ABSTRACT

The most enduring and contentious public policy issue in Indiana history may be the seemingly prosaic matter of “what time is it?” This analysis focuses on the implications of the State of Indiana’s recent change to daylight-saving time in conjunction with near-statewide Eastern time. I argue that the economic and commercial basis for the new temporal regimen is erroneous, and that its educational and humane implications are substantial. Finally, I outline a proposal for resolution of these issues. Although the concentration here is the Indiana situation, lessons are generalizable to other states, counties, and regions facing similar time-regulatory considerations.

Key Words: Indiana, public policy, time zones, U.S. Department of Transportation

INTRODUCTION

Even those who are based nowhere near Indiana may be aware of the state’s convoluted time legislation experience, especially the most recent such occasion in 2005-06. After nearly six decades of resistance, the Indiana state legislature approved daylight-saving time in the spring of 2005. The principal motivation for proponents, prominently including the state Chamber of Commerce and Governor Mitch Daniels, was seasonal alignment and work-day consistency with most of the rest of the country, which was expected to facilitate business convenience. That is, no more confusion by out-of-state, daylight-saving observant business contacts over the exact hour in Indiana.

This action only set in motion a derivative controversy about whether to be assigned to the Eastern or Central time zone. Although most of Indiana had nominally been in the Eastern zone for 40 years, because of non-observance of daylight-saving time (DST, equivalent to “Summer Time” in the U.K.), the state was effectively on Central time for six or seven months per year during that 40-
year period. True to form, different Indiana counties opted for different time zones in their 2005 petitions to the federal government, but the majority of the state, 77 of 92 counties, remains on Eastern time even since DST has been imposed there. Yet because of some undesirable consequences of this discontinuity, opposition to DST, Eastern time, or both, continues within broad areas of Indiana.

The comprehensive assessment to follow relies upon analytical argument, case study, and disclosure and analysis of secondary data to address the question of the true, possibly veiled, nature of a particular intersection of geography and public time policy. Before considering the evidence and implications, a more detailed review of the underlying policy background could be helpful.

**DIALIGHT-SAVING TIME HISTORY**

The genealogy of DST should first acknowledge the history of standard time, which was adopted in the United States and internationally as an outcome of the Prime Meridian Conference of 1884. Before then, individual jurisdictions, even municipalities, established their own local times, producing a patchwork-quilt pattern of time zones (Aldrich 2005). The obvious havoc this regime created for railroad schedules was the principal impetus for standard time.

Benjamin Franklin, no less, may actually have been the father of daylight-saving time via a 1784 essay (Goodman 1931), the idea culminating in British Summer Time, enacted by Parliament in 1916 after first being rejected in 1907. Franklin’s original rationale, remarkably durable over the following two centuries, was energy savings—primarily from evening lamp-light usage in his day. The desire to conserve national energy resources during the two world wars contributed additional American momentum, as DST was decreed in 1918-19 and 1942-45, but the practice remained very unpopular in the inter-war period when it was merely a local option, selectively applied. U.S. states and localities again had discretion over DST observance between 1945 and the late 1960s, when the Uniform Time Act (1966) created homogeneous national DST from April to October, subject to state or locality opt-out by ordinance. In 1986, the Reagan Administration and Congress lengthened the period of U.S. DST to approximately seven months per year from six, and since March 2007 its duration has been protracted to nearly eight months, March to November (Energy Policy Act of 2005). Worldwide, about 150 countries and territories observe DST at least in some locale, but even more (157 nations and territories) do not. Notable non-DST holdouts, as of this writing, are China, India, Japan, Indonesia, and much of Brazil and Australia.

**INDIANA LEGISLATIVE RECORD**

In 1949, literally under the cover of night, the Indiana state Senate passed a bill to outlaw DST and mandate Central time. In the state House, however, urban legislators in favor of daylight-saving/Eastern time, and their rural counterparts who advocated standard/Central interests, could not come to agreement. Only after filibuster and actual breaking of the official chamber clock, ironically, to prolong the session by stopping “official” time, did the pro-Central, anti-DST bill pass. The law then was ignored by communities favoring the so-called “fast time” of either Eastern or DST (Indianapolis Star 2005).

