



## **Cost-Benefit Analysis of Daylight Saving Time in Ohio**

October 2023

## Executive Summary

Currently, the federal government allows states to choose to either follow daylight saving time during part of the year or stay on standard time year-round. Currently, all but two states change their clocks during the year, observing daylight saving time from March to November and standard time from November to March. Ohio is among those 48 states. In this analysis, we evaluate how adoption of permanent standard time or permanent daylight saving time would affect Ohio's economy.

We analyze the impacts of changing to permanent standard or daylight saving time on car crashes, energy use, productivity, and crime. The largest impact moving to permanent daylight saving or standard time would be the impact on productivity each year. Moving to permanent daylight saving or standard time would save Ohio metropolitan areas roughly \$30 million each year in lost productivity.

We project the present net benefit of a change to permanent daylight saving time to be between \$39 million and \$41 million, due mostly to increased productivity and a reduction in crime because of the extra hour of sunlight in the night.

Similarly, if Ohio was to follow Hawaii and Arizona and change to standard time permanently, it could save the state about \$36 million and \$39 million annually. The increase in productivity from doing away from the time change provides large benefits, but unlike permanent daylight time we see additional savings thanks to a reduction in energy usage due to less use of air conditioning and heating rather than a reduction in crime.

## Why do we change our clocks?

When daylight saving time was established in 1918, policymakers aimed to help save fuel costs during World War I by adding another hour of sunlight in the evenings.<sup>1</sup> Daylight saving was brought back during WWII for the same reason.

In 1966, the Uniform Time Act made the time change an annual event. In 2007, daylight saving time was extended to last one month longer. This is the current state

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1. Gary Stephenson, "A short history of daylight saving time," 2023, <https://spectrumlocalnews.com/nc/charlotte/weather/2021/02/24/why-daylight-saving-time-#:~:text=In%20the%20United%20States%2C%20daylight,wass%20called%20%22War%20Time.%22>.

of daylight saving time.<sup>2</sup>

The debate surrounding the benefits and costs of daylight saving time have been brought to the forefront of the policy conversation when the Sunshine Protection Act was passed by the U.S. Senate in March of 2022

Changing clocks twice a year creates social problems. People forget to set their clocks, miss appointments, and are late to work when the time change occurs. There are even more severe consequences due to the change in circadian rhythms such as car accidents and heart attacks.<sup>3</sup>

We move our clocks twice a year to adjust to the position of the sun. In November, we set clocks back an hour and we lose an hour of sunlight in the evening in exchange for an hour of sunlight in the morning. In March, we move clocks forward an hour to gain an hour of evening sunlight in exchange for an hour of morning sunlight.

During daylight saving time, the extra hour of evening sunlight allows for more outdoor activities, less light usage, and lower crime rates. When the state is on standard time, it gains an hour of sunlight in the morning which allows commuters and school children to travel in the daylight and reduces use of air conditioning in the evening and heat in the morning.

## Policy Landscape

In March of 2019, Senate Bill 119 was introduced in the Ohio legislature by Representatives Kristina D. Roegner and Bob Peterson.<sup>4</sup> This bill would move Ohio to permanent daylight saving time if Congress authorizes states to do so. It was referred to a committee in 2019 and the topic has not risen again since.

This report focuses on the impact of the three different timekeeping policies that

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2. S.582 - Sunshine Protection Act of 2023 - congress.gov, accessed August 16, 2023, <https://www.congress.gov/bill/118th-congress/senate-bill/582>.

3. Anis Rehman Danielle Pacheco, “Daylight Saving Time,” 2023, <https://www.sleepfoundation.org/circadian-rhythm/daylight-saving-time#:~:text=These%20issues%20include%20upticks%20in,View%20Source%20..>

4. WLWT5, “Could Daylight Saving Time become permanent in Ohio? Where legislation stands,” 2023, <https://www.wlwt.com/article/daylight-savings-time-ohio-permanent-2023-laws/43263075>.

may be utilized by US states in the future. The goal of analyzing these policies is to understand the economic impacts of the time change and the relative costs and benefits of an extra hour of sunlight in the evening (daylight saving time) or in the morning (standard time).

The main reason why permanent daylight saving has not been implemented by US states is because it is not authorized by the federal government. Although 19 states have attempted to enact policy that would allow them to implement permanent Daylight Saving Time, none will be able to do so until Congress authorizes them to.<sup>5</sup> The Sunshine Protection Act of 2023 is the most recent legislation that would authorize states to change to permanent Daylight Saving Time. The 2022 version of the act passed the U.S. Senate but was not entertained in the House of Representatives.

