).

300 Coate & Markowitz, supra note 227, at 10 n.11.

301 Hearing on S. 980 and S. 2566, supra note 18, at 19 (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, & International Affairs, Department of Transportation). A study by the National Bureau of Standards later questioned the validity of the Department of Transportation's findings. National Bureau of Standards, supra note 192, at E-3 ("There was a statistically significant increase of school-age children fatalities in the morning during the four-month period January-April 1974 as compared to the same period (non-DST) of 1973."). However, the NBS considered only injuries to pedestrians and pedal-cyclists, completely excluding the category of motor-vehicle occupant fatalities experienced by school-age children. Daylight Saving Time Act of 1976: Hearings Before the Subcomm. on Transportation and Commerce of the Comm. on Interstate and Foreign Commerce on H.R. 13089, H.R. 13090 (and Similar Bills) and S. 2931, 94th Cong. 51 (1976) (statement of Robert H. Binder, Assistant Secretary for Policy, Plans, & International Affairs, Department of Transportation). A comparison of standard time (1973) and winter daylight saving time (1974) showed motor-vehicle occupant fatalities for school-age children decreasing at all times of the day. Id. The NBS methods thus are incomplete and skew the analysis.

302 See, e.g., Schools Starting Later to Protect the Children, N.Y. Times, Jan. 14, 1974, at 21 (noting that school districts in Minneapolis; Norwalk, Conn.; Philadelphia; Winston-Salem, N.C.; and parts of Wisconsin had delayed start times); Ayres, supra note 162 ("Hundreds of schools, including those in Tallahassee, now open their doors a half an hour or so later than before.").

303 National Bureau of Standards, supra note 192, at S-6.

304 Energy Hearing on H.R. 704 and 1647, supra note 18, at 96 (post-hearing answers submitted by William R. Harris).

305 Id. at 56 (statement of James C. Benfield, Bracy Williams & Co.) (emphasis added); see also Hillman, supra note 237, at 5 (noting that the small increase in morning children fatalities during Britain's 1968-1971 experiment with year-round daylight saving time "seems to have been so imprinted on the public memory that the far more substantial decrease stemming from the lighter late afternoons in the winter and evenings in the summer has been overlooked"). Moreover, this problem relates to systematic misperception of risk--people fear and overreact to highly publicized risks that they see and hear about (even ones that are minimal) far more than they fear risks they do not see and hear about (even where they are far greater). See generally Steve P. Calandrillo, Responsible Regulation: A Sensible Cost-Benefit, Risk Versus Risk Approach to Federal Health and Safety Regulation, 81 B.U. L. Rev. 957, 1000-02 (2001) (discussing the effect of societal misperception of risk on policy decisions).

306 Final Daylight Saving Report, supra note 142, at 113-14 (reporting the findings of Department of Agriculture).

307 See, e.g., Congress For Repeal of Daylight Saving, supra note 78 (reporting that agricultural interests successfully lobbied Congress for repeal of the first daylight saving law).

308 See Robert Tuttle, Happy to Spring Ahead, More Daylight-Saving? Local Businesses Say It's Time For a Change, Newsday (N.Y.), Aug. 10, 2005, at A39.

309 See supra Part II.B.

310 Hearing on H.R. 704 and 1647, supra note 18, at 75 (statement of James C. Benfield, Bracy Williams & Co.).

311 Final Daylight Saving Report, supra note 142, at 111 (stating that the FCC estimated that the 1974 experiment with winter daylight saving time resulted in a revenue loss of $750,000, which is "statistically insignificant" when measured against total AM broadcast revenues of $1.5 billion that year).

43 WFLR 45

End of Document

SenatorReady_info_SB0517
Uploaded by: Senator Ready, Senator Ready
Position: FAV

The Report of the Special Commission on the Commonwealth's Time Zone

DRAFT Sept. 18, 2017

Contents

Executive Summary

Purpose of the Special Commission

In the summer of 2016, the Legislature passed *An Act relative to job creation and workforce development*. Section 136 of the bill established a special commission with the purpose of conducting "a comprehensive study relative to the practical, economic, fiscal and health related impacts of the commonwealth remaining on Eastern Daylight Time, 4 hours behind coordinated universal time, also known as Atlantic Standard Time, throughout the calendar year."

Structure of the Special Commission

The statute that established the special commission required that the commission consist of 11 members appointed by the governor, the speaker of the House, the president of the Senate, the House minority leader, and the Senate minority leader.

Background

Twice a year, as Massachusetts residents are reminded to set their clocks forward or back an hour, media outlets inundate the public with anecdotes and opinions that usually bemoan (and occasionally celebrate) this ritual. Until the formation of this Commission, however, the Commonwealth had not tasked any group with researching or analyzing the wisdom of maintaining the status quo of switching back-and-forth between daylight saving time ("DST") and standard time.

The tradition of moving the clocks forward one hour and back one hour annually may appear longstanding, but DST was only introduced in the U.S. during World War I, and then federally abandoned (although intermittently used by some states) until 1966 when Congress pass the Uniform Time Act, which established DST as running from the last Sunday of April until the last Sunday in October. DST dates have been amended several times since 1966. The current dates for "springing forward" and "falling back" – the second Sunday in March until the first Sunday in November – have been in place since 2007.

One of 17 states in the Eastern Time Zone, Massachusetts currently follows Eastern Daylight Time ("EDT," coordinated universal time minus 4 hours) when observing DST, and Eastern Standard Time ("EST," coordinated universal time minus five hours) when observing standard time.

Although DST is observed in 48 U.S. states (Hawaii and Arizona – with the exception of the Navajo Nation – do not participate), a surprising lack of uniformity exists around the world. DST is employed in only about 70 countries. Most of Africa and Asia do not observe DST, and South America is split, with many of its northern countries not observing DST, while nations like Paraguay and southern Brazil following DST. Even those countries that observe DST have inconsistent start and end dates. For example, Canada follows the United States' DST dates, Europe observes DST but switches its clocks a few weeks after the U.S, and the parts of

Australia that observe DST do so during the lighter half of the Australian year, from October through April.

No mechanism exists through which Massachusetts could adopt year-round DST, as federal law only allows states to opt out of DST. But the Commonwealth could effectively achieve that goal by moving from the Eastern Time Zone to the Atlantic Time Zone and then opting out of DST. Several states are considering bills that would move them to year-round DST, including four of the five other New England states. If Massachusetts does move to the Atlantic Time Zone and opt out of DST, then the Commonwealth would be an hour ahead of the rest of the East Coast for roughly four months each year.

Findings

This Commission researched and evaluated the impact of time and DST to understand whether the inconvenience of changing clocks twice per year is fulfilling goals in various policy areas from energy to crime to public health. Following this analysis, the Commission considered whether Massachusetts should move to the Atlantic Time Zone (effectively observing year-round DST).

The Commission utilized a data-driven approach in reaching its findings and recommendations, relying on experts, academic papers, facts, and data. The Commission reached the following findings:

- *Economic Development: Commerce and Trade.* The United States has a history of adjusting the clocks or the calendar to increase retail sales, and year-round DST has the potential to create economic growth in Massachusetts as people tend to shop, dine out, and engage in other commercial activities more in after-work daylight. Year-round DST could also increase the state's competiveness in attracting and retaining a talented workforce by mitigating the negative effects of Massachusetts' dark winters and improving quality-of-life.

- *Labor and Workforce*. Eliminating the spring transition to DST could increase productivity and cut down on both the number and severity of on-the-job injuries, which would lead to lower costs for businesses (e.g. more productivity, lower rates for workers' compensation insurance, and less need for hiring and training replacement workers).

- *Public Health.* Adopting year-round DST could improve public health in the Commonwealth by eliminating the annual spring transition to DST—and the corresponding increase in traffic fatalities, workplace injuries, and heart attacks—and also by providing residents with additional evening daylight during the winter, which would lead to increased physical activity among residents.

- *Energy.* Year-round DST has the potential to produce some energy savings for Massachusetts residents. Due to the timing of those savings and New England's current energy portfolio, year-round DST could lead to meaningful reductions in both future energy costs and greenhouse gas emissions.

- *Crime and Criminal Justice*. Research suggests that year-round DST would reduce street crime, produce significant social cost savings, and also reduce inequities within the criminal justice system.

- *Transportation*. Year-round DST could have a mixed impact on transportation. While year-round DST would lead to fewer traffic fatalities, unilateral action by Massachusetts would complicate interstate travel.

- *Broadcasting*. Year-round DST may have some negative effects on broadcasters and scheduled television programming unless other states also adopt year-round DST.

- *Education and School Start Times*. With current school schedules remaining in place, adopting year-round DST could pose a safety risk to school-aged children in the winter. Those risks could be mitigated, however, by delaying school start times. In addition to alleviating safety concerns, later school start times have led to higher attendance rates; lower tardiness and dropout rates; and improved grades and test scores in schools in Massachusetts and around the country.

Recommendations

Based on its research and findings, and after weighing the costs and benefits associated with the observance of time in Massachusetts, the Commission believes that under certain circumstances the Commonwealth could make a data-driven case for moving to the Atlantic Time Zone year-round (effectively observing year-round DST). Although there are appreciable costs associated with making this change, on balance the Commission finds that doing so could have positive benefits that largely stem from the absence of a spring transition to DST and the additional hour of winter evening daylight.

However, the Commission does not recommend a simple switch to the Atlantic Time Zone, and cautions that several qualifiers should accompany any future conversations or legislative proposals with respect to how Massachusetts observes time. The Commission offers the following blueprint of concerns for a thoughtful implementation of year-round DST, should Massachusetts ever decide to pursue this policy change:

- *Regional action*. Massachusetts should only move to year-round DST if a majority of other New England states also do so.

- *Later school start-times*. Any move to year-round DST should be accompanied by statewide standards for delaying school start-times to mitigate safety issues and help students.

- *Public awareness*. The Commonwealth should not adopt year-round DST unless it simultaneously commits funding to educate the public about the implications of the change.

Purpose of the Commission

In the summer of 2016, the Legislature passed *An Act relative to job creation and workforce development*. Section 136 of Chapter 219 of the Acts of 2016 established that:

> [T]here shall be a special commission to conduct a comprehensive study relative to the practical, economic, fiscal and health related impacts of the commonwealth remaining on eastern daylight time, 4 hours behind coordinated universal time, also known as Atlantic standard time, throughout the calendar year. The commission shall focus on the impact to local and regional economies, education, public health, transportation, energy consumption, commerce and trade if the time zone is altered.

To carry out its purpose, the Commission held several public meetings during which it received testimony from a variety of experts and stakeholders. Experts reported on a variety of subjects, including the history of times zones in the United States, economic and retail development, criminal activity, the region's energy system, transportation, broadcasting, public health, and school start time/student performance impacts related to daylight and time zones.

For a complete list of meeting participants, subject matters, and testimony offered, please refer to Appendices A and B of this report.

Structure of the Commission

The statute that established the Commission also delineated its structure and required that the Commission be made up of eleven members appointed as follows:

> The commission shall be comprised of the following members: 3 members to be appointed by the governor, 1 of whom shall be a member of the executive office of health and human services and 1 of whom shall be a member of the executive office of education; 3 members to be appointed by the president of the senate, 1 of whom shall have expertise in economic development and 1 of whom shall have expertise in energy; 1 member to be appointed by the senate minority leader; 3 members to be appointed by the speaker of the house of representatives, 1 of whom shall have expertise in interstate commerce and 1 of whom shall have expertise in transportation; and 1 member to be appointed by the house minority leader.

In accordance with the statutory guidelines, the members of the Commission are:

Senate president appointments:

Senator Eileen Donoghue, Chair
First Middlesex District

Mr. Peter Shattuck
Director of the Clean Energy Initiative, Acadia Center

Mr. Thomas Emswiler
Public health advocate

Speaker of the House appointments:

Representative Daniel Cahill
Tenth Essex District

Representative Michael Finn
Sixth Hampden District

Dr. Judith Owens
Director of the Center for Pediatric Sleep Disorders, Boston Children's Hospital

Governor appointments:

Mr. Tim Miley (replaced by Ms. Jennifer Barrelle in August 2017)
Department of Public Health

Mr. Robert LePage
Assistant Secretary for Career Education, Executive Office of Education

Mr. John Warren
General Manager of the Sports Licensed Division, Reebok International, LTD

Senate minority leader appointment:

Dr. Yvonne Spicer
Vice President for Advocacy & Educational Partnerships, National Center for Technological Literacy

House minority leader appointment:

Representative Paul Frost
Seventh Worcester District

Background

DST began during World War I when Germany moved its clocks back to reduce electricity usage and make more coal available for other uses.[1] The United States followed suit, passing the Standard Time Act of 1918, which established the four time zones still found across the continental United States.[2] The national observation of DST ceased after the war, but many states, counties, and even individual municipalities continued the practice, creating a confusing patchwork of DST observance across the country.[3]

The lack of a standardized approach to DST complicated commerce, particularly in the transportation and broadcasting industries, which prompted Congress to act.[4] The Uniform Time Act of 1966 created a system in which every state observed DST beginning on the last Sunday in April and ending on the last Sunday in October, unless an entire state opted out of DST.[5] The Act was later amended so that a state straddling two time zones could exempt a portion of the state from DST. The Uniform Time Act ended the country's slapdash geographical calendar of DST observances.[6]

During the oil embargo of 1973, Congress experimented with year-round DST to conserve fuel.[7] The experiment was intended to last from January 6, 1974, to April 27, 1975, although the country returned to an abbreviated period of standard time after parents raised concerns about children walking to school in the dark.[8] In 1975, the U.S. Department of Transportation evaluated the experiment and determined that extending the DST period from six to eight months could have modest benefits "in the areas of energy conservation, overall traffic safety, and reduced violent crime."[9]

In 1986, Congress advanced the start date of DST by three weeks to the first Sunday in April in another attempt to conserve energy.[10] Then, in 2007, following the passage of the Energy Policy Act of 2005, the start date of DST moved forward an additional three weeks to the second Sunday in March, and the end date moved back one week to the first Sunday in November.[11]

[1] Matthew J. Kochten & Laura E. Grant, *Does Daylight Saving Time Save Energy? Evidence from a Natural Experiment in Indiana*, 93 Review of Econ. and Stat. 1172, 1172 (2011).
[2] Daniel S. Hammermesh et. al, *Cues for Timing and Coordination: Latitude, Letterman, and Longitude*, 26 J. Lab. Econ. 223, 227 (2008).
[3] Jody Brumage, *The Uniform Time Act of 1966*, Robert C. Byrd Center for Congr. History and Educ. (Mar. 15, 2009), www.byrdcenter.org/byrd-center-blog/the-uniform-time-act-of-1966.
[4] *Id*.
[5] Beth Cook, Cong. Research Serv., R44411, Daylight Saving Time (2016).
[6] *Id*.
[7] *Id*.
[8] *Id*.
[9] Office of the Assistant Sec'y for Policy, Plans, and Int'l Affairs, U.S. Dep't of Transp., Exec. Summary of the Final Report on the Operation and Effects of Daylight Saving Time (1975).
[10] Kochten, *supra* note 1.
[11] *Id*.

Most U.S. states and territories observe DST, with the exceptions of American Samoa, Arizona (except the Navajo Nation, which does observe DST), Guam, Hawaii, the Northern Mariana Islands, Puerto Rico, and the Virgin Islands.[12] Thus, after several decades and two separate extensions, the United States ended up with eight months of DST, the system that remains in place today.[13]

[12] Cook, *supra* note 5.
[13] Brian Resnick, *The awfulness of daylight saving time, mapped*, Vox (Mar. 12, 2016, 9:15 am), www.vox.com/science-and-health/2015/11/19/9762276/daylight-saving-time-bad-mapped.