In 1956 a non-binding state referendum found that a narrow majority of state voters preferred Central time without DST. A strong majority was opposed to the Eastern time zone along with DST. The next year the Indiana legislature made Central time the official state time, but this law was repealed in 1961 (Indianapolis Star 2005).

Based on a compromise plan initiated by the newly-formed U.S. Department of Transportation in 1969, the Indiana legislature approved Eastern Standard Time as the year-round technical norm for the state, with the understanding that Indiana also would
be exempted from mandatory DST by the United States Congress, producing the practicality of half-year Central time, in effect. The counties around Gary (northwestern Indiana, near Chicago) and also Evansville in the extreme southwestern corner of Indiana, abutting western Kentucky and southern Illinois, which follow Central time, would be allowed to abide by normal Central time with DST. This solution finally prevailed in 1972 after legislative override of Governor Edgar Whitcomb’s veto and Congressional concurrence via amendment of the Uniform Time Act (Wikipedia 2008; Indianapolis Star 2005). The pact survived for 33 years until April 2005 when, after numerous failed attempts spanning decades, the Indiana legislature passed a DST bill (An Act to Amend the Indiana Code ... 2005), thereby implementing it effective upon the next national “spring forward” clock change. Later that year came the time zone petitions and federal hearings.¹

Now with the advantage of perspective, examination of the consequences of Indiana’s 2005-06 policy action is “timely.” Because of the many ramifications of the state’s compound time-alteration episode, several types of metrics can be reviewed, including those available in real time as of the decision period, and some developed since. The variety of reflections this approach generates is the subject matter to come. In particular, key input content of the decision itself will be re-examined, with secondary data cited and applied, all adduced into a grounded summary appraisal of the present state of time law in Indiana—the piece of U.S. geography having the most difficult historical relationship with legislated time.

CHILDREN’S SAFETY

During the 2005-06 time zone debate in Indiana, one of the most compelling arguments against Eastern time, ostensibly, was that the extra hour advancement (compared with more natural Central time or the prior non-DST status) causes extended morning darkness. This condition, in turn, is an intolerable danger to schoolchildren because it requires them to walk and/or wait in darkness for the morning school bus, at least for major segments of the school year (Federal Register 2006, 3235-3236). Why is this such a problem for Indiana but not other parts of the country? The difference is that Indiana, if in the Eastern zone, is at the extreme western boundary of an arbitrarily expanded time zone which exaggerates consequences and problems such as the inordinate morning darkness (to be explicated presently). Most areas of the U.S. that are at Indiana’s longitude are in the Central time zone (Fig. 1).²

To what extent are children, and others, really endangered by the compulsory time formulary? Initial drive-time accident reports from around the state have appeared ominous (Evans and Tuohy 2006; Lopp 2007), although total traffic fatalities in the first few DST years since 2006 have been slightly reduced throughout Indiana (Indiana Criminal Justice Institute 2009). But short-term evidence is insufficient to establish a trend, and causality is inevitably more complex than this associative suggestion. In fact, the nominally improved safety record merely continues a 25-year state and national pattern. The most recent evidence does suggest a spate of traffic accidents, assaults, and abductions in Indiana’s neo-A.M. cloak of darkness (Central Time Coalition 2010) but, again, the evidence is limited. Therefore, the historical time series of traffic fatality data needs to be plumbed for insight, as is done in the next section.

INDIANA EVIDENCE

Table 1 furnishes the results of longitudinal intervention analysis (methodological, not geographic, usage of “longitudinal”), with the 2006 enactment of statewide daylight-saving time the dummy variable. The intervention aspect refers to a circumstantial discontinuity—here, the change in time policy—represented by the before/after dummy. Raw data are, first, the 41 years of total Indiana traffic fatalities from 1970
through 2010, and also fragmentary accessible data on under-17 child traffic fatalities in the state (Indiana Criminal Justice Institute 2011; National Highway Traffic Safety Administration 2010b). (Multiple state agencies that I contacted either could not or would not supply complete data on child fatalities.) Technically, the dependent variables are traffic deaths per constant (current) population units. That is, all fatality data are normalized for state population change.