## Policy Alternatives

Currently, Arizona and Hawaii are the only U.S states that observe permanent standard time.<sup>6</sup> Federal law authorizes states to unilaterally move to permanent standard time but states must have approval from Congress to adopt year-round daylight saving time. By being on standard time, Arizona and Hawaii stay on the same time all year round. The other 48 states move clocks ahead to daylight saving time in March and back an hour to standard time in November each year.

One alternative that we analyze is the **status quo of keeping temporary daylight saving time**. Since there is more light in the evening, cities have seen decreases in crime. Some also argue that the time change reduces energy use as well.

One alternative to the status quo that we analyze is **changing Ohio to permanent standard time**. This approach is a legal change that Ohio can currently undertake at the state level. This alternative would involve no more time change according to the time of year. More than 60% of countries in the world utilize standard time including most of Asia.<sup>7</sup> The experts at the American Academy of Sleep Medicine

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5. Whitney Kimball, “19 States That Have Passed Permanent Daylight Saving Time and Why They Haven’t Implemented It,” 2023, <https://gizmodo.com/18-states-that-have-passed-permanent-daylight-savings-t-1848005046>.

6. Janessa Hilliard Jennifer Sangalangm, “Daylight saving time math: ‘Spring forward, fall back,’ meet ‘3 hours in the summer, 2 in the winter’,” 2023, <https://www.palmbeachpost.com/story/news/2023/03/10/daylight-saving-time-zone-math-florida-arizona-hawaii-spring-forward/69884893007/>.

7. “Daylight Saving Time and Your Health Plus, Steps to Saving Zzz’s,” 2021, <https://www.nm>.

claim that standard time lines up with our internal clock. With more light in the morning, there is less safety concern for commuters and school children.

The final policy option we will investigate is the **effect of instituting permanent daylight saving time in Ohio**. The Ohio General Assembly passed a resolution to urge Congress to enact The Sunshine Protection Act, which would permanently institute daylight saving time.<sup>8</sup> The Sunshine Protection Act passed the U.S. Senate in 2022 but the bill failed to pass in the House. While states can choose to switch to permanent standard time, permanent daylight saving time requires congressional approval. Instituting permanent daylight saving time would eliminate the semiannual changes back and forth between daylight saving and standard time. There are pros and cons to this method as it could help reduce the disruption of sleep patterns but increases energy consumption.

Below are the three policy alternatives we consider in this cost-benefit analysis:

- **Keep Temporary Daylight Saving Time (Status Quo):** Ohio would continue to stay on daylight saving time during part of the year which includes changing clocks twice a year.
- **Institute Permanent Standard Time:** Ohio would move to standard time permanently and not change times. This action is authorized by Congress and therefore could be instituted now.
- **Institute Permanent Daylight Saving Time:** Ohio would move to daylight saving time permanently and stay on that time indefinitely. This action is not authorized by Congress and would take action by Congress to implement.

## Standing

For the purpose of this study, we consider residents of Ohio and its metropolitan areas to have standing. This means we will consider costs and benefits for people within Ohio and people nearby who may work in Ohio who would be impacted by changes in timekeeping policy in the state.

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org/healthbeat/healthy-tips/daylight-savings-time-your-health..

8. <https://ohiohouse.gov/members/rodney-creech/news/house-passes-resolution-urging-the-sunshine-protection-act->

## Impacts

During our research, we decided to investigate four major impacts of daylight saving time and its alternatives. The impacts we analyzed were car crashes, energy, productivity, and crime.

### Car Crashes

Car crashes are the leading cause of death in the U.S. for people age 1 to 54.<sup>9</sup> When the U.S. moves clocks forward for daylight saving time in March, analysts observe a six percent increase in fatal accident risk in the U.S. The biggest impact is in the morning hours of the days immediately following the time change.<sup>10</sup> Drowsiness and darker mornings, both due to daylight saving time, are leading factors in car crashes.<sup>11</sup>

If Ohio were to stay with the status quo of changing clocks twice a year, we estimate the state would have about one death a year due to car accidents. When the time change occurs in March, mornings are darker. With the darker mornings and the drowsiness connected to daylight saving time, Ohio loses a life every year. Using the EPA's value of a statistical life, we estimate the change will cost Ohio about \$11 million a year.<sup>12</sup> Since this impact occurs due to abrupt changes in sleep patterns from the time change, we estimate the reduction in car crash deaths would be a benefit for both permanent standard time and permanent daylight saving time.

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9. CDC, "Road Traffic Injuries and Deaths—A Global Problem," 2023, <https://www.cdc.gov/injury/features/global-road-safety/index.html#:~:text=Road%20Traffic%20Injuries%20and%20Deaths%E2%80%94A%20Global%20Problem&text=Road%20traffic%2>.