Although DST is observed in 48 states, a surprising lack of uniformity exists globally. DST is employed in only about 70 countries.[14] Most of Africa and Asia do not observe DST,[15] and South America is split, with many of its northern countries not observing DST, while places like Paraguay and southern Brazil following DST.[16] Even those countries that do observe DST have different start and end dates. For example, Canada follows the United States, Europe observes DST but switches its clocks a few weeks after the United States, and the parts of Australia that observe DST do so from October through April.[17]

No mechanism exists through which Massachusetts could adopt year-round DST, as federal law only allows states to opt out of DST,[18] but the Commonwealth could effectively achieve that goal by moving from the Eastern Time Zone to the Atlantic Time Zone and then opting out of DST.[19] A geographic area can change its time zone through an act of Congress, or through regulations issued by the U.S. Secretary of Transportation.[20] Under the regulatory route—the only approach used in recent decades—a state government petitions for a change in time zone, and the Secretary of Transportation evaluates the petition based on the change's impact on commerce.[21]

Several other states are considering bills that would move them to year-round DST, including four of the other five New England states.[22] A bill that would have made such a change in Maine—but only if Massachusetts and New Hampshire also participated—passed both legislative chambers but was ultimately laid aside.[23] A similar bill passed New Hampshire's House but was rejected by its Senate.[24] Bills establishing year-round DST were also filed in the Connecticut and Rhode Island legislatures, and in the legislatures of Illinois, Michigan, Mississippi, New Mexico, and Wyoming.[25]

[14] Meeting of the Special Comm'n on the Commonwealth's Time Zone [hereinafter Comm'n], statement of Dr. David Prerau (Apr. 12, 2017).
[15] *Worldwide Daylight Saving Time*, Web Exhibits: Daylight Saving Time (2008), www.webexhibits.org/daylightsaving/g.html (last accessed 9/12/17).
[16] *Id.*
[17] *Id.*
[18] Cook, *supra* note 5.
[19] Matt O'Brien, *Could New England Secede from Eastern Standard Time?*, Bos. Globe (Mar. 11, 2016), www.bostonglobe.com/metro/2016/03/11/will-new-england-secede-from-eastern-standard-time/4T9tNuLYXX3rz3SKWMpkZI/story.html.
[20] U.S. Dep't of Transp., Procedure for Moving an Area from One Time Zone to Another (2013).
[21] *Id.*
[22] *See* Time Zone Report: Following Daylight Saving Time legislation in the U.S., timezonereport.com/ [hereinafter Time Zone Report].
[23] Joe Lawlor, *Maine legislators set aside bill to end twice-a-year clock changes*, Press Herald (Jun. 12, 2017), www.pressherald.com/2017/06/12/atlantic-standard-time-zone-bill-all-but-dead-in-legislature/.
[24] David Brooks, *Senate votes down push to switch N.H.'s time zone*, Concord Monitor (May 11, 2017), www.concordmonitor.com/time-zone-change-atlantic-9808198.
[25] Time Zone Report *supra* note 22.

If Massachusetts does move to the Atlantic Time Zone and opts out of DST, then the Commonwealth would be an hour ahead of the rest of the East Coast for roughly four months each year.[26]

The following table breaks down the periods of the year when Massachusetts would be in or out of sync with the rest of the Eastern Time Zone:

	Massachusetts	Rest of Eastern Time Zone	Difference
Second Sunday in March until first Sunday in November (34 weeks, roughly 2/3 of the year)	Coordinated Universal Time minus four hours	Coordinated Universal Time minus four hours	No difference
First Sunday in November until second Sunday in March (18 weeks, roughly 1/3 of the year)	Coordinated Universal Time minus four hours	Coordinated Universal Time minus five hours	Massachusetts one hour ahead

[26] *Supra* note 14, statement of Dr. David Prerau (Apr. 12, 2017).

Findings

Twice a year, as Massachusetts residents are reminded to set their clocks forward or back an hour, media outlets inundate the public with anecdotes and opinions that usually bemoan (and occasionally celebrate) this ritual switching. Until the formation of this Commission, however, the Commonwealth had not requested any group to analyze the wisdom of maintaining the status quo and switching back-and-forth between EDT and EST.

This Commission researched and evaluated the impact of time zones and DST in terms of energy, crime, and public health to help to determine the advisability of Massachusetts moving to the Atlantic Time Zone (effectively observing year-round DST). The Commission utilized a data-driven approach in determining its findings and recommendations, and relied on experts, academic papers, and data to evaluate the merits of questions about time zones. The Commission reached the following findings:

Economic Development: Commerce and Trade

The United States has a history of adjusting the clocks or the calendar to increase retail sales.[27] For example, Thanksgiving has been moved to an earlier date to lengthen the shopping season leading up to Christmas,[28] and the 2007 extension of DST was at least partially motivated by a desire to increase evening retail sales.[29] Year-round DST represents another opportunity to fuel consumer spending.

Jon Hurst, president of the Retailers Association of Massachusetts, surveyed his organization's members about DST in March 2017 and shared the results with the Commission. A majority of the responding retailers did not believe that Massachusetts should continue the status quo and switch between standard time and DST, and while no clear consensus existed about the choice that Massachusetts should make, a plurality of respondents indicated that Massachusetts should adopt year-round DST.[30] Mr. Hurst emphasized that New England adopting year-round DST as a region would be preferable to Massachusetts acting alone.[31]

Many of the retailers surveyed by Retailers Association of Massachusetts cited the positive impact of additional evening daylight on consumer spending as the reason for supporting year-round DST.[32] A 2016 study conducted by JPMorgan Chase & Co. compared consumer spending in Los Angeles, where DST is observed, and Phoenix, where it is not, during the 30 days before

[27] Comm'n *supra* note 14, statement of Mr. Jon Hurst (Mar. 15, 2017).
[28] Lily Rothman, *FDR Moved Thanksgiving to Give People More Time to Shop*, TIME (Nov. 28, 2014), time.com/3603622/fdr-moved-thanksgiving/.
[29] Lucas Powers, *Daylight Saving Time 2016: How Big Business Benefits from More Sunshine*, *CBC News* (Mar. 12, 2016), www.cbc.ca/news/business/daylight-saving-business-energy-1.3485281.
[30] Comm'n *supra* note 14, statement of Mr. Jon Hurst (Mar. 15, 2017).
[31] *Id.*
[32] *Id.*

and after DST started and ended.[33] The study found that relative to consumer spending in Phoenix, consumer spending in Los Angeles increased by 0.9 percent at the start of DST and decreased by 3.5 percent at the end of DST.[34]

Several Commissioners raised the question of whether being temporally out of sync with East Coast markets like New York City would increase the costs of doing interstate business, particularly in financial services. Data show that some people in jurisdictions that do not observe DST end up changing their work schedules to stay in sync with business partners in nearby states, which suggests that interstate synchronization of schedules has economic value.[35]

Another Commissioner raised the prospect of year-round DST giving the Commonwealth's businesses a competitive advantage in terms of employee recruitment and retention. In large sectors like financial services and technology, Massachusetts businesses compete for talent with New York City and Silicon Valley, where the earliest sunsets of the year occur at 4:28 p.m. and 4:50 p.m., respectively.[36] In Boston, the earliest sunset of the year currently occurs at 4:11 p.m.[37] Year-round DST would push back the earliest sunset to 5:11 p.m., giving Massachusetts a small, but potentially meaningful, competitive advantage.[38]

A 2003 report on Massachusetts' retention of college graduates—commissioned by The Boston Foundation and the Greater Boston Chamber of Commerce—identified Greater Boston's climate as one of students' main frustrations with the region.[39] The report also found that students seeking relief from Greater Boston's long, dark winters often relocated to the San Francisco metropolitan area after college.[40] Massachusetts cannot rectify this problem by changing its weather or the length of its seasons, but it might make its winters more palatable to college graduates by making evenings less dark.

Although some questions about coordination with East Coast markets remain unanswered, the Commission found that year-round DST would positively impact consumer spending, which in turn could help the Commonwealth attract and retain more talented workers.

[33] *See* Diana Farrell et. al, *Shedding Light on Daylight Saving Time*, JPMorgan Chase Inst. (Nov. 2016), www.jpmorganchase.com/corporate/institute/document/jpmc-institute-daylight-savings-report.pdf.
[34] *Id*. at 2.
[35] Hammermesh *supra* note 2, at 244-245.
[36] Tom Emswiler, *Why Mass. should defect from its time zone*, Bos. Globe (Oct. 4, 2014), www.bostonglobe.com/ideas/2014/10/04/why-massachusetts-should-defect-from-its-time-zone/zusFxWGPQmwv6bfUb1ssxH/story.html.
[37] *Id*.
[38] *Id*.
[39] The Bos. Consulting Grp., Preventing a Brain Drain: Talent Retention in Greater Boston 18 (2003), www.tbf.org/~/media/TBFOrg/Files/Reports/Preventing%20Brain%20Drain%20report.pdf.
[40] *Id*. at 10

Labor and Workforce

The spring transition to DST causes people to lose sleep, not only on Sunday—the day following the transition—but also during that work week. Using sleep data from the Bureau of Labor Statistics, University of Washington professor Christopher M. Barnes and University of Oregon professor David T. Wagner—who have done extensive research on sleep and fatigue issues in the workplace—found that workers lost an average of 40 minutes of sleep on the Monday following the spring transition. [41] That lost sleep can profoundly affect both productivity and safety.[42]

Professors Barnes and Wagner investigated the impact of lost sleep on workplace safety by analyzing 23 years of data from the Mine Safety and Health Administration.[43] Mines are useful workplaces to examine when considering the effect of transitioning to DST because mining work occurs largely underground; therefore, differences in sunlight do not skew the data.[44] The analysis showed a 5.7 percent increase in the number of injuries on days following the spring transition to DST and a 67.6 percent increase in the number of days lost due to injury, suggesting an increase in the severity of the injuries.[45]

In addition to compromising workers' safety, the spring transition to DST compromises their productivity. Professors Barnes and Wagner collected Google search data from the Monday following the spring transition to DST and measured an increase in traffic to entertainment-related websites of between 3.1 and 6.4 percent, which they interpreted as a sign that workers were too tired to focus on their jobs.[46] A lab experiment also revealed that an hour of disturbed sleep led study participants to "cyberloaf" for, on average, 20 percent of the duration of an assigned task.[47]

The Commission finds that eliminating the spring transition to DST would increase productivity and cut down on both the number and severity of on-the-job injuries, which would lead to lower costs for businesses (e.g. more productivity, lower rates for workers' compensation insurance, and less need for hiring and training replacement workers).

[41] *See* Christopher M. Barnes and David T. Wagner, *Changing to Daylight Saving Time Cuts Into Sleep and Increases Workplace Injury*, 94 J. Applied Psychol. 1305 (2009).
[42] *Id*.
[43] *Id*. at 1310.
[44] Comm'n *supra* note 14, statement of Mr. Christopher M. Barnes (Apr. 12, 2017).
[45] *Supra* note 41, at 1305, 1310-1311 (2009).
[46] Christopher M. Barnes et. al, *Lost Sleep and Cyberloafing: Evidence from the Laboratory and a Daylight Saving Time Quasi-Experiment*, 97 J. Applied Psychol. 1068, 1071 (2012).
[47] *Id*. at 1073.

Public Health

DST, as currently observed, has several impacts on public health. The spring transition itself has negative consequences, most of which result from lost sleep, while the additional evening daylight provided during DST improves public health by increasing physical activity among residents.[48] As previously stated, people lose a significant amount of sleep in the days following the spring transition to DST, which leads to an increase in traffic fatalities and an increase in both the frequency and severity of on-the-job injuries.

In addition to those risks, the spring transition to DST has another potentially fatal consequence: a higher incidence of acute myocardial infarction—also known as heart attack.[49] A study published in the *New England Journal of Medicine* in 2008 found that the incidence of heart attack was significantly increased during the three weekdays following the spring transition, but significantly reduced for only one weekday following the fall transition.[50] The authors stated that "the adverse effect of sleep deprivation on cardiovascular health" was the "most plausible explanation" for their findings.[51]

The public health benefits of year-round DST do not just stem from the elimination of the spring transition. A study that followed more than 23,000 children before and after the clocks changed found that more evening daylight correlated with a small, but meaningful, increase in their physical activity levels.[52] The impact occurred population wide, which is important, according to the authors, "because even small changes to the population mean can have important public health consequences."[53] The authors also noted that the effect size of additional evening daylight compared favorably to the effect size of "intensive, individual-level interventions," suggesting that daylight saving is a highly efficient means of promoting exercise.[54]

The Commission finds that adopting year-round DST would improve public health in the Commonwealth by eliminating the annual spring transition to DST—with its corresponding increase in traffic fatalities, workplace injuries, and heart attacks—and also by providing residents with additional evening daylight during the winter, which would lead to increased physical activity among residents.

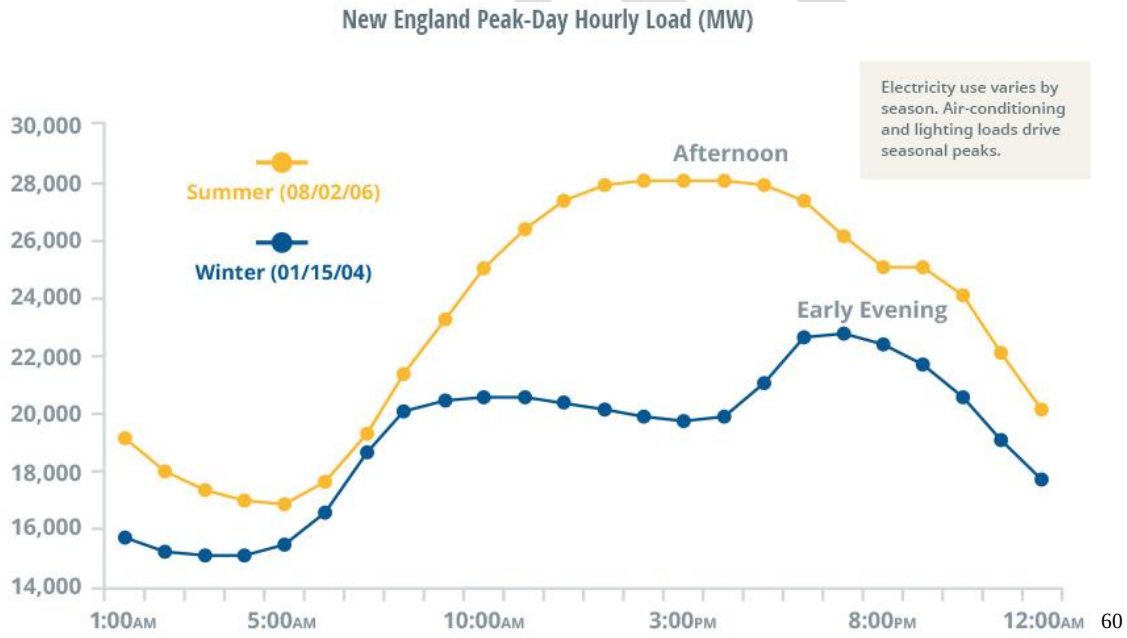
[48] Heindrik Wolff & Momoe Makino, Does Daylight Saving Time Burn Fat? Time Allocation with Continuous Activities 3 (2014), econ.washington.edu/sites/econ/files/old-site-uploads/2014/06/Economica-R-and-R-2014-Wolff-Makino.pdf.
[49] Barbara S. Taylor, M.D. & Scott M. Hammer, M.D., *Shifts to and from Daylight Saving Time and Incidence of Myocardial Infarction*, 359 New Eng. J. Med. 1966, 1966 (2008).
[50] *Id*.
[51] *Id*.
[52] Anne Goodman et. al, *Daylight saving time as a potential public health intervention: an observational study of evening daylight and objectively-measured physical activity among 23,000 children from 9 countries*, 11 Int'l J. Behav. Nutrition and Physical Activity 1, 7 (2014).
[53] *Id*.
[54] *Id*. at 1.

Energy

Most of the academic literature on DST and energy focuses on energy usage during the March-to-November DST period. While interesting, that information is not particularly relevant to the Commission, which is charged with investigating how DST would affect energy usage from early November to mid-March rather than how DST affects energy usage during the summer. There is, however, some information that sheds light on the impact that winter DST would have on energy consumption.

According to a presentation made by Commission member Peter Shattuck, a study conducted by the U.S. Department of Energy (DoE) following the 2007 extension of DST provides the energy usage data most relevant to the Commission.[55] This 2007 extension added three weeks of DST in the spring and one week in the fall, creating a natural experiment that can be exploited to measure how energy usage changes when DST encroaches deeper into winter.[56]

The DoE study compared electricity consumption during those four weeks in 2006 and 2007. DoE found a 0.48 percent drop in electricity consumption nationally following the extension of DST and a 0.68 percent drop in New England.[57] In Massachusetts, electricity consumption increased by 1.2 percent in the morning during the spring, but decreased by 3.2 percent in the afternoon and evening.[58] During the fall, electricity consumption increased by one percent in the morning, but decreased by 2.8 percent in the afternoon and evening.[59]



60

[55] *See* U.S. Dep't of Energy, Report to Cong.: Impact of Extended Daylight Saving Time on National Energy Consumption (2008).
[56] *Id.*
[57] *Id.*
[58] *Id.*
[59] *Id.*
[60] ISO New Eng., 2015 Regional System Plan (2015).

Mr. Shattuck helped put those numbers in context for the Commission, explaining that in New England, peak demand for electricity occurs in the early evening during the winter. He added that peak winter demand poses a problem because the region has developed a heavy reliance on natural gas for electricity generation, and in the winter natural gas is used for heating.[61] Residents have felt the impact of that heavy reliance in recent winters when natural gas was scarce and its price spiked, causing electricity bills to rise sharply.[62]

Because afternoon and evening are the hours of peak winter electricity demand, Mr. Shattuck explained, even a small reduction in afternoon and evening electricity consumption can have significant benefits.[63] If the Commonwealth were having difficulty meeting demand for even a few hours each winter, then Massachusetts might be compelled to invest in costly new energy infrastructure.[64] Even a half a percentage point reduction in peak demand could obviate the need for that new infrastructure, which would result in lower greenhouse gas emissions and lower costs for ratepayers.[65]

The Commission finds that year-round DST has the potential to produce modest energy savings. The Commission also finds that due to the timing of those savings and New England's current energy portfolio, year-round DST could lead to meaningful reductions in both future energy costs and greenhouse gas emissions.