Ultimately, the latter data series on child fatalities is crucial for understanding patterns and trends in traffic safety. To analyze these data, I employed time-series regression analysis, which allows for the examination of the effect of various factors on traffic fatalities over time.

Table 1. Time-Series Regression Results

<table>
<thead>
<tr>
<th>Dependent variable: Total Indiana traffic fatalities</th>
<th>Parameter Estimate</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>-4.36</td>
<td>-14.37</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>DST</td>
<td>16.48</td>
<td>1.36</td>
<td>0.1814</td>
</tr>
</tbody>
</table>

$R^2 = .871$, Adj. $R^2 = .864$

<table>
<thead>
<tr>
<th>Dependent variable: Indiana child traffic fatalities</th>
<th>Parameter Estimate</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>-18.87</td>
<td>-6.07</td>
<td>0.0009</td>
</tr>
<tr>
<td>DST</td>
<td>8.32</td>
<td>2.72</td>
<td>0.0346</td>
</tr>
</tbody>
</table>

$R^2 = .967$, Adj. $R^2 = .956$
mortality includes only the 1996-2009 period, with four years of missing values. Normally, this data constraint would inhibit analysis. I have taken the liberty of applying it in this case, though, because (1) the limitation was externally imposed, and it was a matter of the available data or nothing; (2) the under-17 data analysis was conceived as an adjunct or satellite to the other data set with a more adequate number of cases \( (n = 41) \); (3) despite the sample size and low statistical power, results proved significant and interesting, so are reported nevertheless; (4) the exploratory spirit of this part of the research question helps justify such latitude; and finally, (5) the surprisingly large \( R^2 \) value also mitigates the usual \( n \) threshold retroactively, to as low as six or seven needed observations in this case, in contrast to the general rule of 20 per independent variable (Park and Dudycha 1974, 216; Toy and Hayya 1974, 43-44).

Further, it was not practical to try to model the innumerable other plausible independent variables by adding to the regression specification. For example, common belief among in-state observers is that increased highway troopers, tougher drunk driving laws, and demographics are factors contributing to the long-term downward trend in motor vehicle deaths (which mirrors the U.S. trend; Indiana Criminal Justice Institute 2009, 3). Other variables desirable to incorporate could be gasoline prices, seat-belt use, and air-bag technology, possibly offset by fuel economy standards and vehicular downsizing. Gasoline prices, however, have actually been rather constant in real terms over the time-series period, which would come as a surprise to many (Federal Trade Commission 2005, viii; Kilian and Sims 2006, 29-30). Even the National Highway Traffic Safety Administration does not attempt explanation of vehicular accidents beyond a subset of these factors (NHTSA 2010a), so limiting the predictors is conventional. With a maximum of 41 observations, the generally accepted limit of two independent variables is reached anyway (Toy and Hayya 1974, 32), as will be seen.

RESULTS

From the time-series regression encapsulated in Table 1, we find a positive but non-significant effect of DST on total fatalities but, even with the very limited data, a significant positive impact on child traffic deaths \( (b = 8.32, p = 0.035) \). This finding may properly be regarded as tentative and a preliminary baseline, but also troubling. What it says explicitly is that post-2006/DST Indiana child traffic fatalities are above trend. The DST coefficient, perhaps a bit inflated by exclusion of covariates such as suggested previously, estimates how much above trend it is. The regression coefficient of 8.32 translates literally as over eight more child fatalities per year attributable to DST, compared with the expected total had the new time law not been in force.

While this analysis has applied to DST per se, not Eastern time, the shared characteristic between the two is the period of extra A.M. darkness. The 2006 imposition of DST and Eastern time in unison has brought about the specter of “double fast” time across most of Indiana. Results can be broadened and attributed to Eastern time, in a fashion, because prior to statewide DST, Indiana had been on Central time for seven months a year, in effect, compared with twelve annual months of Eastern time thereafter.