10. Nerenberg Law Associates, "Do Car Accidents Increase in the Week Following Daylight Saving Time?," 2021, <https://www.phillypilaw.com/2021/03/15/car-accidents-daylight-saving-time/#:~:text=According%20to%20data%20from%20the,around%2028%20deaths%20each%20year>.

11. Jane Ulitskaya, "Daylight Saving Time Dangers: Deadly Crashes Spike, Studies Show," 2023, <https://www.cars.com/articles/daylight-saving-time-dangers-deadly-crashes-spike-studies-show-463423/>.

12. EPA, "Mortality Risk Valuation," 2023, <https://www.epa.gov/environmental-economics/mortality-risk-valuation>.

## Energy

During daylight saving time, there is an extra hour of daylight in the evening. More evening daylight could reduce the demand for energy used to light homes and businesses. When the Department of Energy investigated the effects of a change in daylight saving time policy in the 1970s, researchers found that the average American home uses about 0.5 percent less energy per day during daylight saving time, which adds up to nationwide savings of 1.3 Terawatt-hours (TWh) per year.<sup>13</sup> However, this study did not take into account the possibility of increased demand for air conditioners in the summer and heat in the winter. A study done in Indiana found that daylight saving time actually increased the demand for energy and increased pollution output.<sup>14</sup>

Using values reported in this study and data from the Department of Energy, we are able to estimate the effect of temporary daylight saving time on energy use in Ohio.<sup>15</sup> If Ohio were to continue to observe temporary daylight saving time and the energy costs were similar to those found in Indiana, we estimate temporary daylight saving time costs Ohioans \$17 million every year due to the increased use of energy relative to the cost during standard time. This value does not consider the external costs of pollution due to the extra energy used, which could vary from \$3 million to \$10 million every year for Ohio.

With the implementation of permanent standard time in Ohio, the state would not increase energy use during daylight saving time each year. This amounts to a \$17 million benefit in energy savings each year.

While the Indiana report does not directly investigate the cost of energy if permanent daylight saving time was implemented, we can estimate how this would affect Ohio residents using the data provided about the current impact of daylight saving time. Daylight saving time currently occurs 65% of the year.<sup>16</sup> If we assume that permanent daylight saving time puts us in a high-energy-use environment year round, then we

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13. Corporate Editorial Team, “Does Daylight Saving Time Really Save Energy?,” 2020, <https://www.energynewsroom.com/article/does-daylight-saving-time-really-save-energy/>.

14. Matthew J Kotchen and Laura E Grant, “Does daylight saving time save energy? Evidence from a natural experiment in Indiana,” *Review of Economics and Statistics* 93, no. 4 (2011): 1172–1185.

15. Corporate Editorial Team, “Ohio Energy Consumption Estimates, 2020,” 2020, <https://www.energynewsroom.com/article/does-daylight-saving-time-really-save-energy/>.

16. Catherine Boeckmann, “Daylight Saving Time 2023: When Does the Time Change?,” 2023, <https://www.almanac.com/content/when-daylight-saving-time#:~:text=Daylight%20Saving%20Time%20begins%20on,more%20light%20in%20the%20evening..>

can extend the \$17 million cost to the additional 18 weeks of the year that the state currently observes standard time. This results in an additional \$9 million above baseline costs if the state changes to permanent daylight saving time.

## Productivity

The Monday after the change to daylight saving time is known as sleepy Monday as people wake up an hour earlier than they had for months before.<sup>17</sup> People are less productive on these days because their sleep pattern is disturbed and concentration decreases.

Chmura Economics & Analytics conducted a study called “Estimating the Economic Loss of Daylight Saving Time for U.S. Metropolitan Statistical Areas” that investigated the economic losses due to daylight saving time.<sup>18</sup> This lost hour includes the costs of the increased number of heart attacks, cyberloafing and workplace injuries due to the time change. They estimate that the U.S loses about \$434 million in productivity every year due to the time change.<sup>19</sup> We summed all the Ohio metropolitan areas in order to estimate the total cost of the time change to the state of Ohio. After adjusting this number to 2023 dollars, we estimate the cost of the lost hour to Ohio each year is \$30 million.

Because of the negative impact associated with losing an hour of sleep one day each year, both changing to permanent daylight or permanent standard time would lead to a benefit of \$30 million in fewer heart attacks, cyberloafing, and workplace injuries each year.

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17. Richard Feloni, “The Monday after the switch to Daylight Savings Time is disastrous for all kinds of workers,” 2015, <https://www.businessinsider.com/sleepy-monday-after-daylight-savings-time-2015-3>.