Crime and Criminal Justice

Proponents of DST have long speculated that its observance reduces crime, which academic researchers have recently confirmed. University of Virginia professor Jennifer Doleac and Cornell University professor Nicholas Sanders, both of whom offered expert testimony to the Commission, used transitions to and from DST as a natural experiment to measure the impact that shifting daylight from the morning to the evening has on crime. They published their results in 2015.[66]

The study found a seven percent decrease in robberies due to an additional hour of evening daylight, including a 27 percent reduction during evening commuting hours, with no corresponding increase in crime during morning commuting.[67] The study also found suggestive but not conclusive evidence of a decrease in the incidence of rape.[68] Commuting hours offer the

[61] *Id*.
[62] Megan Woolhouse, *National Grid's Electric Rates Going up for Winter*, Bos. Globe (Sept. 15, 2015), www.bostonglobe.com/business/2015/09/15/national-grid-electric-rates-going-for-winter-but-not-much-last-year/s3nFnwz4on3IrXD8L4MRoO/story.html.
[63] Comm'n, *supra* note 22, statement of Mr. Peter Shattuck (Mar. 15, 2017).
[64] *Id*.
[65] *Id*.
[66] *See* Jennifer L. Doleac and Nicholas J. Sanders, *Under the Cover of Darkness: How Ambient Light Influences Criminal Activity*, 97 The Review of Econ. and Stat. 1093 (2015).
[67] *Id*. at 1094.
[68] *Id*. at 1100.

most potential victims to would-be robbers, which might be why preventing those hours from occurring in darkness leads to such a significant reduction in crime.[69]

Professors Doleac and Sanders estimated that the three-week extension of DST in the spring of 2007 generated $59.2 million in national social cost savings due to a reduction in robberies.[70] If that reduction were consistent throughout the year, then year-round DST would generate $1 billion in national social cost savings compared to year-round standard time.

The transition to DST also has several impacts on the criminal justice system. Researchers have demonstrated that people of color are more likely to be searched arbitrarily and arrested in the days following the transition.[71] In addition, judges hand out longer sentences in the wake of the annual transition to DST.[72] Unlike the effect of evening daylight on crime, which last through the duration of DST, these effects are limited to the days following the spring transition to DST.[73]

Based on the strength of the academic research, the Commission finds that year-round DST could reduce street crime and produce significant social savings, and could also reduce criminal-justice inequities.

Transportation

Moving Massachusetts' time zone out of sync with other eastern states from November to mid-March has the potential to cause confusion at the Commonwealth's airports. José C. Massó, director of policy at Massport, told the Commission that although airports use universal time to communicate with each other, they use local time to communicate with the public.[74] He warned that an hour time difference would likely confuse passengers traveling to or from nearby destinations served by Logan International Airport, including New York City, Washington, D.C., and Atlanta.[75]

Mr. Massó informed the Commission that during the three weeks of the year when the United States observes DST but Europe does not, manageable logistical challenges for both passengers and airports result.[76] Ed Freni, Massport's director of aviation, testified that extra resources are needed to plan for the complexity of those three weeks, and additional staff is needed to assist passengers.[77] Year-round DST could cause airports located in the Commonwealth to incur those additional costs over a longer period and for more flights.[78]

---

[69] *Id*. at 1101.
[70] *Id*. at 1102.
[71] Comm'n *supra* note 14, statement of Mr. David Wagner (Apr. 12, 2017).
[72] Kyongmin Cho et. al, *Sleepy Punishers are Harsh Punishers: Daylight Saving Time and Legal Sentences*, 28 Psychol. Sci. 242, 245 (2016).
[73] *Id*.
[74] Comm'n *supra* note 14, statement of Mr. José C. Massó (Mar. 15, 2017).
[75] *Id*.
[76] *Id*.
[77] Comm'n *supra* note 14, statement of Mr. Ed Freni (Mar. 15, 2017).
[78] Comm'n *supra* note 14, statement of Mr. José C. Massó (Mar. 15, 2017).

Regional action would help mitigate the negative impacts to airports caused by a change to year-round DST, according to Mr. Massó.[79] He would prefer that all the New England states and possibly New York act together to minimize the costs and confusion that would ensue if Massachusetts acted alone.[80]

While having a clear impact on modes of transportation like air and rail that rely on carefully calibrated schedules, DST also has an impact on general vehicular traffic. A study conducted by Austin C. Smith, an economist at the University of Colorado, found a 5.4 to 7.6 percent increase in fatal crashes during the six-day period following the beginning of DST.[81] Mr. Smith estimated that over a decade, the spring transition caused 302 deaths and resulted in a social cost of $2.75 billion.[82]

Mr. Smith found that the fall transition to standard time had no aggregate impact on traffic fatalities.[83] The reallocation of light from the evening to the morning did lead to a corresponding reallocation of fatal crashes from the morning to the evening, but those changes balanced each other out.[84] Other researchers have reached different conclusions. Paul Fischbeck and David Gerard of Carnegie Mellon University found that brighter mornings and darker evenings led to a net increase in pedestrian fatalities, with more lives lost in the evening than saved in the morning.[85] Their findings suggest that observing DST throughout the winter would save lives.[86]

The Commission finds that year-round DST would have a mixed impact on transportation. While evidence suggests that year-round DST would lead to fewer traffic fatalities, unilateral action by Massachusetts would likely complicate air travel.

Broadcasting

Adopting year-round DST could prove problematic for Massachusetts broadcasters.[87] If Massachusetts adopted year-round DST on its own, national evening news programs would broadcast an hour later from early November to mid-March, as would the 8 p.m. to 11 p.m. slot for national programming.[88] Those changes could disrupt local news programs, which are the biggest sources of revenue for local broadcasters, according to Jim Smith, general counsel to the

[79] *Id.*
[80] *Id.*
[81] Austin C. Smith, *Spring Forward at Your Own Risk: Daylight Saving Time and Fatal Vehicle Crashes*, 8 Am. Econ. J.: Applied Econ. 65, 79 (2016).
[82] *Id.* at 89
[83] *Id.* at 68
[84] *Id.* at 80
[85] David Gerard, "The Spring Time Change Saves Lives." N.Y. Times: Room for Debate (Mar. 6, 2014), www.nytimes.com/roomfordebate/2014/03/06/daylight-saving-time-at-what-cost/the-spring-time-change-saves-lives?mcubz=0.
[86] *Id.*
[87] Comm'n *supra* note 14, statement of Mr. Jim Smith (Apr. 12, 2017)
[88] *Id.*

Massachusetts Broadcasters Association.[89] The fact that Central time zone audiences often have television shows broadcast an hour earlier, however, suggests that the logistical issues arising from the four-month shift may have manageable solutions.

Live television events would pose additional challenges to broadcasters.[90] As currently programmed, an event like the Oscars that ended after midnight this year would instead end after 1 a.m., which would likely diminish viewership.[91] Primetime sports events like Sunday, Monday, and Thursday night football would begin broadcasting after 9 p.m. and conclude well after midnight. Broadcasters and producers might have to take into account the relative size and market power of Massachusetts when deciding what time to air certain programs between November and March. Leagues and major events would not alter their schedules to accommodate Massachusetts alone, according to Mr. Smith, because the need to capture the West Coast market is greater than the need to capture the Massachusetts market.[92]

Mr. Smith additionally informed the Commission that even if all six New England states observed year-round DST they would still be outliers, adding that there would likely be no changes in national live broadcast schedules unless New York or Pennsylvania joined New England in making the change.[93] He said that New England acting alone presents issues to broadcasters, which is why the Massachusetts Broadcasters Association opposes a change to year-round DST.[94]

Moving national television programming and live events to a later hour could also impact the sleep habits of some Massachusetts residents. The Commission discussed how the national programming slot, which ends at 11 p.m. in the Eastern and Pacific Time Zones and at 10 p.m. in the Central and Mountain Time Zones, has been exploited by researchers looking to measure the effect of television schedules on people's behavior. Researchers have found that the one-hour difference in schedules had a meaningful effect on when people went to bed in the evening and when they woke up and went to work in the morning.

People in the early zones (Central and Mountain) are 6.4 percentage points less likely to watch television between 11 p.m. and 11:15 p.m. than those in the later zones (Eastern and Pacific).[95] Those nighttime television habits lead to corresponding changes in morning habits. People in the early zones (who stopped watching television at an earlier hour) are 3.4 percentage points less likely to be asleep at 7 a.m. and 3.4 percentage points more likely to be at work at 8 a.m. than people in the later zones.[96] Based on that information, a Massachusetts move to year-round DST may alter the sleep schedules of residents.

The Commission finds that year-round DST could have some negative effect on broadcasters, unless other states adopted year-round DST. Additionally, the Commission finds that some

[89] *Id.*
[90] *Id.*
[91] *Id.*
[92] *Id.*
[93] *Id.*
[94] *Id.*
[95] Hammermesh, *supra* note 2, at 233.
[96] *Id.*

residents would change their sleep habits due to later television schedules by either sleeping less or waking up later.

Education and School Start-Times

Year-round DST would shift one hour of daylight from the morning to evening from early November to mid-March, leading to darker mornings as children head to school, but lighter afternoons as children engage in end-of-school and after-school activities. Parents have long worried that darker mornings make traveling to school more dangerous, and both the available data and other factors such as puberty, sleep, and alertness suggest they might be correct.[97]

Although the Commission has not learned of recent studies on the effect of daylight on the safety of schoolchildren's commute, in a 1976 report to Congress on the impacts of the nation's year-round DST experiment, the National Bureau of Standards ("NBS") found evidence of increased fatalities among school-aged children from January to April of 1974, when DST was in effect, compared with the same period (non-DST) in 1973.[98] However, NBS could not determine what, if any, part of the increase was due to DST rather than other factors. Further, when these same data were analyzed on a month-by-month basis for March and April, no significant difference was found for fatalities among school-age children in the morning.[99]

According to Commission member Dr. Judith Owens, dark winter mornings also might make high school students more prone to exacerbated seasonal affective disorder and increased car accidents.[100]

One way to avoid the downsides of year-round DST for school-aged children would be to delay school start times until after there is sufficient daylight for safe travel.[101] Civil twilight, which occurs roughly half an hour before sunrise, is the moment when there is generally enough natural light to engage in out outdoor activities, such as walking or driving to school.[102]

[97] Cook, *supra* note 5; *see also* Judith A. Owens, MD, *School Start Times for Adolescents*, 134 Pediatrics 642, 642 (2014).
[98] Cook, *supra* note 5.
[99] *Id.*
[100] Comm'n, *supra* note 14, statement of Dr. Judith Owens (May 31, 2017).
[101] *Id*.
[102] *Id*.

The following table shows the range of civil twilight times in Massachusetts from November 2017 to March 2018 under both standard time and DST:

	Nov	Dec	Jan	Feb
Civil Twilight EST	5:53-6:21am	6:22-6:41am	6:29-6:42am	5:54-6:28am
Civil Twilight DST	6:53-7:21am	7:22-7:41am	7:29-7:42am	6:54-7:28am
Sunrise EST	6:23-6:52am	6:53-7:13am	6:59-7:13am	6:22-6:58am
Sunrise DST	7:23-7:52am	7:53-8:13am	7:59-8:13am	7:22-7:58am

- If school starts at 7-7:30am, en route will be in complete darkness (before civil twilight) for almost all of 4 months and before sunrise for all 4 months
- If school starts at 7:30-8am, en route will be before civil twilight for 3 months and before sunrise for most of 4 months
- If school starts at 8-8:30am, en route will be before civil twilight for 2 months and before sunrise for 2 months
- If school starts at 8:30am or later, en route will be after civil twilight for all 4 months and after sunrise for most of 4 months

*assuming average commute time of 30 minutes

[103]

During the 2014-2015 academic year, the average start time for a Massachusetts middle or high school was 7:37 a.m., meaning that the average middle or high school would open in the dark for much of December and January under year-round DST. [104] However, most schools are not in session for a week or more during the darkest period in late December and early January. Pushing back start times to 8 a.m. would mean that schools never open in the dark, even under year-round DST, while pushing start times to 8:30 a.m. would mean that few students would even have to commute to school in the dark under year-round DST.

Delaying school start-times for middle and high school students would also be consistent with the health recommendations of the American Academy of Pediatrics[105] and the Massachusetts Medical Society.[106] Adolescents naturally fall asleep and wake up later, so delayed school start-times enable them to obtain an adequate amount sleep.[107] For teenagers, receiving adequate sleep lowers stress and risk of obesity, improves executive functioning and mood, and reduces risk-

[103] *Id*.
[104] *Id*.
[105] Owens, *supra* note 91.
[106] *See Massachusetts Medical Society Physicians Adopt New Resolutions at Interim Meeting*, Mass. Med. Soc'y (Dec. 5, 2015), http://www.massmed.org/News-and-Publications/MMS-News-Releases/Massachusetts-Medical-Society-Physicians-Adopt-New-Resolutions-at-Interim-Meeting/#.WbLms2eWyUm.
[107] Owens, *supra* note 91, at 644.

taking behavior.[108] Adolescents who sleep for eight or more hours nightly are also less likely to be involved in physical altercations, smoke, drink alcohol, be sexually active, feel sad, and consider suicide.[109]

In addition, later middle and high school start-times have led to higher attendance rates, lower tardiness and dropout rates, and improved grades and test scores in schools in Massachusetts and around the country.[110] When Nauset Regional High School pushed first period back from 7:25 to 8:35 a.m. in 2012, the tardiness rate dropped by 35 percent, and the number of "D"s and "F"s fell by half.[111] After delaying its start from 7:25 to 7:55 a.m. in 2016, Hanover High School saw a 32 percent drop in "D"s and "F"s and a 10 percent jump in "A"s in first-period classes.[112]

According to a macroeconomic state-by-state analysis conducted by the RAND Corporation, a delay in school start-times to 8:30 am nationwide correlates with an annual increase in the national economy of approximately $9.3 billion, an increase in high school graduation rates of 13.3 percent, and an increase in college attendance of 9.6 percent. [113] The stronger academic and professional performance for students reflected in these numbers, as well as a reduction in car crash rates among adolescents, could lead to an estimated additional $83 billion contribution to the U.S. economy within the next decade.[114] Effects from delayed school start-times could be felt within a year of making this shift.[115]

The Commission finds that with current school schedules remaining in place, adopting year-round DST can pose a public safety risk to school-aged children in the winter months. Those risks could be mitigated by delaying school start-times, however, which would also bring additional benefits, including healthier adolescents and better academic performance among middle and high school students.

[108] *See* Stacy Simera, MSSA & Mary Haymaker, JD, *Massachusetts School Start Time Legislation Parameters and FAQs*, Start Sch. Later, Mass. Chapter (2017).
[109] *Id*.
[110] Owens, *supra* note 91, at 644.
[111] James Vaznis, *Students Find More Awareness with Later Starts*, Bos. Globe (Mar. 10, 2016), www.bostonglobe.com/metro/2016/03/09/students-see-benefits-from-later-school-start-times/OOb4vtHm4XZTBLm5X78V9L/story.html?event=event12.
[112] Comm'n, *supra* note 22, from presentation by Dr. Judith Owens (May 31, 2017).
[113] *See* Hafner et. al, *Later School Start Times in the U.S.: An Economic Analysis*, The RAND Corp. (2017), www.rand.org/pubs/research_reports/RR2109.html.
[114] *Id*.
[115] *Id*.

Recommendations

Based on its research and findings, and after weighing the costs and benefits associated with the observance of time in Massachusetts, the Commission believes that under certain circumstances the Commonwealth could make a data-driven case for moving to the Atlantic Time Zone year-round (effectively observing year-round DST). Although appreciable costs associated with making this change would result, on balance the Commission finds that doing so could have positive benefits that largely stem from the absence of a spring transition to DST and the additional hour of winter evening light.

Providing an additional hour of winter evening light could bring societal benefits to Massachusetts largely by boosting consumer spending and economic development opportunities, reducing certain types of crime, increasing the population's physical activity level, and cutting greenhouse gas emissions and associated energy costs for residences in Massachusetts from early November to mid-March, when Massachusetts currently observes standard time.

The adoption of year-round DST also would eliminate the spring transition to DST and the week of population-wide sleep loss that results. Preventing that sleep loss could have broad and powerful impacts on public health in the Commonwealth. During the week in question, Massachusetts residents could experience fewer traffic fatalities, workplace injuries, and heart attacks, with many lives and tens of millions of dollars saved as a result.