OTHER EVIDENCE AND INTERPRETATION

The best evidence of the time/traffic hazard at issue actually comes from outside Indiana, by way of a classic National Bureau of Standards study showing that the excessive morning darkness resulting from a position on the extreme western edge of the wrong time zone or, comparably, DST, does indeed increase motor vehicle fatalities to school-
children at a statistically significant level (U.S. National Bureau of Standards 1976). However, the U.S. Department of Transportation, which had the task of ruling on the petitions of 18 Indiana counties that applied to move to the Central time zone in 2005, was not receptive to this argument and disallowed most of the cases. As expressed in its Final Rule of January 18, 2006, “(A)s for the 1976 National Bureau of Standards study... while there were reports of increased fatalities among school-age children in the mornings during the test period, it was impossible to determine whether this was due to Daylight Saving Time which would have resulted in a later sunrise” (U.S. Department of Transportation 2006). The DoT cited a 1975 report to Congress on the morning darkness danger issue: “(T)he has been discovered that, in the morning, school-age children fatal accidents were not significantly different from fatal accidents in the total population” (U.S. Department of Transportation 1975).

Unfortunately, the U.S. Department of Transportation misinterpreted this evidence in its Indiana time zone decisions of 2005-2006. The department’s use of the 1975 Congressional report to attempt to rebut the 1976 NBS study was a non sequitur. Essentially, even if true that “school-age children fatal accidents were not significantly different,” the relevant comparison is between (a) danger at a dark A.M. time and (b) danger at the same time with an hour’s more daylight. In other words, even if schoolchildren and the total population share the same danger at a given early morning darkness time, the children (actually both groups) would be safer with an additional hour’s worth of light. This abstracts from possibly offsetting hazard to the general population from evening drive-time darkness, which would not apply to schoolchildren, and is addressed subsequently. The quoted “impossible to determine” was no more than standard scientific boilerplate, essentially a disclaimer confessing that it is not possible to know anything with absolute certainty, a caveat the U.S. DoT over-interpreted.

So an Eastern zone decision adds to A.M. risk for schoolchildren by attaching the same degree of greater danger that the rest of the population also suffers, thus accepting the validity of the cited report (and other evidence to be referenced subsequently). This DoT posture, as should be obvious, is not valid evidence in rebuttal to the morning darkness danger argument.

In sum, the schoolchildren-versus-general-population comparison is not on point. A schoolchildren-in-the-dark versus schoolchildren-in-the-light comparison is the proper one, and that test is the essence of the preceding Indiana analysis as well as the 1976 NBS study. DST (or misapplied Eastern time) is the practical induction of the one-hour daylight difference variable, in effect. Moreover, the NBS research post-dated the 1975 DoT Congressional report, and incorporated, reviewed, and corrected it. Also noteworthy is that the DoT has accepted the NBS results in previous cases (U.S. House of Representatives 2001).

Because children’s safety was acknowledged by DoT as a vital constraint for its 2006 final ruling for Eastern time (U.S. Department of Transportation 2006), that decision should now be reversed, especially in view of the potentially catastrophic consequences. Without attributing motives, interpretation of the DoT’s paradoxical and simultaneous dismissal of the child safety concern is challenging. The Indiana state government, however, had been applying unremitting pressure for an early and pro-Eastern time zone decision from the department (Advisory Committee on the Time Zone 2010), so an ethical question arises, i.e., inappropriate means regardless of the worthiness of the ends. So, at minimum, a department of the U.S. federal government, the DoT, opens itself to criticism for misconstruing and misapplying scientific evidence in a way that undermines its purported objectives, to the detriment of public welfare and safety.