18. Ibid.

19. “SleepBetter Lost-Hour Economic Index,” Chmura, March 11 2016, Available Online: <https://www.chmura.com/blog/2016/march/11/sleepbetter-lost-hour-economic-index>



## Crime

Criminals are less likely to commit crimes in broad daylight than darkness. This has implications for daylight saving policy: studies have shown that crimes decrease 7% during the extra hour of sunlight provided by daylight saving time.<sup>20</sup> Researchers at Stanford University found that temporary daylight saving time saves the U.S about \$501 million in cost to society per year.

Given 34 weeks of daylight saving time each year, this comes out to about a \$15 million reduction in crime for each week that we have an extra hour of sunlight in the evenings across the nation. If we assume that these benefits are constant for every week in the year, then it follows that switching to permanent daylight time would save \$270 million across the country. Adjusting this number based on Ohio’s population means that Ohio could save \$9.4 million each year in reduced crime by changing to permanent daylight saving time.

Conversely, by switching to permanent standard time, Ohio would lose the benefits it currently sees in reduced crime during those 34 weeks. This means that the \$14.8 million reduction in crime would instead be an added cost for those weeks. Adjusting again for Ohio’s population relative to the nation as a whole, this means Ohio would incur costs of \$17.9 million each year.

## Results

Table 1: Monetized Benefits (Millions of \$)

Alternative	Car Crashes	Energy	Productivity	Crime	Total Benefits
Daylight Saving Time	\$11.4	-\$8.7	\$30.4	\$9.5	\$42.6
Standard Time	\$11.4	\$16.6	\$30.4	-\$17.9	\$40.7

Our analysis shows that Ohio can increase economic output by changing to permanent daylight saving time or permanent standard time. Most of the benefits come from removing the need to change clocks twice a year, in the forms of improved productivity and a reduction in car accidents. Adoption of permanent standard time would lead to

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20. 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): 1093–1103.

a large reduction in energy use in exchange for an increase in crime while adoption of permanent daylight saving time would lead to a large reduction in crime in exchange for an increase in energy use.

This represents a tradeoff for policymakers. Adopting permanent daylight saving time or standard time eliminates the car crash and productivity impacts that come from changing timekeeping twice a year. Permanent daylight saving time leads to fewer crimes but higher energy costs. Permanent standard time leads to more crimes but lower energy costs. While the magnitude of economic effects of these two are comparable, policymakers may favor permanent daylight saving time for its reduction in crime or permanent standard time for its environmental benefits.

## Sensitivity Analysis

To better understand the range of possible outcomes, we perform a Monte Carlo simulation with 10,000 replications varying the inputs to our model in each step. Specifically, we test what happens when we change the following variables.

- The number of fatal car crashes
- The Value of Statistical Life
- The amount of extra energy consumed per week of daylight saving time
- The lost productivity of switching
- The reduction in crime
- The discount rate

We vary these inputs in order to see how changes in potential values could change the outcomes of the study.

Below are histograms showing the range of possible outcomes and their relative likelihood.

The Monte Carlo histograms for both policy options have roughly the same shape. The daylight saving results are about \$2 million higher relative to the standard time

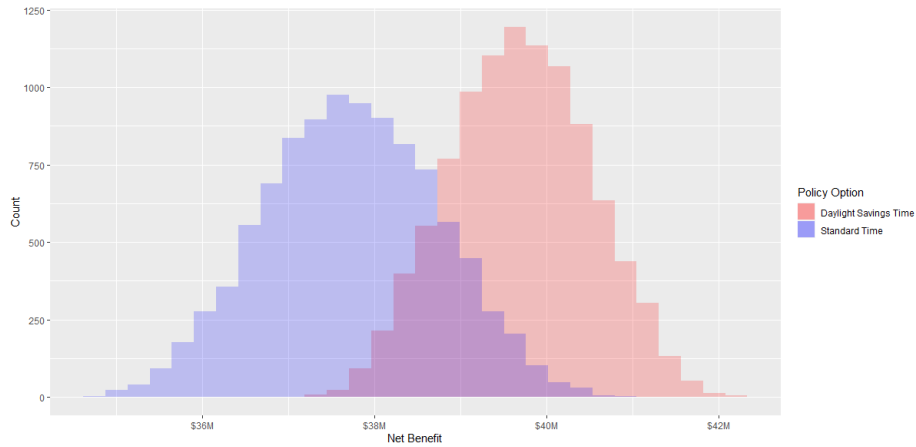


Figure 1: Monte Carlo Results

results due to the slightly larger impact on crime than energy use. Note that the 95% range of possible outcomes overlap for the two alternatives. This implies that it is likely that the economic impact of either adopting permanent standard time or permanent daylight saving time are very similar.