However, the Commission does not recommend a simple switch to the Atlantic Time Zone, and cautions that several qualifiers should accompany any future conversations or legislative proposals with respect to how Massachusetts observes time. The Commission offers the following blueprint of concerns for a thoughtful implementation of year-round DST, should Massachusetts ever decide to pursue this policy change:

Regional action

Any move to year-round DST should be regional, because acting alone would make Massachusetts a significant outlier, and could disrupt commerce, trade, interstate transportation, and broadcasting. The Commission recommends that the Legislature adopt year-round DST only if a majority of other New England states do so as well.

As stated previously, several other New England states are already considering bills that would have them observe DST year round. Maine's bill passed both legislative chambers before being laid aside. New Hampshire's passed the House but was rejected in the Senate. Connecticut and Rhode Island are considering such bills but have not voted on them. Vermont is not currently considering legislation related to year-round DST, but is weighing a resolution urging Congress to abolish DST.[116]

[116] Time Zone Report *supra* note 21.

If a group of New England states does decide to pursue year-round DST, then they should also consider recruiting New York, as benefits described in the Findings section of this report would likely be applicable to it and other states as well.

For Massachusetts to spur regional action, the Legislature could consider passing a bill that instructs the Secretary of the Commonwealth to petition the U.S. Secretary of Transportation to place Massachusetts in the Atlantic time zone and—pending the U.S. Secretary of Transportation's approval of the petition—amend section 10 of chapter 4 of the General Laws in order to opt the Commonwealth out of observing DST. Such a bill should condition the shift taking place only after a majority of other New England states have passed legislation to the same end.

Later School Start-Times

Year-round DST would bring darker mornings from early November to mid-March, and without changes to school schedules, could lead to children traveling to school in darkness when the sun rises latest. Although there would be more daylight for after-school activities and travel home for these children (and there are winter school breaks during parts of this time), the early-morning transit time has the potential to pose public safety risks. Moreover, independent of public safety concerns, the Commission has found compelling data that indicate that the early-morning start-times can negatively impact some students' academic performance, with students not fully awake when they begin classes.

The Commission therefore recommends that any move to year-round DST is accompanied by statewide standards for allowable school start-times that start later in the morning to mitigate safety issues, and help students and their families — for example, 8 a.m. for elementary schools and 8:30 a.m. for middle and high schools. These standards could mitigate the negative effects of darker mornings, ensuring that children head to school in the dark for only a handful of days each winter. They could also improve both students' performance in school, and their physical and mental health.

Public Awareness

The Commission found that the change to year-round DST could cause confusion in broadcasting, commerce, and interstate transportation. That confusion—and any ensuing economic disruption—could be minimized through effective communication with the public. For that reason, the Commission believes that the Legislature should not adopt year-round DST unless it simultaneously commits funding to educate the public about the implications of the change.

The Legislature would need to focus its public awareness efforts on communities in close proximity to new time zone boundaries. If New York did not join New England states in adopting year-round DST, for example, then people on both sides of the border between Massachusetts and New York would need to be fully informed about the change. Public

awareness would be the best way to avoid disruptions caused by confusion around the four-month time difference.

The Legislature would also need to work with Amtrak, Massport, the Massachusetts Department of Transportation, and others to ensure that people traveling to and from Massachusetts would be aware that the Commonwealth does not observe Eastern Standard Time from early November to mid-March. Public awareness campaigns would need to be repeated each November when most states transition from DST back to standard time.

Even if Massachusetts does not adopt year-round DST, public awareness about transitions to and from DST would still be beneficial. A public awareness campaign preceding the spring transition to DST would help residents prepare for the sleep loss caused by the transition so that they could try to mitigate its negative consequences.

APPENDIX A: Individuals Invited to Testify

Meeting 2 (Mar. 15, 2017):

- Jennifer Doleac, University of Virginia Professor, and Nicholas Sanders, Cornell University professor, co-authors of the paper "Under the Cover of Darkness: How Ambient Light Influences Criminal Activity"
- Jon Hurst, President of the Retailers Association of Massachusetts
- Peter Shattuck, Member of the Commission, Director of Acadia Center's Clean Energy Initiative and Director of the Massachusetts Office

Meeting 3 (Apr. 12. 2017):

- Christopher M. Barnes, University of Washington Professor, and David T. Wagner, University of Oregon Professor, co-authors of the papers "Changing to Daylight Saving Time Cuts Into Sleep and Increases Workplace Injuries" and "Lost Sleep and Cyberloafing: Evidence From the Laboratory and a Daylight Saving Time Quasi-Experiment"
- David Prerau, DST researcher, historian, and author of the book "Seize the Daylight: the Curious and Contentious Story of Daylight Saving Time"
- Jim Smith, General Counsel to the Massachusetts Broadcasters Association
- José C. Massó, Director of Policy at Massport
- Nancy Donoghue, Director of Government Affairs at Massport
- Ed Freni, Director of Aviation at Massport

Meeting 4 (May 31, 2017):

- Dr. Judith Owens, Director of the Center for Pediatric Sleep Disorders at Boston Children's Hospital, Neurology Professor at Harvard Medical School, and member of the Commission
- Thomas Emswiler, Member of the Commission, public health advocate

APPENDIX B: Meeting Minutes

Special Commission on the Commonwealth's Time Zone

Wednesday, January 11, 2017 (Meeting 1)

Massachusetts State House
Hearing Room 222
Boston, MA 02133

Members present (appointed by):
Representative Daniel Cahill (Speaker), Chairman Eileen M. Donoghue (Senate President), Thomas Emswiler (Senate President), Representative Michael Finn (Speaker), Representative Paul Frost (House Minority Leader), Tim Miley (Governor), Peter Shattuck (Senate President), John Warren (Governor)

Members absent:
Robert LePage (Governor)

Members yet to be appointed:
One from the Speaker of the House
One from the Senate Minority Leader

Meeting Minutes

Senator Donoghue welcomed and thanked the members of the special commission for being in attendance. She introduced the members present in the room and then spoke about the creation of this special commission through Chapter 219 of the Acts of 2016, also known as the economic development bill. She noted that the special commission is charged with conducting a comprehensive study on the commonwealth remaining on Eastern Daylight Time throughout the entire year, with attention paid to the impact that this change would have on the economy as a whole, on the education system, on public health, on the transportation system, on energy consumption, and on commerce. Senator Donoghue said that the special commission is tasked with filing a report by March 31, 2017, a deadline that it will do its best to meet. She stated her hope that the commission would take a data-driven approach.

Members of the special commission then introduced themselves and spoke briefly about their background, their goals for the special commission, and topics they would like to consider at future meetings.

John Warren said that he had worked as a CFO and COO for Reebok and Adidas and would bring his business background to bear on the special commission's work.

Peter Shattuck said he was interested on potential energy and climate change impacts and suggested that the special commission could examine data on energy usage in the weeks before and after time changes.

Thomas Emswiler noted that his op-ed published in the *Boston Globe* two years ago was the first step towards the creation of the commission. He thanked Senator Keenan for filing by request a bill to form the commission and stated his intention to remain objective throughout the process.

Representative Cahill said that he represented Lynn, a gateway city near Boston where transportation is an important issue, and that he will focus on the impact of a time zone change on transportation.

Senator Donoghue reintroduced herself, noting that she was appointed by Senate President Rosenberg, and said that as the Senate chair of the Joint Committee on Economic Development and Emerging Technologies she will be particularly interested on the economic development component of the commission's work.

Representative Finn said that he was new to the idea of changing time zones and that research about its public health effects had caught his attention. He added that the commission was a good opportunity to discuss an issue that the commonwealth might not have otherwise had the chance to address.

Representative Frost noted that the Joint Committee on State Administration and Regulatory Oversight had considered time zone changes in the past and said that although he would keep an open mind, he would also play the role of skeptic. He mentioned concerns including the safety of children going to school in the dark, practical issues related to the possibility of Massachusetts acting without other New England states, and potential problems caused by glare on the commutes into and out of Boston from Western Massachusetts.

Tim Miley said that the Department of Public Health had data that is relevant to the commission's work and that he hoped to bring those resources to bear on the study.

Senator Donoghue said that the commission members needed to elect a chair who would organize the commission and handle administrative issues. Mr. Emswiler nominated Senator Donoghue. Representative Cahill seconded the nomination. The commission members unanimously elected Senator Donoghue, who thanked her colleagues, mentioned the possibility of soliciting input from the public, and suggested that the commission would meet once a month with a full agenda before submitting its data-driven report to the legislature by the early spring.

Senator Donoghue adjourned the meeting at 11:43 a.m.

Special Commission on the Commonwealth's Time Zone
Wednesday, March 15, 2017 (Meeting 2)

Massachusetts State House
Hearing Room 222
Boston, MA 02133

Members present (appointed by):
Representative Daniel Cahill (Speaker), Chairman Eileen M. Donoghue (Senate President), Thomas Emswiler (Senate President), Representative Michael Finn (Speaker), Representative Paul Frost (House Minority Leader), Tim Miley (Governor), Robert LePage (Governor), Dr. Judith Owens (Speaker), Peter Shattuck (Senate President), Yvonne Spicer (Senate Minority Leader), John Warren (Governor)

Meeting Minutes

Senator Donoghue welcomed the members of the special commission and thanked them for being in attendance. She introduced two members of the commission who had been appointed since the January meeting.

Senator Donoghue said that Yvonne Spicer is the vice president for advocacy and educational partnerships at the National Center for Technological Literacy, a role in which she directs the Museum of Science's efforts to improve K-12 STEM education in Massachusetts and around the world. She added that Ms. Spicer—who has had a distinguished career in STEM education, including stints with the Framingham Public Schools, the Newton Public Schools, and the Massachusetts Department of Elementary and Secondary Education, and several state and national advisory boards related to technology and education—will be a great resource and partner on the commission. Senator Donoghue also noted that Senate Minority Leader Bruce Tarr had appointed Ms. Spicer to the commission.

Senator Donoghue then introduced Dr. Judith Owens, director of the Center for Pediatric Sleep Disorders at Boston Children's Hospital and a member of the faculty of neurology at Harvard Medical School. She said that Dr. Owens is an internationally recognized authority on pediatric sleep, and has written more than 75 research and review articles on the subject and that Dr. Owens' extensive knowledge will be incredibly helpful to the commission as it considers the impact of later winter sunrises on sleep schedules and school start times. She noted that Speaker of the House Bob DeLeo had appointed Dr. Owens to the commission.

Senator Donoghue motioned that the minutes of the commission January 15 meeting be approved. Representative Finn seconded the motion, and the minutes were approved unanimously on a voice vote.

Senator Donoghue introduced University of Virginia professor Jennifer Doleac and Cornell University professor Nicholas Sanders, co-authors of the paper "Under the Cover of Darkness: How Ambient Light Influences Criminal Activity," who joined the commission via conference

call. Ms. Doleac and Mr. Sanders said that their paper examined the effect that shifting daylight from the morning to the evening had on crime. They said that the switch to and from daylight saving time (DST) was a natural experiment that enabled them to measure that effect. They said that they found a seven percent decrease in robberies due to an additional hour of evening daylight, including a 27 percent reduction during evening commuting hours, and no corresponding increase in crime during the morning commuting hours. Ms. Doleac and Mr. Sanders concluded that an additional hour of evening daylight had a big, meaningful impact on street crime, and that making DST permanent would therefore also have a meaningful effect.

Thomas Emswiler noted that the paper estimated that the three-week extension of DST in the spring of 2007 generated $59.2 million in social cost savings due to a reduction in robberies. He said that he had done some back-of-the-envelope math and calculated that if these savings were consistent throughout the year, year-round DST would generate more than $1.2 billion in social costs savings. Mr. Emswiler asked if that figure sounded right, and Ms. Doleac and Mr. Sanders said that it did.

Dr. Owens asked if there were any data available on how ambient light affects delinquency. Ms. Doleac and Mr. Sanders said that there was not reliable time-based data for delinquency. Dr. Owens also asked if there were any data about crime during the year-round DST experiment that took place nationally between 1974 and 1975. Ms. Doleac and Mr. Sanders said that a study had found a 10 to 13 percent reduction in street crime in Washington, D.C. during the DST experiment. They said this study was not as reliable as their own, however.

Representative Paul Frost asked how much crime occurred around the time of sunset. He also asked if delaying sunset by one hour would delay criminal activity by one hour, rather than reducing it. Ms. Doleac and Mr. Sanders said that a substantial number of robberies occur during the commuting hours around sunset, when there are more people on the street who can potentially be robbed. They added that their study found that criminal activity was reduced due to a later sunset, and not simply delayed by it.

Peter Shattuck asked for the source of the data. Ms. Doleac and Mr. Sanders said that the data came from 558 jurisdictions around the country, including many in New England.

Senator Donoghue thanked Ms. Doleac and Mr. Sanders for their testimony and introduced Jon Hurst, president of the Retailers Association of Massachusetts (RAM) so that he could discuss small retailers' thoughts about switching to year-round DST.

Mr. Hurst said that there was a history of adjusting the clocks or the calendar to promote sales, including changing the date of Thanksgiving to lengthen the shopping season leading up to Christmas. He noted that 70 percent of the economy is driven by the consumer, and that e-commerce makes it more important than ever to look at how policies affect retailers. Mr. Hurst said that nationally, 18 percent of Christmas shopping took place online last year, and that policies including the sales tax, blue laws, and even time zones can incentivize or dis-incentivize consumers to spend locally. He added that weather and sunshine impact consumer choices.

Mr. Hurst said that he surveyed the 4,000 members of his organization about DST policies and received responses from 5 percent of them. He added that the typical response rate was 2 percent, but that surveys about issues that have a significant impact on sales or expenses receive a good response. Mr. Hurst said that 34 percent of the members who responded favored Massachusetts remaining on DST year round; 24 percent favored Massachusetts remaining on standard time year round; 23 percent did not necessarily disagree with the concept of year-round DST but preferred national action on the issue; and 19 percent favored the status quo. Mr. Hurst noted that a majority of the respondents favored year-round observation of time, rather than switching between standard time and DST. He also noted that respondents had mentioned in their comments the need for consistent regional observation of time, especially since many consumers and employees cross state lines to shop or work. Mr. Hurst concluded by stating that RAM had no official position on whether or not Massachusetts should observe year-round DST.

Senator Donoghue asked how sunlight affected sales. Mr. Hurst said that most shopping takes place on weekday evenings and weekends, and that many retailers believe that extra evening daylight attracts people to go shopping and increases sales.

Representative Michael Finn asked Mr. Hurst which option the plurality of respondents had chosen. Mr. Hurst said that the plurality supported year-round DST in order to increase sales, adding that in an age where people can shop on their iPhones, anything that policymakers can do to keep business in Massachusetts is helpful.

Representative Frost asked if out-of-state consumers and employees would be confused if the change to year-round were not regional, if it did not involve New York, or if it did not involve the rest of the East Coast. Mr. Hurst reiterated that RAM had no official position, adding that personally he believed that Massachusetts should not act alone. He said it was the same case with GMO labeling bills. Mr. Hurst suggested that if the commission did recommend a switch to year-round DST, it could recommend that any related legislation not take effect until a certain number of New England states also pass it.

Representative Daniel Cahill asked if DST affected employee health and productivity and said that he would love to see data in those areas. Mr. Hurst said that it was a great question, but one to which he did not have an answer, and suggested that an organization like the Chamber of Commerce might be able to investigate it.

Mr. Shattuck said that it can be difficult to remember the meanings of the terms DST, standard time, and Atlantic Time Zone and asked how clear the meaning of year-round DST was to the members who responded to the survey. Mr. Hurst said that the survey question framed the issue in terms of sales, crime, and health and that he would be happy to share the text of the question with the commission.

Mr. Emswiler said that it would be helpful to do a deeper dive with RAM members in order to ask them about the potential for a regional switch to year-round DST. He noted that related legislation has been filed in Connecticut, Maine, New Hampshire, and Rhode Island.

Senator Donoghue thanked Mr. Hurst for his testimony and introduced commission member Mr. Shattuck so that he could discuss the potential energy impacts of year-round DST.

Mr. Shattuck said that the U.S. had extended DST by weeks in 2007, adding three weeks in the spring and one in the fall. He said that the Department of Energy (DoE) had compared electricity consumption during those four weeks in 2006 and in 2007, which offers a chance to measure the impact of extended DST. Mr. Shattuck said that the DoE analysis found a 0.48 percent drop in electricity consumption nationally and a 0.68 percent drop in New England. He said that factors like air conditioning in the South and New England's location at the eastern edge of its time zone could help account for that difference. Mr. Shattuck also noted that in Massachusetts, electricity consumption increased by 1.2 percent in the morning during the three spring weeks, but decreased by 3.2 percent in the afternoon and evening; electricity consumption increased by one percent in the morning during the fall week, but decreased by 2.8 percent in the afternoon and evening.