To lend clarity and texture to the vehemence of the Central time faction’s position on the humane ramifications, a class warfare
subtext to this Indiana time issue can even be identified, and supported by its proponents: It is mainly the middle class and underclass children waiting on the street corner in the dark, they allege. The upper strata offspring are more likely chauffeured to school in the family SUV (Gaski 2011, 7-8). (Empirical evidence does confirm an association between income and mode of school transport; Teske, Fitzpatrick, and O’Brien 2009, 20). This implied sentiment also approximates the spirit of the Indiana state PTA and many school districts in contesting DST and Eastern time (U.S. Department of Transportation 2005, 8), the combination Indiana locals refer to as the odious “double fast time.” Those in direct contact with the state’s children understandably are most concerned with such an unnecessary threat to their charges’ safety. In St. Joseph County, for example, all school districts supported the county’s 2005 Central time petition (St. Joseph County 2005). In fact, this issue is not solely an empirical question, but also an analytical one. It is nearly inescapable, physically and physiologically, that darkness during A.M. drive time will be more dangerous to children than the same during the evening, especially in the winter. There are problems of fog and “black ice” that generally do not occur in the evening, following the warmer daytime temperatures (Laing 1970), in addition to early morning driver and pedestrian drowsiness (Danner and Phillips 2008; Figueiro and Rea 2010b; Vorona et al. 2011). Not to be overlooked either are the raw numbers: a multitude of children on the streets in A.M. darkness, which has no parallel in the P.M. darkness. Nowhere in U.S. geography (except Alaska during the dark part of the year; U.S. Naval Observatory 2011) has darkness fallen by the time of regular afternoon school bus runs. This comparative issue comes down to the masses endangered in morning darkness by government decree, compared to none in the evening—unless they are out volitionally.

Because of daylight-saving now combined with Eastern time, the number of after-7:30 sunrises in Indianapolis has increased from 92 per year to 158, with the after-8:00 total rising from 30 to 50. By comparison, Chicago has none of either, New York has one, and Los Angeles has none (Sagarin 2011). If on Central time, even with DST, Indianapolis’ total would be zero as well. Eastern time, of itself, contributes to a level of morning hazard that would be largely removed if Indiana were on Central time. With the overhang of DST extended even into November and March, the compound double-fast effect reaches into much of the school year and cold weather months. Figures 2 and 3 vividly display the A.M. darkness-light frontier for Central Indiana if on Eastern or Central time comparatively (Burdass 2009; 2010).

Cited evidence and logic say the E/DST detractors have a point (for more of the overall epistemology, also see Coren’s (1998) related finding of a 17% increase in traffic fatalities associated with sacrifice of an A.M. hour, though his study could not sort out whether the cause was A.M. darkness per se or sleep deficit). Also, there is no corresponding afternoon darkness danger if and when Indiana is on Central time. In that case, the earliest Indianapolis (or South Bend) sunset during the school year would be at 4:20 P.M., with the earliest dusk at 4:50 P.M., long after the school buses have run. This can be verified with U.S. Naval Observatory information (2011), compactly summarized by Sagarin (2011). Furthermore, extant evidence professing to show public safety enhancement from extended evening daylight (qua DST or misplaced Eastern time; Aldrich 2005) does not necessarily apply to an area on the far-flung fringe of the wrong, eccentrically distorted time zone, such as Indiana (or adjacent Western Michigan), because harm at the opposite end of the day more than offsets. In fact, other recent empirical evidence confirms an increase in net traffic accident rates of 7% attributable to DST (Coren 1996, cf. his similar 1998 finding). The 1973 federal law that required the nation to observe daylight time year round was actually repealed less than a year later because of an increase in highway
Figure 2. Indianapolis A.M. Darkness-Light Boundary: Eastern Time (Source: Burdsall 2009)
Figure 3. Indianapolis A.M. Darkness-Light Boundary: Central Time (Source: Burdsall 2009)
traffic deaths (Emergency Daylight Saving Time Energy Conservation Act 1973). The people of Indiana now suffer the equivalent of year-round daylight time, and then some, through irrational time zone assignment.5