Mr. Shattuck said that the National Bureau of Economic Research (NBER) had studied the energy impact of DST by comparing electricity consumption across Indiana counties, some of which observed DST and some of which did not. He stressed this study focused on the impact of DST as it is currently observed and not the impact of extending DST, which is what the commission is charged with considering. Mr. Shattuck said that the NBER study found a 1 percent overall increase in electricity consumption during DST, attributable largely to air conditioning usage, and an increase of two to four percent in early fall. He said that the key takeaways were that the increase was found in the spring, summer, and fall, but not during the winter, and that Massachusetts and Indiana have different energy profiles and climates.

Mr. Shattuck proceeded to describe the context of energy in Massachusetts and New England. He said that in New England, peak demand for electricity occurs in the afternoon during the summer and in the early evening during the winter. He added that peak winter demand poses a problem because the region has developed an overreliance on natural gas for electricity generation, and in the winter natural gas is used for heating. He said that residents felt the impact of that overreliance in the winter of 2013-2014, when natural gas was scarce and its price spiked, causing electricity bills to rise sharply. Mr. Shattuck said that electricity generators that rely on natural gas have since purchased backup fuels including oil and liquid natural gas to prevent the same problem from recurring. He also pointed to a study conducted by the Attorney General's Office that suggested that Massachusetts could meet its energy needs by investing in renewables and energy efficiency, rather than by constructing new natural gas pipelines.

Mr. Shattuck then stated the he wanted to place the DoE study—and its finding that extended DST reduced electricity consumption by 0.68 percent in New England, with particularly strong effects in the afternoon and early evening—within that broader context of energy in Massachusetts and New England. He said that because afternoon and evening are the hours of peak demand, and because solar stops generating electricity during those hours, even a small reduction in afternoon and evening electricity consumption can have significant benefits in terms of reducing energy infrastructure costs and greenhouse gas emissions. Mr. Shattuck concluded by saying that extended DST could produce modest but meaningful electricity savings.

Dr. Owens asked why there was a greater change in electricity consumption in the evening during DST. Mr. Shattuck said that people's routines are more flexible in the evening, so the amount of electricity they consume in the evening can fluctuate more.

John Warren asked if the data included commercial electricity consumption. Mr. Shattuck said that the data included all electricity, including commercial consumption.

Representative Frost said that he had always heard that the energy savings from DST were negligible and asked for Mr. Shattuck's response. Mr. Shattuck said that while the savings were not massive, they were appreciable. He added that energy efficiency reduced Massachusetts' electricity consumption by three percent, enough to make the commonwealth a national efficiency leader, so even a 0.5 percent decrease due to DST would go a long way in helping Massachusetts avoid new infrastructure and environmental costs.

Robert LePage asked if variations in weather impacted the data. Mr. Shattuck said that between summer and winter that impact would be large, but that when comparing certain months from one year to the next it would not be large. Mr. LePage asked what the dollar value of a 0.5 percent reduction in energy savings would be. Mr. Shattuck said that he would have to get back to Mr. LePage with an answer.

Representative Cahill said that he agreed with the analysis of how extended DST would affect electricity consumption in the morning and in the afternoon and evening, even though the electricity consumption of hospitals and similar organizations is to some extent fixed. Representative Frost said that because hospitals always have their lights on he is not sure that they would see savings. Mr. Shattuck said that savings would flow to everyone if year-round DST prevented a buildup of infrastructure to meet peak demand.

Senator Donoghue asked if the DoE study contained the best data available for the commission's purposes. Mr. Shattuck said that it was the best data available to the commission, and that the DoE study was more relevant than the Indiana study.

Senator Donoghue thanked Mr. Shattuck for his testimony and opened the commission meeting to general discussion. Representative Frost said that he remained concerned about children going to school in the dark and mentioned a study conducted in the 1970s that addressed the issue. He added that the commission should hear from Massport and also from television broadcasters, because residents might have to stay up late to watch the Patriots on Sunday Night Football. Representative Finn said that he would like to hear from the entire New England Region. Mr. LePage said that he wanted to hear about the impact year-round DST would have on student and employee performance, the financial services industry, and television broadcasters. In addition to the question of children going to school in the dark, Mr. Emswiler suggested that commission consider a paper published by the American Academy of Pediatrics recommending that school start times be pushed back to a later hour. Dr. Owens noted that she had written the paper. Mr. Emswiler added that Massachusetts could throw its weight around and force Sunday Night Football to start earlier. Representative Frost said that Roger Goodell would never agree to that.

Senator Donoghue said that it was clear that the commission members were very invested in the issue and that the commission would continue to learn more about it.

Senator Donoghue adjourned the meeting at 12:41 p.m.

Special Commission on the Commonwealth's Time Zone
Wednesday, April 12, 2017 (Meeting 3)

Massachusetts State House
Hearing Room 222
Boston, MA 02133

Members present (appointed by):
Representative Daniel Cahill (Speaker), Chairman Eileen M. Donoghue (Senate President), Thomas Emswiler (Senate President), Representative Michael Finn (Speaker), Representative Paul Frost (House Minority Leader), Tim Miley (Governor), Robert LePage (Governor), Yvonne Spicer (Senate Minority Leader), John Warren (Governor)

Members absent (appointed by):
Dr. Judith Owens (Speaker), Peter Shattuck (Senate President)

Meeting Minutes

Senator Donoghue welcomed the members of the special commission and thanked them for being in attendance. She motioned that the minutes of the commission March 15 meeting be approved. Representative Cahill seconded the motion, and the minutes were approved unanimously on a voice vote.

Senator Donoghue introduced University of Washington professor Christopher M. Barnes and University of Oregon professor David T. Wagner, authors of the papers "Changing to Daylight Saving Time Cuts Into Sleep and Increases Workplace Injuries" and "Lost Sleep and Cyberloafing: Evidence From the Laboratory and a Daylight Saving Time Quasi-Experiment," who joined the commission via conference call. Senator Donoghue noted that Mr. Barnes and Mr. Wagner specialize in, among other things, sleep and fatigue issues in the workplace and that of particular interest to the commission is their research and writing about the impact that transitioning to daylight saving time (DST) has on workplace injuries, workplace productivity, and even the sentencing habits of judges. She added that Mr. Barnes has also authored a paper making sleep-related public health policy recommendations.

Mr. Barnes and Mr. Wagner said that their study on workplace injuries measured the effect that transitioning in and out of DST has on sleep using data from the Bureau of Labor Statistics. They said that while they found no effect from the fall transition, workers lost an average of 40 minutes of sleep on the Monday following the spring transition. Mr. Barnes and Mr. Wagner then proceeded to describe the second piece of the study, which relied on 23 years of data from the Mine Safety and Health Administration. They noted that mines were a particularly useful workplace to examine, because mining work occurs largely underground and differences in sunlight would therefore not confound the data. Mr. Barnes and Mr. Wagner said that they found a 5.7 percent increase in the number of injuries on days following the spring transition to DST and a 67.6 percent increase in the number of days lost due to injury, suggesting an increase in the severity of the injuries.

Mr. Barnes and Mr. Wagner then moved on to their study on cyberloafing, the first part of which used Google search data from 203 metropolitan areas to determine whether workers were more likely to visit websites that were unrelated to their jobs on the Monday following a transition to DST. They said that they measured an increase in traffic to entertainment-related websites of between 3.1 and 6.4 percent, which they interpreted as a sign that workers were too tired to focus on their jobs. Mr. Barnes and Mr. Wagner explained that the second part of their study used data from a laboratory experiment to determine the impact of sleep interruption on cyberloafing. They said that they found that an hour of disturbed sleep led study participants to cyberloaf for, on average, 20 percent of the duration of an assigned task.

Mr. Barnes and Mr. Wagner then ran through many of their other studies, which have found that following the spring transition to DST judges hand out longer sentences, minorities are more frequently searched and arrested frivolously, the rates of heart attacks and fatal vehicle accidents increase, and children are less attentive in class and receive lower scores on the SAT. Thomas Emswiler asked if Mr. Barnes and Mr. Wagner could share those studies with the commission. Senator Donoghue said the commission would welcome them, and Mr. Barnes and Mr. Wagner said they would share the studies.

Senator Donoghue thanked Mr. Barnes and Mr. Wagner for their testimony and introduced Dr. David Prerau, a DST researcher, historian, and author. She noted that Dr. Prerau is a world-renowned authority on DST, the author of the book Seize the Daylight: The Curious and Contentious Story of Daylight Saving Time, which details the history, science, and politics of the practice, contributed to the largest ever technical study on DST, coauthored three reports to Congress on the subject, and served as a consultant to both the U.S. Congress and Britain's Parliament on legislation related to extensions of DST.

Dr. Prerau said that he was happy to be able to share his 40 years of expertise on DST with the commission. He noted that DST was first practiced during World War I and is now observed in 70 countries and in 48 states. He said that although people can adapt to losing an hour of sleep during the spring transition to DST, there are effects that resemble those caused by jet lag. Dr. Prerau added that these effects could perhaps be mitigated by a public health information campaign leading up to the transition date. He cautioned commission members to carefully distinguish between the effects of the transition to DST and the effects of the period itself.

Dr. Prerau said that one of the major benefits of year-round DST—more sunlight during winter afternoons—has a flipside: darker winter mornings. He noted that with year-round DST in place, January sunrise times would be as late as 8:23 a.m. in Boston and late as 8:23 a.m. in Williamstown. Dr. Prerau said that when Congress experimented with year-round DST in the 1970s there was a negative effect on the safety of children walking to school in the dark, prompting Congress to institute an eight-month DST schedule—longer than the usual six-month schedule, but shorter than the year-round experiment. He added that creating darker, colder commutes during January, the coldest month, could make roads icier or snowier, although he said there was no related data available.

Dr. Prerau said that year-round DST would create a four-month, one-hour time difference between Massachusetts and business and political capitals in New York City and Washington,

D.C., respectively. He noted that the difference would put the commonwealth out of sync with both the stock market and large markets along the East Coast, but had no data on what impact that might have.

Dr. Prerau went on to say that uniformity is a major concern when it comes to the observation of time, noting that after World War II there was hodgepodge of states and cities observing DST on different schedules, which caused chaos. He added that the Uniform Time Act of 1966 instituted national start and end times for DST. He added that following the 2007 extension of DST, Canadian provinces had to choose whether to adjust their DST calendars to match the U.S., and that ultimately every province elected to adopt the new U.S. calendar. He said that a lack of uniformity can affects business by causing confusion around deliveries, calls, and deadlines.

Dr. Prerau then mentioned a number of additional concerns related to Massachusetts ceasing to be in sync with the rest of the Eastern Time Zone, including potential confusion around flight schedules, later start times for live, nationally broadcast events like Sunday Night Football, the State of the Union address, and the Oscars, and the unpleasantness of living near the border between time zones.

John Warren asked if there are any studies of how lack of uniformity in DST observation affects the business community. Dr. Prerau said that there was anecdotal evidence of businesses choosing not to locate in Indiana and noted that the Indiana Chamber of Commerce preferred uniformity.

Representative Frost said he had not thought about the problem of kids going to school in the morning when—in addition to being dark—it is cold and icy. He noted that Massachusetts school districts sometimes delay school due to icy conditions or extreme cold. Dr. Prerau said that in 1974 some schools sought to avoid those problems by starting an hour later, which caused some conflicts with work. He added that some schools distributed reflective tape to students.

Senator Donoghue thanked Dr. Prerau for his testimony and introduced Jim Smith, general counsel to the Massachusetts Broadcasters Association (MBA), a trade organization that represents more than 200 radio and television broadcasters in the commonwealth.

Mr. Smith said that year-round DST would be hard to implement for Massachusetts broadcasters. He said that national evening news programs would be broadcast an hour later during the four-month period when Massachusetts would be out of sync with the rest of the Eastern Time Zone, affecting local evening shows. He added that the 8 p.m. to 11 p.m. slot for network programming would become a 9 p.m. to midnight slot, disrupting local news broadcasts, which are important to broadcasters' bottom lines and to the public interest.

Mr. Smith mentioned the potential for additional confusion in places like the Berkshires, where broadcasts are often coming from Albany. He said there would also be a need to educate broadcasters about the implications of the change to year-round DST, noting that there are sometimes restrictions on when syndicated shows can be broadcast. *The Ellen DeGeneres Show*, he said, is embargoed until a certain time. Mr. Smith said that radio would also be affected by the

change to year-round DST. He said that national news shows, for example, have to be coordinated across time zones.

Mr. Smith went on to say that the biggest complication of year-round DST would be the scheduling of live television events. He said that an event like the Oscars, which ended at around 12:10 a.m. this year, would instead end at around 1:10 a.m. With regard to sports, Mr. Smith said that p.m. is primetime for school and work night events and leagues would not alter their schedules to accommodate Massachusetts because the need to capture the West Coast market is greater than the need to capture the Massachusetts market. He said that even if every New England state observed year-round DST they would still be outliers, adding that there would be no changes in national live broadcast schedules if New York or Pennsylvania did not join New England.

Mr. Smith concluded by stating that the practical concerns of observing year-round DST are too great for the MBA to support it and by thanking the commission for including the MBA.

Representative Frost asked whether the MBA would be more supportive if New York changed to year-round DST in addition to New England. Mr. Smith said yes, reiterating that New England acting alone presents enormous issues to broadcasters.

Mr. Emswiler asked if local news was the biggest revenue source for broadcasters. Mr Smith said it was. Mr. Emswiler asked if there were local news shows during morning hours. Mr. Smith said there were. Representative Frost asked if revenue earned from an additional hour of local news in the morning would offset revenue lost due to changes in local news schedules in the evening and at night. Mr. Smith said that it would not, because the 6 p.m. and 11 p.m. slots are the biggest revenue generators.

Senator Donoghue thanked Mr. Smith for his testimony and introduced José C. Massó, director of policy at Massport. She noted that Mr. Massó has also served as Massport's director of community relations and that he advises the agency on policies that might affect its ownership and management of Boston Logan International Airport, Hanscom Field, Worcester Regional Airport, and the Port of Boston.

Mr. Massó said that he was joined by Nancy Donoghue, Massport's director of government affairs, and Ed Freni, Massport's director of aviation. He noted that airports used universal time to communicate with each other, but not with the public, and said that a change to year-round DST would cause confusion in nearby destinations served by Logan International Airport, including New York City, Washington, D.C., and Atlanta. Mr. Massó added that a number of transportations services that connect to Logan, including rail and bus services, would have to adjust their schedules.

Mr. Massó said that Logan serves 36 million passengers each year, with millions of them taking international flights. He said that there is already a three weeks of the year during which the U.S. observes DST and Europe does not, which causes confusion and creates new challenges. Mr. Massó commented that there would be similar confusion were Massachusetts to observe year-round DST, although the situation might be better if all the New England states acted together.

Representative Frost asked whether Massport would be more supportive if New York changed to year-round DST in addition to New England. Mr. Massó said that it is important not to be an outlier, but the bigger the better when it comes to the size of the region observing year-round DST.

Representative Frost asked if the change to year-round DST would cause confusion for business travelers. Mr. Eni said that there would be a new layer of confusion.

Mr. Miley asked for further explanation of the challenges associated with the three weeks during which the U.S. observes DST and Europe does not. Mr. Eni said that during those three weeks there is a need for additional staff at gates and resources are needed to plan for the additional complexity. He added that the entire U.S. is dealing with that complexity during those three weeks.

Robert LePage asked about the impact on travelers going to airports in Hartford or Albany from Western Massachusetts. Mr. Eni said that if Massachusetts were out of sync with a neighboring state, then travelers would have to do the same mental calculations that they do now when traveling to a different time zone.

Mr. Warren asked if there were significant costs to nonconformity. Mr. Eni said that he did not have specific numbers, but that there would be staff costs, scheduling costs, and transaction costs.

Mr. Emswiler asked if most of Logan's passengers were from New England. Mr Eni said yes, but not exclusively.

Representative Frost asked if there would be costs to an advertising campaign educating passengers about the change to year-round DST. Mr. Massó said there would be costs to such a campaign.

Mr. Miley asked what percentage of Logan's 36 million annual passengers stop at the airport to make a connection. Mr. Eni said about 10 percent of passengers are making a connection.

Senator Donoghue thanked Mr. Massó for his testimony and adjourned the meeting at 12:50 p.m.

Special Commission on the Commonwealth's Time Zone
Wednesday, May 31, 2017

Massachusetts State House
Hearing Room 222
Boston, MA 02133

Members present (appointed by):
Chairman Eileen M. Donoghue (Senate President), Thomas Emswiler (Senate President), Representative Michael Finn (Speaker), Representative Paul Frost (House Minority Leader), Yvonne Spicer (Senate Minority Leader), John Warren (Governor); Dr. Judith Owens (Speaker), Representative Daniel Cahill (Speaker),

Members absent (appointed by):
Peter Shattuck (Senate President), Tim Miley (Governor), Robert LePage (Governor)

Meeting Minutes

Senator Donoghue welcomed the members of the special commission and thanked them for being in attendance. She motioned that the minutes of the commission April 12 meeting be approved. The minutes were approved unanimously on a voice vote.

Senator Donoghue introduced commission member Dr. Judith Owens, director of the Center for Pediatric Sleep Disorders at Boston Children's Hospital and a professor of neurology at Harvard Medical School, to discuss the impacts of year-round DST on student sleep, health, and safety.

Dr. Owens began her presentation by introducing basic background information on the function of sleep. She explained that sleep is regulated by two simultaneous processes, the 24 hour circadian rhythm of sleep/wakefulness and the sleep drive. Dr. Owens said that the sleep drive is contingent on a number of factors including how long a person has been awake, the quantity and quality of the person's previous night's sleep, and the person's individual sleep needs. She then provided a more thorough explanation of the circadian timing system, the governing function of all physiologic systems in the human body. She explained that each cell in the body possess an internal clock that must be synchronized with other cells and with the environment, adding that misalignment between the internal clock and the external light-dark cycle can have negative consequences for a person's physiologic function and health. Dr. Owens stressed that it is not just how much a person sleeps, but also when a person sleeps that has a significant impact on well-being. Dr. Owens explained that sleep regulation consists of two competing functions, the homeostatic sleep drive and the circadian wake drive, which fluctuate throughout the day and impacts a person's level of alertness.

Dr. Owens said that it is critically important for adolescents to get a healthy amount of sleep every night. She explained that all adolescents experience a shift in their sleep patterns, especially with the onset of puberty, and that as a result of this biological shift, sleep times and wake times change drastically. According to Dr. Owens, adolescents are biologically programmed to wake up at 8 a.m. or later, but due to school start times, many teens are required

to wake up much earlier, at a point in their sleep cycle when they are the least alert. As a result, Dr. Owens said, many adolescents are not sleeping enough during the week and trying to compensate by sleeping in on weekends. She added that from a biological perspective, sleeping in cannot make up for insufficient sleep during the week and can actually exacerbate problems with the body's sleep cycle, a phenomenon known as "social jet lag" that can persist for up to three days, causing daytime sleepiness, poor concentration, or a depressed mood. Dr. Owens stated that eight to 10 hours of average sleep is needed for middle school and high school students to maintain optimal health, safety, and achievement, while children ages six to 12 need nine to 12 hours of sleep.

Dr. Owens then discussed sleep's effect on performance, health, and safety. She explained that either too much sleep or too little sleep can drastically change the brain's ability to function in response to the environment, impacts gene activation, slows the ability to recover from stress, and causes the release of stress hormones. Dr. Owens added that lack of sleep has serious negative impacts on executive functions such as planning, problem solving, decision making, divergent thinking, judgment, motivation, and emotional response. In addition, she said that the reward-related functions of the brain undergo changes during adolescence that, if combined with insufficient sleep, can impact teen's decision making behaviors and their ability to perceive negative consequences, which leads to increased risk taking. Dr. Owens said that teens who slept for fewer than eight hours on average were more likely to be involved in physical altercations, smoke cigarettes or marijuana, drink alcohol, be sexually active, feel sad or hopeless, and have considered suicide than teens who slept for eight or more hours on average.

Dr. Owens went on to explain the effects of sleep loss on a person's diet. Dr. Owens stated that studies have shown that lack of sleep can be associated with an increased risk of obesity; as a person's sleep duration affects hunger, food intake, eating patterns, physical activity, and insulin metabolism.

According to Dr. Owens, drowsy driving accounts for roughly 7% of all crashes in which a vehicle is towed from the scene, 13% of crashes that result in hospital admission, and 16-21% of all fatal crashes. Dr. Owens expounded upon this by stating that driver who are 16 to 25 years of age are involved in more than 50% of the 100,000 police-reported fatigue-related crashes each year. Dr. Owens stressed the dangers our drowsy driving by informing the commission that sleep loss impairments can be just as dangerous as alcohol intoxication in drivers.

Dr. Owens then transitioned her presentation to the topic of school start times and how adolescents would greatly benefit from additional sleep. Dr. Owens shared with the committee that the American Academy of Pediatrics recommended that schools not start until 8:30 AM or later, to allow teens to get the appropriate amount of sleep during the growth years.

Dr. Owens presented information that supports the concept of delayed school start times and went on to explain that even a modest delay of 30 minutes has been shown to have significant impacts on student health and academic achievement. Dr. Owens continued to support this claim by stating that students who get more sleep have improved attendance, lower rates of tardiness, higher grades, and a declined dropout risk. Dr. Owens also shared delayed start times are

associated with improvements in mood, health, and safety; as there is a significant decline in early morning car accidents amongst teenaged drivers.

Dr. Owens then went on to present information on elementary school start times and how the data is not as extensive as studies that have been done on middle school and high school students. Dr. Owens says that this lack of data is due to school-aged children being more likely to be "morning people" who have a strong preference for earlier bed and wake times.

Dr. Owens included detailed information on Massachusetts public school start times. According to a study presented by Dr. Owens, the average start time for public schools in Massachusetts was 7:53 AM in the 2011-2012 school year, but dropped to 7:37 AM in the 2014-2015 school year. Dr. Owens also shared that in the 2011-2012 school year only 8% of all Massachusetts public schools started before 7:30 AM, but that average has increased to 26% during the 2014-2015 school year.

Dr. Owens then proceeded to explain the concept of civil twilight. According to Dr. Owens, civil twilight is when the sun is just below the horizon and there is enough natural light to have high visibility to do most outdoor activities. Dr. Owens started that civil twilight occurs in Massachusetts approximately 30 minutes before sunrise.

Dr. Owens presented information highlighting the impact that shifting time zones has on civil twilight and sunrise in Massachusetts. According to Dr. Owens, civil twilight and sunrises occurs 30 minutes to an hour later during daylight saving time in the months of November, December, January, and February than when on Eastern Standard Time. Dr. Owens proceeded to explain what this effect has on school start times.

According to Dr. Owens, if school starts between 7:00 AM and 7:30 AM, commutes will be in complete darkness for almost all four months and before sunrise for all four months; if school starts between 7:30 AM and 8:00 AM, commutes will be before civil twilight for three months and before sunrise for most of four months; if school starts between 8:00 AM and 8:30 AM, commutes will be before civil twilight for two months and before sunrise for two months; and if school starts at 8:30 AM or later, commutes will be after civil twilight for all four months and after sunrise for most of four months.

Dr. Owens went on to discuss safety concerns for elementary school students in regards to early morning commutes. According to Dr. Owens, shifting time zones would increase the number of days that elementary school children would be waiting for the bus or walking to school before sunrise. Dr. Owens stated that additional safety measures may be needed, such as; lighted bus stops, neighborhood school bus stop monitoring by parents when it is dark in the winter; and walking patrols.

Dr. Owens then discussed potential safety concerns for high school students. Dr. Owens explained that high school students may be more prone to exacerbated seasonal affective disorder and increased car accidents due to lack of light in the morning hours of winter. Dr. Owens also provided information showing that there are significantly more teen involved car crashes in the morning during the school year than during the summer.

Dr. Owens concluded her presentation by stating that she would support Massachusetts changing time zones only if delayed school start times would be considered in the commission's final recommendations. Dr. Owens stated that due to concerns for sleep, health, and wellbeing, all Massachusetts schools should start after 8:00 AM and all middle school and high schools should start after 8:30 AM.

Senator Donoghue then introduced commission member and public health advocate Thomas Emswiler. Mr. Emswiler greeted the commission and began a presentation on the public health impacts that daylight saving time has on the human body.

According to Mr. Emswiler, shifting daylight patterns and sleep deprivation accounted for 30 daylight saving time related fatalities annually in the United States between 2002 and 2011. Mr. Emswiler also elaborated to explain that daylight saving time had a societal cost of $275 million annually in the United States.

Mr. Emswiler then went on to explain the immediate health impacts that daylight saving time has on public health. According to Mr. Emswiler, there is an increased likelihood of heart attack within the first three days of transitioning to daylight saving time, with those under the age of 65 being affected the most.

Mr. Emswiler also stated that when the United States expanded daylight saving time in the United States, there was a 30 minute increase in daily outdoor recreation, a nine minute decrease in television viewing, and people burned 10% more calories; one pound of body fat every 2.5 weeks.

Mr. Emswiler then concluded his presentation by explaining that the shift to daylight saving time is responsible for increased workplace injuries and springing forward is bad for people's health.

Senator Donoghue thanked the speakers for their testimony.

The Commission members engaged in general discussion concerning the testimony from the speakers. The meeting was adjourned at 12:45 p.m.

#LockTheClock_S Yates_FAV_SB0517
Uploaded by: Yates, Scott
Position: FAV

SB 0517

Dear members of the Education, Health, and Environmental Affairs committee,

My name is Scott Yates. I'm the leader of the international movement known as #LockTheClock, but really I am just a citizen with a blog. There's no foundation or institute or whatever. It's just me.

Six years ago I started writing a blog because changing the clocks just annoyed me. Rather than complain about it, my wife challenged me to do something about it.

At first, I didn't do much, I just wrote blog posts. But then I started reading the academic research about what happens when we change the clocks.

These studies were alarming. Heart attacks go up. Strokes. Traffic accidents. Workplace accidents.

I collected that research, and put it on a page on my blog. That collection of research then lead to legislators contacting me, and journalists around the world asking me to help them understand this issue.

You see, this was once viewed as a quirky, almost meaningless issue. *The clocks are the clocks, and certainly somebody somewhere has a reason why they are this way.*

It turns out that there is no good reason for changing the clocks. The history is a painful collection of diversions from other issues.

In short, the farmers are not the reason for Daylight Saving Time, and in fact the farmers have always been against the clock changing.

We do it now, really, only because we've always done it. The reasons are lost to the mists of history.

The thing that we know now that we didn't fully understand when the Uniform Time Act of 1966 was signed into law was that the actual changing of the clocks is deadly. The most recent study issued just on the single issue of traffic safety says that 28 deaths per year are directly attributable to the Spring Forward time change. That's on top of all the other deaths from heart attacks and more.

This is no longer a quirky issue, it is a legitimate public policy health issue. If a toaster came out that killed or injured hundreds of people every year, how fast would the government take action?

In short: The Government is in charge of the clocks. The clocks are killing people. It's time to Lock The Clock.

Now, your next question may be: What good does this bill do? We need the federal government to take action.

I can tell you that every time a state bill passes, I let the sponsors of the two main bills in front of Congress know, and they are very interested for the news. And they use that information.

For instance, Sen. Marco Rubio has a bill to #LockTheClock. His co-sponsors include Senator Patty Murray of Washington State. She signed up immediately after the Washington state legislature passed a bill to put Washington State into permanent Daylight Saving Time.

So will this bill in front of you today actually fix the clocks for the people of Maryland, or will it just be a signal to the U.S. Congress? I don't know, but either way, it is progress in the right direction.

There is no partisan angle to this bill at all. There is only good government. In these fraught times, the citizens are looking to our leaders to actually do something to show that government can actually work on behalf of the people. This is just the thing that you can do today that will make things better for real people.

Thank you very much

2020-03-04 Save Standard Time to MD

Uploaded by: Pea, Jay

Position: UNF

SAVE STANDARD TIME
SaveStandardTime.com • Twitter.com/SaveStandard • info@SaveStandardTime.com • San Francisco, California

2020 March 4

Maryland Senate Education, Health, & Environmental Affairs Committee
The Honorable Paul G Pinsky, Chair
Miller Senate Office Building, 2 West Wing
11 Bladen Street
Annapolis MD 21401-1991

Re: SB 517 (Permanent Daylight Saving Time) – Oppose (Amend to Permanent Standard Time)

Dear Senator Pinsky and Members of the Committee,

Thank you for your work in the best interests of Maryland's citizens. I write with the concerns of circadian-health researchers and advocates for children's well-being, to request you oppose a bill that awaits your committee's hearing. SB 517 has good intentions, but until it is amended from permanent Daylight Saving Time (pDST) to permanent Standard Time (pST), it is poised to harm rather than benefit the public good.

Clock choice is not arbitrary. While SB 517's plan to retry pDST would remove the acute harms caused each March by changing clocks from Standard Time (ST) to Daylight Saving Time (DST), it would increase the chronic harms caused every day by continually observing the clock that disrupts civil time from human circadian rhythms—the clock known as DST.

Many lawmakers, with all due respect, are unfortunately confusing evidence against DST as being merely against clock changes.

ST is objectively defined as an approximation of solar time, to which human biology is intrinsically tied through our internal circadian rhythms. DST disrupts civil clocks from these rhythms. Its artificially delayed sunsets and sunrises make it harder for us to sleep and harder for us to wake. It decreases exposure to morning sunlight, when mental and physical health need it most. Its continual observation leads to chronic sleep deprivation, which manifests as increased disease, accidents, and deaths, and as decreased scholastics, productivity, and even wages. Claims that DST increases exercise have been debunked as anecdotal and culturally dependent. Observation of DST also increases energy waste, which costs millions of dollars each year. And pDST threatens to reverse the necessary and popular benefits of starting school later.

pDST was first introduced to America during World War II; it was unpopular and quickly reverted. It was retried in 1974, when it was again reverted—though sadly after the loss of at least eight children's lives to sleep-deprived motorists. Similar trials have proved disastrous in the UK (1968–1971) and Russia (2011–2014). Why repeat bad history?

Current scientific polling (AP-NORC, October) shows most Americans prefer pST when given all three choices of pST, pDST, and biannual clock changes. History shows even when pDST is greeted with optimism (79% approval in the US in 1973), it quickly reverses once experienced (42% approval in the US in 1974).

DST has long been promoted by merchants of gasoline, golf, and candy, since DST may temporarily benefit these special interests. But momentary profits for a few shouldn't come at the unending cost of the general population's health, safety, and prosperity. It is unjust to force needlessly harmful conditions on the entire citizenry.

This is a public-health issue; it must be decided by data:

> If someone says, "I like Daylight Saving's longer evenings," it's the same as saying, "I like smoking." Both are correct on a hedonic level. Both do not take into account evidence that both are bad for us. Over time, they become very expensive experiments by society.
> —Dr Till Roenneberg, Professor of Chronobiology, Ludwig Maximilian University

> Permanent Daylight Saving undermines any benefits of shifting school start time later. A required wake time of 7am during Daylight Saving leads to the same degree of [circadian] misalignment as a required wake time of 6am during Standard Time.
> —Anne Skeldon PhD, Professor of Biology, University of Surrey

> Permanent Standard Time is the only fair and viable option.
> —Gene Block PhD MS BA, Chancellor, University of California, Los Angeles

pST is the quickest way to end clock changes, since it is the only way approved by Congress (it's what Arizona and Hawaii do). History and polling show it's the most popular and sustainable way forward. Scientific consensus worldwide—and studies of millions of citizens over several years in countless locations—all show it to be the healthiest, safest, most economical, and most environmental way.

Please oppose SB 517. Please urge its sponsors to amend to a restoration of pST. Please consider drafting new legislation for pST if need be.

Most respectfully yours,

Jay Pea
Save Standard Time
PO Box 40238
San Francisco CA 94140
info@SaveStandardTime.com
Twitter.com/SaveStandard
SaveStandardTime.com

Save Standard Time is a nonprofit, nonpartisan, single-issue, volunteer-run effort, presenting concerns of scientists and advocates, seeking to preserve and extend the observation of Standard Time.

SAVE STANDARD TIME

SaveStandardTime.com • Twitter.com/SaveStandard • info@SaveStandardTime.com • San Francisco, California

Endorsements of Permanent Standard Time as the Better Year-Round Clock

The following parties reject permanent Daylight Saving Time and endorse permanent Standard Time as the better year-round clock. These are not implied to be endorsements of the Save Standard Time entity.