SUBSIDIARY ISSUES: ACADEMICS

Eastern daylight-saving time’s interaction with Indiana children is not limited to school safety. Forcing schoolchildren to awaken and try to function an hour (or two) earlier than their biological clocks command, an hour or more earlier than natural time, can even be detrimental to scholastic performance. This is the circadian rhythm problem, sometimes manifestly aggregated into “Seasonal Affective Disorder,” which may appear to be gobbledygook until one discovers that it is true. For the individual’s daily routine to go against natural sleep cycles does indeed cause physiological and psychological harm. Persuasive scientific evidence in the medical literature affirms the phenomenon and connection (Wagner 1999; Avery 2000; National Sleep Foundation 2000; White et al. 2005/2006; Lewy et al. 2006; Kantermann et al. 2007; Gangwisch et al. 2010; Owens, Belon, and Moss 2010; IARC 2011). The basic mechanism is the astronomical light-darkness cycle that regulates human bihythms, along with the derived lethargy from extended morning darkness, especially during winter—in contravention of the natural daylight/daytime harmony—which underlines intellectual function and even emotion.

The dramatic results of White et al. (2006, 744) illustrate this well:

(1) later clock time of sunrise in winter ... is ... depressogenic ... (l)Incidence of winter major depression, ... fatigability, hypersomnia, and weight gain were all significantly higher in the western tier of the Eastern Time Zone than in the ... eastern tier of the Central Time Zone ... . The delayed clock time of sunrise in the western tier of a time zone exag-erates the incidence (of) winter depression, raises the proportion of people with clinically significant seasonality, and promotes atypical neurovegetative symptoms.

The data setting for this study was, in fact, the Indiana/Michigan—Illinois/Wisconsin time zone boundary. Similar results can be found in Figueiro and Rea (2010a), Marcheva et al. (2010), Papatheodorou and Kutcher (1995), Rea et al. (2008), and Terman and Terman (2005). The human body’s out-of-phase production of the melatonin hormone seems to be a major contributory factor. Melatonin, which reacts to light and darkness, regulates the brain’s central clock and major organs including the pancreas, lungs, liver, and heart on a 24-hour cycle. In turn, functions such as fluid balance, body temperature, cardiac output, oxygen consumption, metabolism, endocrine gland secretion, and sleeping are governed (Marcheva et al. 2010). Given such findings, the Seasonal Affective Disorder (S.A.D.) aspect could be an issue in its own right, apart from its relation to scholastic achievement. Nevertheless, S.A.D. is no way for a young student to begin the school day.

Concerning cognitive consequences, new evidence finds a 16-point decrement in Scholastic Aptitude Test scores associated with Eastern daylight time in particular, at Indiana longitude, even controlling for socioeconomic status and other variables (Gaski and Sagarin 2011; the study was based on time-series and cross-sectional data within Indiana’s multiple combined time zone and DST checkerboard landscape for the decade prior to the 2006 conversion, as a quasi-natural laboratory). The potential commercial and economic side-effects of such statewide “dumbing-down” are also notable. In fact, the referenced study estimates annual aggregate income loss of $1.291 billion for the Indiana population based on secondary data isolating income effects per SAT point (Mur-nane et al. 2000). The sequence, in short: If DST causes a decrement in SAT performance (as proxy for mental acuity), and SAT/intel-
lectural ability influences income, then DST has a negative impact on income. So now Indiana seems to have both S.A.D. and SAT problems—brought on by its own clumsy time machinations.

Still another academic dysfunction induced by “fast” Eastern time in Indiana is the greater frequency of weather-related school delays and cancellations. As testified to at various in-state hearings by school corporation officers and other public officials (U.S. Department of Transportation 2006, 25-26), that extra hour can make all the difference with a morning fog or snow delay, or a school district’s decision to cancel a class day (a judgment which must be finalized within the first two hours of the daily schedule).

Table 2 summarizes recent statewide school delay data (for Eastern zone counties, which is most of them), showing a one-year cost estimate of over $56 million resulting from postponed school day starts due to snow or fog. (There are never any delays because of excessive sunlight!) Any two-hour delay would hypothetically have been of one hour duration if on Central time. Given a basic estimated cost of $10 per student hour, as documented in the table based on total state direct school spending allocated across total student hours, Central time replacing Eastern time produces a $28 million saving to Indiana schools.