Organizations

Society for Research on Biological Rhythms
Canadian Society for Chronobiology
European Sleep Research Society
Chronobiology Lab Groningen
Sleep Medicine Association
Society for Sleep Research & Medicine
National Education Association
National PTA
Association of Canadian Ergonomists
Time Reform Catalonia
Association Against Double Summer Time
Rabbinical Council of California
Agudath Israel of California
Adath Israel San Francisco
Society for Light Treatment & Biological Rhythms
European Biological Rhythms Society
Australasian Chronobiology Society
Dutch Society for Sleep–Wake Research Dutch
Francophone Chronobiology Society French
Northwest Noggin Neuroscience
National School Boards Association
American Federation of Teachers
German Society for Time Policy
Saratov for a Healthy Time
Rabbinical Council of America
Agudath Israel of America
Agudath Israel of Florida

Individuals (non-comprehensive list)

Konstantin V Danilenko MD PhD, Institute of Physiology & Basic Medicine, Novosibirsk, Russia
Marijke CM Gordijn MS PhD, Chrono@Work, University of Groningen, Netherlands
Elizabeth B Klerman MD PhD, Associate Professor, Harvard Medical School, Boston, Massachusetts
Michael T Lam MD PhD, San Diego, California
Michael McCarthy MD PhD, Center for Circadian Biology, University of California, San Diego
Girish Melkani MS PhD, Associated Research Professor, San Diego, California
Thomas E Nordahl MD PhD, Professor Emeritus, University of California, Davis
David K Welsh MD PhD, Professor Emeritus, University of California, San Diego
Amir Zarrinpar MD PhD, Assistant Professor, San Diego, California
Salman Ahsan PhD, San Jose, California
Shimon Amir PhD, Professor, Concordia University, Montréal, Québec
Sonia Ancoli Israel PhD, Professor Emeritus, University of California, San Diego
Michael Antle PhD, Professor, Hotchkiss Brain Institute & University of Calgary, Alberta
William Bechtel PhD, Distinguished Professor, University of California, San Diego
Mikhail Borisenkov PhD, Institute of Physiology, Komi Science Centre, Russian Academy of Sciences
Joseph Boyd PhD, Research Scientist, MilliporeSigma, Temecula, California
Hugo Calligaro PhD, San Diego, California
Joanna C Chiu PhD, Vice Chair, Department of Entomology & Nematology, University of California, Davis
Scott Cookson PhD, Quantitative BioSciences, San Diego, California
Grant Denn PhD, Physics Department Chair, Metropolitan State University of Denver, Colorado
Susan S Golden PhD, Director, Center for Circadian Biology, University of California, San Diego

Bill Griesar PhD, Northwest Noggin Neuroscience Outreach Group, Portland, Oregon
Liz Harrison PhD, Center for Circadian Biology, University of California, San Diego
Dietrich Henckel PhD, Professor, Technical University of Berlin, Germany
Erik Herzog PhD, Professor of Biology, Washington University, St Louis, Missouri
Myriam Juda PhD, Researcher, Simon Fraser University, Vancouver, British Columbia
Katja Lamia PhD, Associate Professor of Molecular Medicine, Center for Circadian Biology, UC San Diego
Andy LiWang PhD, University of California, Merced
Travis Longcore PhD, Institute of the Environment & Sustainability, University of California, Los Angeles
Emily Manoogian PhD, Postdoctoral Fellow, San Diego, California
Erik Maronde PhD, Scientist, Frankfurt, Germany
Matt Metzgar PhD, Clinical Professor of Economics, University of North Carolina, Charlotte
Ralph Mistlberger PhD, Professor, Simon Fraser University, Vancouver, British Columbia
Marie Pariollaud PhD, Postdoctoral Associate, Scripps Research, La Jolla, California
Linda Petzold PhD, Professor, University of California, Santa Barbara
Frank Powell PhD, Professor of Medicine, University of California, San Diego
Kendall Satterfield PhD, San Diego, California
Dorothy D Sears PhD, San Diego, California
Benjamin Smarr PhD, Professor of Bioengineering & Data Science, University of California, San Diego
Andrea Smit PhD, Researcher, Simon Fraser University, Vancouver, British Columbia
Andrew Steele PhD, Associate Professor of Biological Sciences, California State Polytechnic University
Jennifer Thomas PhD, Professor, San Diego, California
Roger Tseng PhD, Biological Scientist, USDA, Ames, Iowa
Judy Village PhD CCCPE, President, Association of Canadian Ergonomists, British Columbia
Daniel S Whittaker PhD, Los Angeles, California
Irving Zucker PhD, University of California, Berkeley
Mariah Baughn MD, San Diego, California
Mona Ezzat MD, San Diego, California
John F Gottlieb MD, Clinical Assistant Professor of Psychiatry & Behavioral Sciences, Chicago, Illinois
Royan Kamyar MD, Physician, La Mesa, California
Beth Malow MD MS, Medical Doctor & Researcher, Brentwood, Tennessee
Tessa Sugarbaker MD MFT, San Francisco, California
Nathaniel F Watson MD MSc, Bainbridge Island, Washington
Dr Archana G Chavan, University of California, Merced
Dr Chelsea Gustafson, Assistant Professor, Portland, Oregon
Dr Paul Kelley, Milton Keynes, United Kingdom
Dr Irving Lebovics, Los Angeles, California
Lisa Alexia PA-C, Physician Assistant, Alaska
Stacey Harmer, Professor, University of California, Davis
Lisa L Heschong BSc, Writer & Researcher, Santa Cruz, California
Betty C Jung MPH RN MCHES, New Haven, Connecticut
Michelle Luxwolda BSc, Groningen, Netherlands
Aleta March RPSGT, Pilot Hill, California
Angela Miller MA BSEd, Department Chair, Ozarks Technical Community College, Springfield, Missouri
Norman F Ruby, Senior Research Scientist, Stanford University, California
Keith Eichner CWO, Contract Weather Observer, Western New York
TTC David A Martin (Ret), Indiana
Deap Singh Bhandal, Health Scholar, Simi Valley, California
Stephen Fleming, Engineer, Tucson, Arizona
Michael Herf, President, f.lux software LLC, Los Angeles, California
James Perrault, Geographer, Hawthorne, California
John Farrar, Elementary School Teacher, California
Michael Lang, Editor, Tumwater, Washington
Kindra Crick, Artist, Portland, Oregon
Elizabeth Wellburn, Author, Victoria, British Columbia

theSOURCE

SCIENCE & TECHNOLOGY

WashU Expert: This year, let's make standard time permanent

By Talia Ogliore • October 24, 2019

Erik Herzog, professor of biology in Arts & Sciences at Washington University in St. Louis, is among the experts in biological rhythms who believe that the United States should abolish daylight saving time. (Photo: Shutterstock)

Never again.

After we turn back the clocks one hour on the morning of Nov. 3, Washington University in St. Louis chronobiologist Erik Herzog wants us to just keep it that way.

"Just lock it in," Herzog said. "Forever."

Herzog

Herzog is a professor of biology in Arts & Sciences and president of the Society for Research on Biological Rhythms (SRBR), a scientific organization dedicated to the study of biological clocks and sleep. He is often asked his opinion about time changes.

The SRBR recently released a formal position paper, titled "Why Should We Abolish Daylight Saving Time?" The researchers have been carefully following the initiatives of the European Commission and California Proposition 7 to abandon the annual clock-time changes in spring and autumn.

There is a consensus among experts that the advantages of permanent standard time outweigh those of switching back and forth to daylight saving time annually — or of switching to daylight saving time permanently.

In the SRBR position paper, the researchers recommend:

- If we want to improve human health, we should not fight against our body clock.
- We should return to standard time — which is when the "sun clock" time most closely matches the "social clock" time — throughout the year.
- This solution would fix both the acute and the chronic problems of daylight saving time.

The science behind this choice is clear, the researchers said. Living creatures have a body clock that creates daily rhythms. For humans, this body clock organizes our biology, such as when we eat and sleep, when we

can run fastest and when our brain works at its best. The body clock must be made to match our 24-hour environment.

Throughout the year, standard time will be healthier than daylight saving time in terms of sleep, cardiac function, weight, cancer risk and alcohol and tobacco consumption, to name a few examples.

To help the public and politicians understand the benefits of permanent standard time, SRBR has put together a helpful list of resources on this topic.

"We must recognize the important role of sunlight in shaping our daily behavior and the important role of our body clock in maintaining our health and well-being," Herzog said.

USC News

USC University of Southern California

Is year-round daylight saving time a good idea? Maybe not

USC experts confirm biological challenges of the time change; if anything, they say we should be on standard time all year.

BY **Joanna Clay** MARCH 19, 2019

If you were yawning more than usual thanks to last week's switch to daylight saving time, you weren't alone.

It takes some people a full week to recover from feeling more sluggish than usual after rolling back the clock for daylight saving time. Experts call the phenomenon "social jet lag."

Much like the jet lag we experience after flying across time zones, losing an hour upsets our circadian rhythm. That not only throws off our sleep schedule but actually has impacts on the cellular level, since many biological functions are timed to that clock.

"It really messes people up," said Steve Kay, the director of the USC Michelson Center for Convergent Bioscience who is considered one of the preeminent experts in circadian rhythm.

"It affects human performance. The data has been clear in terms of traffic accidents and there's also data that it's not great in terms of cardiovascular health: Heart attacks go up."

In California, daylight saving time could become year-round after voters in November approved Proposition 7. The ballot measure allows the state legislature to make daylight saving time permanent, provided federal law is changed to allow the move.

Research shows there are all kinds of health concerns when it comes to circadian disruption. When experienced long term, as is the case with night shift workers, an individual's likelihood to develop obesity, Type 2 diabetes or cancer increases, according to USC experts.

OSHA includes daylight saving time side effects in its trainings, since workplace accidents increase by about 6 percent.

Some proponents of the proposition brought up the health concerns, such as upticks in traffic accidents and heart attacks, but USC experts say they're missing the mark. Permanent daylight saving time wouldn't solve this issue; instead, it would prolong it — adding more days of social jet lag to the year.

Less light in the a.m. with year-round daylight saving time

There's a long-held understanding that experiencing light when you first get up is good for you, said USC Assistant Professor Travis Longcore, who researches night lighting. If we could shift our work and school schedules to accommodate the time change we would be fine, he said, but we don't. That "summer schedule," during which most of us wake up before the sun, could have real health implications if done long term.

A study on 150,000 nurses found that, over the course of five years, those who worked the night shift had a 30 percent higher chance of developing Type 2 diabetes. If they had other unhealthy habits on top of that, such as smoking, the diabetes risk increased threefold. There's also research that shows night shift workers are more likely to engage in unhealthy behavior, such as having a poor diet or exercise habits.

Longcore noted a study on four million Americans, comparing how far east they lived in their time zone with cancer rates. People who lived west within their time zones saw impacts: each 20 minutes of later sunrise increased certain cancers by 4 to 12 percent. In California, farther-west San Francisco would be hit harder than L.A., where the sun rises earlier, he said.

Year-round daylight saving time and cellular function

A recent study by Kay and his team showed that circadian disruption changed the way cells function to the point of increasing disease risk, including cancer.

It's also a change that could disportionately impact teenagers, whose clocks are biologically shifted to wake up later. When they sleep in late on the weekends, it's not just lethargy — it's biology, Kay said. That's the reason some schools are shifting their start times. A study showed students got 34 minutes more sleep, on average, when school started later.

"As we age, our biological clocks shift earlier," Kay said.

If anything, both Kay and Longcore agree, California should consider switching permanently to standard time, like Hawaii and Arizona. The Society for Research of Biological Rhythms penned a letter to the author of Proposition 7 in support of that. Although it would mean earlier nights, it would address the health implications associated by starting your day in darkness.

"Our highly evolved circadian lifestyle is making us ill," Kay wrote in a recent paper. "Humans are not evolved for night shifts, nighttime lights and intercontinental travel. Modern life challenges to our circadian system present a long-term threat to our health."

CBC

British Columbia

Year-round daylight time will cause 'permanent jet lag,' sleep experts warn in letter to government

Change would particularly affect children, say signatories, who want permanent standard time

CBC News · Posted: Oct 31, 2019 10:59 AM PT | Last Updated: an hour ago

A group of sleep experts have sent a letter to the provincial government asking it to stand down on paving the way for permanent daylight time in the province.

Sleep experts warn reduced light exposure in the morning will disrupt circadian rhythms, making people sleep deprived and putting them at greater risk of vehicle accidents and certain health problems. (Shutterstock)

On Thursday, the B.C. government is introducing legislation that gives the province the power to usher in the change sometime in the future.

The letter, signed by six experts in sleep and biological rhythms, advises the government against the decision, saying it could have adverse long-term implications for public health and safety.

The letter says if daylight time is kept year round, the sun will rise later in the winter, leading to decreased exposure to morning sunlight, which humans need to wake their internal biological clock.

It notes that when exposure to morning sunlight is reduced, it makes it harder to wake up in the morning and more difficult to fall asleep at night.

The letter says sleep deprivation can lead to mental and physical health problems and increase risk of vehicle and workplace accidents. In December, the sun will not rise until around 9 a.m. in southern B.C. — and later further north — if daylight time becomes the norm.

"It will be permanent jet lag," said Myriam Juda, a researcher at Simon Fraser University's Circadian Rhythms and Sleep Lab, on CBC's *The Early Edition*.

Juda said it might seem appealing to have more light exposure in the evening, as will happen with permanent daylight time, but said it will cause increased fatigue and decreased morning productivity.

Children will be particularly affected, Juda said, explaining that they would be woken up earlier when their melatonin levels are high and sleep should not be interrupted.

Juda said inadequate sleep can affect children's developing brains and mental health. There will also be safety risks for them commuting to school in the dark for at least one-third of the school year.

Juda and the letter's other signatories say they would prefer permanent standard time, which their research says is the best option for public health and safety.

Sleep Review

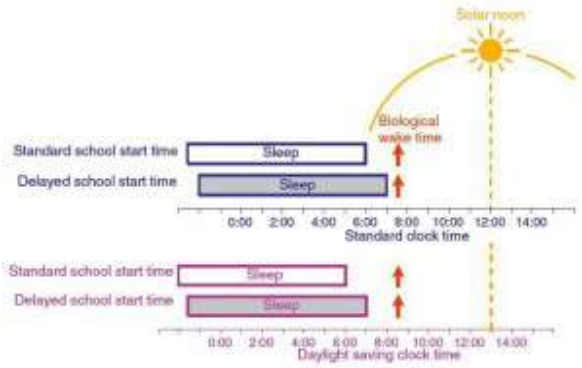
Permanent Daylight Savings May Cancel Out Changes to School Start Times

Posted by Sree Roy | Apr 22, 2019

Moving the clock forward and then back each spring and fall usually draws plenty of complaints and questions about why such a change is necessary. As a result, several states, including California, Washington, Florida, and North Carolina, are now considering doing away with the practice by making daylight savings time (DST) permanent.

But, researchers reporting in the journal *Current Biology* on April 22 say, permanent DST would make it harder to wake up in the winter, as it would remain dark an hour later into the morning. It would also undermine efforts in many states to give teens more time to sleep in by pushing school start times back.

"There has been a long-term, very active debate in the USA and other countries on the difficulties teenagers have in getting up for school," says Anne Skeldon, professor of mathematics at the University of Surrey, UK, in a release. "Similar discussions on school start times and on permanent daylight saving/standard time are happening in Europe. It seemed important to us to point out that moving to permanent daylight saving will undermine any benefits on sleep timing of shifting school start time later."



This figure shows the alignment of sleep timing, clock time, and solar time. Credit: Skeldon and Dijk/Current Biology

Two bills currently making their way through the Californian state legislature are a case in point. Senate Bill SB-328 Pupil Attendance: School Start Time would prohibit middle and high schools from starting earlier than 8:30 in the morning. Senate Bill AB-807 Daylight Saving Time would result in a switch to permanent DST.

Thinking through why permanent DST would negate changes in school start times is a bit tricky, Skeldon explains. That's because it requires understanding how three different times are related to each other and how they shift over the course of the year: environmental time as determined by the sun, our internal biological time (linked to actual light exposure, including sunlight), and the time that we set on our clocks.

If the clocks weren't turned back in the fall, as under permanent DST, it would mean that sunrise would come at an even later clock time than it already does during those shorter days

of the winter. As a result, Skeldon and co-author Derk-Jan Dijk, professor of sleep and physiology and director of the Surrey Sleep Research Centre, write, "a required wake time of 7 am during DST leads to the same degree of misalignment [between the socially required wake time and biological wake time] as a required wake time of 6 am during ST. With permanent DST, schools would need to delay start times by one hour during the winter months just to maintain the status quo!"

Of course, they continued, it's possible that people living indoors under electrical lighting aren't affected that much by shifts in sunrise. But, if that's true, they point out, then it really doesn't matter what time school starts in the first place.

"If we are not entrained to solar time, switching to DST will have no impact on adolescent sleep, but Bill SB-328 delaying school start times is pointless," they write. On the other hand, "if we are completely or partially entrained to solar time, Bill AB-807 leading to permanent DST is bad for adolescent sleep (and the sleep of others) and negates the effect of later school start times."

To sort it out, more research is needed to understand how light exposure affects the sleep and biological clocks of people living in different environments. "We know that spending most of our lives inside and having the lights on late into the evening has had profound effects on when we sleep, but we still have much to learn about exactly how much this matters," Skeldon says.

The year Daylight Saving Time went too far

Susan Steade November 7, 2018 at 11:17 a.m.

The 7 a.m. darkness in the last days before springing forward put us in mind of a historical footnote: the year of unending Daylight Saving Time.

Or at least that was how it was supposed to be.

It was 1974, and the energy crisis was cutting into the American way of life, with odd-even gas rationing, a national speed limit and shortened Nascar races. The Emergency Daylight Saving Time Act signed by President Nixon dictated that clocks would spring forward one hour on Jan. 6 — and stay that way for almost 16 months, until April 27, 1975.

Students wait for a schoolbus at 7:35 a.m. in Astoria, Queens, during the daylight savings experiment. (Getty Images)

By fall, the dark mornings were apparently wearing on the American people. Proclaiming "it's for the children" — those scholars standing at bus stops in the predawn — lawmakers threw in the towel of gloom. Year-round DST

was scrapped, and on Oct. 27, clocks fell back.

But there's no way to stop the Earth from tilting, and — in 1974 as in all years — most of the morning daylight gain was gone within weeks.

The 1974 experiment was but one of the federal revisions of Daylight Saving Time in the past 50 years.

- 1966: To standardize practices across the United States (with a few exceptions), it was declared that DST would run from the last Sunday in April to the last Sunday in October.
- 1986: The start date was moved to the first Sunday in April.
- 2007: DST was extended on both ends, and it now runs from the second Sunday in March to the first Sunday in November.

VOX CEPR Policy Portal
Research-based policy analysis and commentary from leading economists

Does daylight saving time save electricity?

Matthew Kotchen, Laura Grant 05 December 2008

Daylight saving time, designed for energy conservation purposes, is among the most widespread regulations on the planet. Surprisingly little evidence exists that it actually saves energy. This column, using a natural experiment, concludes that "saving" daylight has cost electricity.

Each year, 76 countries practice Daylight Saving Time (DST), referred to as Summer Time in the EU. By setting clocks forward one hour in the spring and turning them back one hour in the fall, DST effectively moves an hour of sunlight from morning to evening. The policy directly affects more than 1.6 billion people worldwide, making it among the most widespread regulations on the planet.

"Saving" daylight to save energy

Although commonly misunderstood to be an agricultural policy, DST has always been about energy conservation. History credits Benjamin Franklin with the original idea in a whimsical essay titled "An Economical Project" (1784). He mused that if people adjusted their schedules during summer months to wake earlier, an immense sum of tallow and wax could be saved in the evening by the "economy of using sunshine rather than candles."

The idea was taken seriously when numerous countries implemented DST during World Wars I and II. But it was not until 1966 that DST became an annual policy in the US, and since that time, the start and end dates have changed several times. Most recently, the Energy Policy Act of 2005 extended DST beginning in 2007 to start three weeks earlier and last one week longer. Congressional debate about the extensions focused on the potential energy savings, with forecasts speculating that each additional day of DST would save the equivalent of 100,000 barrels of oil per day.

Existing evidence

Despite the historical and current practice of DST within the US and around the world, surprisingly little evidence exists that the overall policy actually saves energy. An early and oft-cited study by the US Department of Transportation (1975) found that DST causes a 1% decrease in electricity consumption at the points of transition in the spring and fall. But a subsequent evaluation of the study concludes that the results are statistically insignificant (Filliben 1976). Kellogg and Wolff (in press) find that extending DST in Sydney, Australia during the 2000 Olympic games had no effect on overall electricity consumption because the decrease in evening demand was offset by an increase in morning demand.

A related literature uses engineering simulations, and these results also call into question DST's supposed energy savings. Rock (1997) finds that DST increases electricity consumption on average over 224 different locations throughout the US. Fong et al. (2007) investigate the effects of DST on household lighting in Japan and find a reduction in electricity consumption that varies by region. However, Shimoda et al. (2007) conduct a similar exercise that accounts for air-conditioning as well and find that DST results in a 0.13% increase in residential electricity consumption.

Indiana's natural experiment

Recently, we were able to conduct a study that takes advantage of the unique history of DST in the state of Indiana (Kotchen and Grant 2008), where the policy was instituted statewide only in 2006. Before that year, only a relatively small set of counties were practicing DST. The change in statewide policy thus offered a natural experiment to measure the overall effect on residential electricity consumption. We could compare the amount of electricity used by households in the late-adopting counties during the two years before they switched to DST with the amounts they used during the year afterward – while using counties that always practiced DST as a control group. A notable feature of the research design is that it allows estimation, for the first time, of an overall DST effect and different effects throughout the year over the entire DST period, including the periods of transition.

Our main finding is that – contrary to the policy's intent – DST increases residential electricity demand. Estimates of the overall increase are approximately 1%, but we find that the effect is not constant throughout the DST period. DST causes the greatest increase in electricity consumption in the late summer and early fall, when estimates range between 2% and 4%.

To understand what underlies this result, we simulate the effect of DST on components of household electricity demand with an engineering model. These simulations corroborate our empirical estimates and uncover changes in the quantity and

Matthew Kotchen
Associate Professor of Environmental Economics and Policy at Yale University

Laura Grant
PhD candidate in environmental economics at Bren School of Environmental Science & Management, University of California, Santa Barbara

timing of electricity demand due to the distinct components of lighting and indoor climate control. Consistent with Benjamin Franklin's original intuition, DST is found to save on electricity used for household lighting, but the savings is more than offset by increases in electricity use for heating and especially cooling.

A final component of our analysis is the calculation of costs associated with the estimated effect of DST. We find that the policy costs Indiana households an average of $8.6 million per year in increased electricity bills. We also estimate social costs of increased pollution emissions due to the residential response to be between $1.6 and $5.3 million per year.

Where to from here?

Our analysis does not, of course, suggest that "saving" daylight will always cost electricity, but it, combined with much of the existing literature, casts doubt on the longstanding justification for the policy. The scepticism is particularly important at this point in time, as the US begins to evaluate its recent extensions to DST, as required by the Energy Policy Act of 2005. The US Department of Energy (2008) just released its report to Congress on the effects of extended DST. The main finding is that extending DST saves less than 0.5% of total electricity usage over the extension period.

But as attention begins to focus on the Department of Energy study, the US Congress should bear in mind that even if extending DST saves electricity, the overall policy need not. Making a potentially flawed policy better, does not make it a good policy. The Indiana study provides the first—and only—empirical evidence of DST's effect throughout the entire year, and the results suggest that DST costs, rather than saves, energy. Moreover, the effects are likely to be even worse in areas where demand for air-conditioning is greater.

Further research is currently underway to extrapolate the Indiana results to other regions of the US. But research is also needed to understand the impact of DST in other regions of the world. For instance, Pakistan and Morocco reinstated DST this year in response to energy needs, and other countries, including India and Japan, are now considering implementation of DST. With worldwide energy demand expanding rapidly, along with concerns about climate change, it is increasingly important to know whether DST should be considered part of the problem or part of the solution.

References

Filliben, J. J. 1976. Review and Technical Evaluation of the DOT Daylight Saving Time Study. U.S. National Bureau of Standards, NBS Internal Report Prepared for the Chairman Subcommittee on Transportation and Commerce, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, KF27.I5589, Washington.

Fong, W., H. Matsumoto, Y. Lun, and R. Kimura. 2007. Energy Savings Potential of the Summer Time Concept in Different Regions of Japan From the Perspective of Household Lighting. *Journal of Asian Architecture and Building Engineering.* 6(2) 371-78.

Franklin, B. 1784. An Economical Project. *Journal de Paris.*

Kellogg, R. and H. Wolff. In press. Does Extending Daylight Saving Time Save Energy? Evidence from an Australian Experiment. *Journal of Environmental Economics and Management.*

Kotchen, M. J. and L. E. Grant. 2008. Does Daylight Saving Time Save Energy? Evidence from a Natural Experiment in Indiana. NBER Working Paper 14429.

Rock, B. A. 1997. Impact of daylight saving time on residential energy consumption and cost. *Energy and Buildings*. 25: 63-68.

Shimoda, Y., T. Asahi, A. Taniguchi, and M. Mizuno. 2007. Evaluation of City-Scale Impact of Residential Energy Conservation Measures Using the Detailed End-Use Simulation Model. *Energy*. 32 1617-33.

U. S. Department of Energy. 2008. Impact of Extended Daylight Saving Time on National Energy Consumption: Technical Documentation for Report to Congress. Energy Policy Act of 2005, Section 110.

U. S. Department of Transportation. 1975. *The Daylight Saving Time Study: A Report to Congress from the Secretary of Transportation*. Volumes I and II.

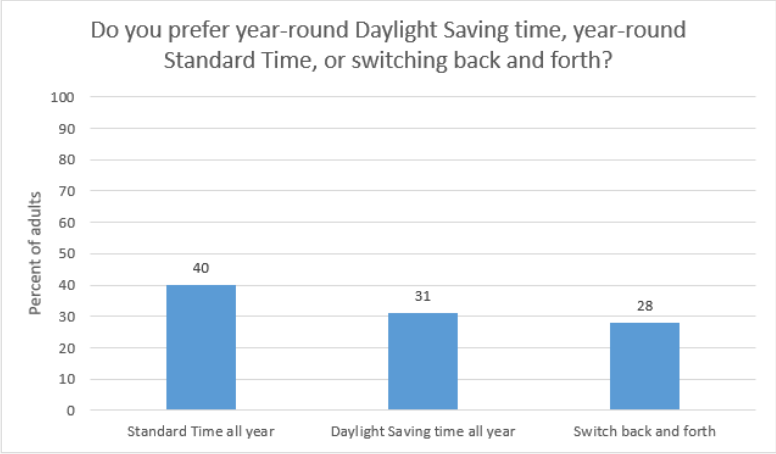
The Associated Press-NORC Center for Public Affairs Research

Daylight Saving Time vs Standard Time

An AP-NORC Poll conducted in October 2019 finds 71% want to end the practice of changing the clocks.

Daylight saving time is observed from the second Sunday in March until the first Sunday in November. While states can opt into standard time permanently — which Hawaii and Arizona have done — the reverse is prohibited and requires congressional action. More than 30 states are considering legislation related to the practice of changing clocks twice a year, and Florida Sen. Marco Rubio introduced legislation making daylight saving time permanent nationwide.

Only 28% want to continue changing the clocks. Among the rest of Americans, 40% prefer year-round standard time and 31% prefer year-round daylight saving time.



Question: Would you prefer to use daylight saving time all year round, standard time all year round, or switch back and forth between them?
Source: AP-NORC poll conducted October 24-28, 2019, with 1,075 adults nationwide.

Older Americans are more likely than younger Americans to support staying in daylight saving time permanently. Thirty-eight percent of Americans age 45 and older support year-round daylight saving time, compared to 22% of Americans under 45.

The nationwide poll was conducted October 24-28, 2019, using the AmeriSpeak® Panel, the probability-based panel of NORC at the University of Chicago. Online and telephone interviews using landlines and cell phones were conducted with 1,075 adults. The margin of sampling error is plus or minus 4.1 percentage points.

SSL MD SB 517 HB 1610 HB March 5, 2020
Uploaded by: VanBuskirk, Lisa
Position: UNF

Testimony in Opposition to SB 517/HB 1610 - General Provisions - Standard Time - Year-Round Daylight Saving Time

March 5, 2020

Good Afternoon Chair Pinsky, Vice Chair Kagan, and members of the Education, Health, & Environmental Affairs Committee:

Thank you for the opportunity to testify in opposition to SB 517/HB 1610.

I am Lisa VanBuskirk, the leader of Start School Later's Maryland and Anne Arundel County chapters. The goal of my all-volunteer organization is to educate communities and policy makers about the physical and mental health, safety, and academic benefits of age-appropriate school hours. In 2014, Maryland was the first state in the nation to pass legislation related to school start times, with a joint study by the Maryland State Department of Education and Maryland Department of Health. In 2016, the General Assembly followed with the Orange Ribbon for Healthy School Hours, which recognizes school systems with no elementary before 8 a.m. and no middle or high school before 8:30 a.m. The average middle school start time is 8:11 and the average high school start time is 7:54 a.m. Both levels have schools that start between 7:00 a.m. and 9:30 a.m. Most elementary schools start later in the morning, but there are elementary schools that start as early as 7:30 a.m. and as late as 9:45 a.m.[1]

I acknowledge the negative health and social impacts society bears when we switch from Standard Time (ST) to Daylight Savings Time (DST) and back again. Just today, the Wall Street Journal published a story about the negative effects of switching back and forth and the call by circadian scientists to move to permanent Standard Time and do away with Daylight Savings Time, the complete opposite of this proposed legislation.[2]

Permanent Daylight Savings Time, combined with the current too-early school start times, would have an even greater negative impact on adolescent circadian rhythm, safety, health, and academics, than the status quo and is contrary to the intent of previous state legislation.

[1] https://www.startschoollater.net/md---statewide.html see multiple graphics with list of all middle and high school start times and bell times relative to Orange Ribbon criteria.
[2] https://www.wsj.com/articles/heres-why-health-experts-want-to-stop-daylight-saving-time-11583340645?fbclid=IwAR0YLjCfiS_D7RMQi55jqaXYUuKUORnk-o5GmmiQCgdOKbzAkLJyijB1Wmc

When Massachusetts studied the issue in 2017, their report made two caveats to the implementation of permanent DST, what they called Atlantic Time; community education and later school start times.[3]

The latest sunrises of the year occur late December through mid-January, which would be at about 8:25-8:35 a.m. depending on where you are in the state, under permanent DST. Civil dawn, the 30 minutes or so before sunrise, when it is light enough to see without artificial illumination, would begin at about 8 a.m. I lived in the Netherlands for four year, where sunrise is as late as 8:50 a.m. (standard time); it was brutal.

The "Save Standard Time" organization has an interactive website where you can put in your location, what time you wake up, and what time you have to be at work or school. It compares the number of days you would wake or be at work/school before sunrise for permanent Standard Time, permanent Daylight Savings Time, and our current practice of shifting clocks.[4] (See also Page 3 for two examples). For example the school that currently starts at 7 a.m, would for the six months from the end of September to the end of March, start before sunrise. They would even start before civil dawn from late October to early March. In comparison, starting school at 9:00 under permanent DST, would always be after sunrise.

It is not just the school bell time we ought to consider, but the fact that so many more Maryland students will be picked up by a bus or walk to school in the dark during the winter, relative to the Standard Time. This is a safety issue. As the Massachusetts report acknowledges "One way to avoid the downsides of year-round DST for school-aged children would be to delay school start-times until after there is sufficient daylight for safe travel." Many Maryland students ride buses for an hour, coupled with having to be at the bus stop 10 minutes early and arriving 15-30 minutes before the bell. We must take into account the impact of permanent DST on the darkness of their commute plus school start time.

Please vote in opposition to SB 517/HB 1610 *or* amend the bill to include a mandate for a minimum safe, healthy, and age-appropriate start time for *all* schools.

Thank you,

Lisa E VanBuskirk

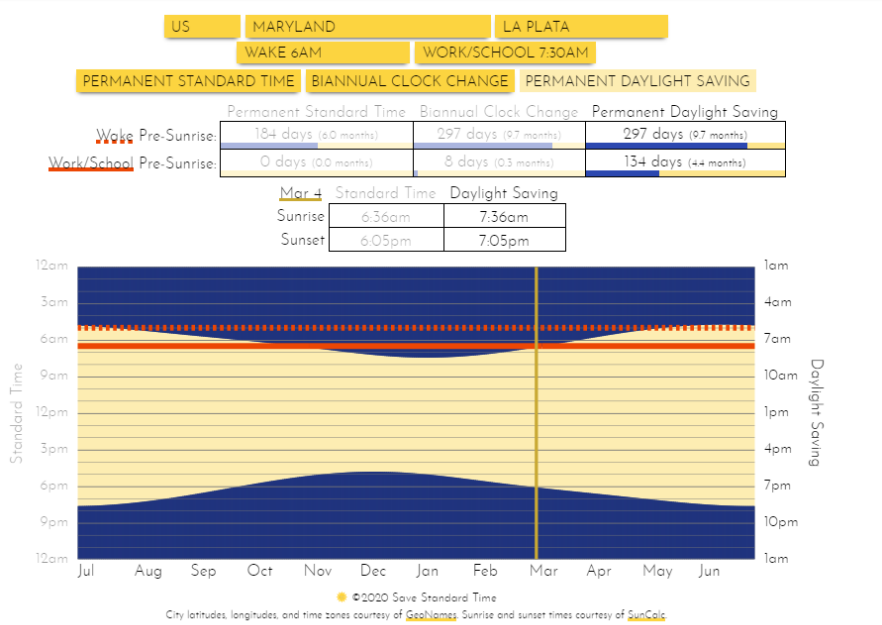
Lisa VanBuskirk, P.E., Chapter Leader, Start School Later Maryland | Start School Later Anne Arundel County
sslaaco@gmail.com

[3] https://www.ctnewsjunkie.com/upload/2017/11/Special_Commission_Commonwealths_Time_Zone.pdf
[4] http://savestandardtime.com/chart/

Screenshots from http://savestandardtime.com/chart/

La Plata, wake at 6 a.m., have to be at school by 7:30 a.m.

Permanent DST- 134 days at school before sunrise.



Hagerstown. Wake at 7:30 a.m. Have to be at school at 9 a.m.

Permanent DST- 0 days at school before sunrise.