**SUBSIDIARY ISSUES: COMMERCIAL ECONOMICS**

This may surprise readers who are more, rather than less, familiar with the history of this issue, but the economic case actually supports Central time for Indiana. The simplest way to explain it is this: When on Eastern time, the cumulative hourly differ-

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Table 2. Cost of School Weather Delays in Indiana Eastern Time Counties

**2009-10**

No. of school districts: 227

*Within-district ranges*

- No. of students: 285-34,050
- No. of delays: 1-11
- Total delay hours: 1-22
- Total estimated cost of delays (No. of students @ $10\(^a\)): $11,400-2,513,520

*Eastern Time Zone county totals*

- No. of students: 762,224
- Student hours lost to delays: 5,687,163; total cost @ $10: $56,871,630
- Estimated net cost of delays (or projected Central time savings):
  - $56,871,630/2 = $28,435,815\(^b\)

**2008-09 Summary**

- Student hours lost to delays: 4,443,094; total cost @ $10: $44,430,940
- Estimated net cost of delays (or projected Central time savings):
  - $44,430,940/2 = $22,215,470\(^b\)

---

\(^a\)Estimated at $10/student by State Representative Jeffrey Thompson of the House Education Committee based on direct state government school spending and total student class hours.

\(^b\)Likely a very conservative estimate. In dividing by 2, analysis realistically and mechanically assumes two-hour delays are reduced to one, but that one-hour delays are reduced to ½-hour, unrealistically, instead of zero. (Delays of more than two hours result in cancellation of school day.)

Sources: Compiled by Gettelfinger (2011); original data source, Indiana Department of Education.
ence between Indiana businesses and other U.S. contiguous time zones is 3 (Pacific), 2 (Mountain), 1 (Central), and 0 (Eastern), for a total of six hours. If on Central time, the respective numbers are 2 + 1 + 0 + 1 = 4! In other words, Indiana is aligned with commerce in the rest of the country better if in the Central time zone.

The direct effect of this discrepancy is surely slight, except for one relation: the three-hour difference from the West Coast. But the simple arithmetic is sufficient to rebut Indiana’s Eastern-ophile faction that has erroneously claimed better commercial alignment via Eastern time. In other words, the better Indiana alignment resulting from Central time may be a minor factor or no factor but, whatever the impact is, it would not favor Eastern time. One study does report that time zone compatibility is a non-trivial condition in international trade (Stein and Daude 2007).

The state Chamber of Commerce in particular has touted the fact that 39 percent of Indiana exports are to the Eastern time zone, more than flow to any of the other three (U.S. Department of Transportation 2002). Accordingly, then, I have adjusted the preceding set of numbers by zonal export volume (Table 3). What we find is that commerce-adjusted time differences still favor the Central time zone for Indiana. By proselytizing for Eastern time in the recent time zone debate, the leaders of the Indiana Chamber of Commerce revealed that they fail to understand that their own data verify Central time as better for Indiana economically, if a material characteristic at all. We can make it even easier: If 39 percent of export trade is with Eastern, this means 61 percent goes to Central and points west. Imports are about a 50-50 wash between Eastern and other zones, so the focus is on exports, which are the load-bearing emphasis of healthy interstate commerce anyway in the typical agenda of mercantilist state governments.7

Let us also note that the economic center of gravity in the United States keeps shifting westward, according to every U.S. census over the past 220 years (U.S. Census Bureau 2010) and geo-economic data. For the half century between 1890 and 1940, the mean population center of the United States, now in Missouri, was actually located within Indiana. Regional economic gravity does closely track population (Reynolds 1953; Sales & Marketing Management 1997, 30-32, 214).

To elaborate this issue further and refine the Table 3 approach, the “business choice maximizing” model developed by faculty at Indiana University represents common (daily) business hours shared with other time zones, adjusted for zone population—i.e., overlap with working hours in other time zones, population-weighted (Sagarin 2009). Table 4 data show that the Central time zone outperforms all other U.S. time zones on this score. The highest total number indicates the closest

Table 3. Trade-Weighted Cumulative Deviations from Other Time Zones

<table>
<thead>
<tr>
<th>Zone - trade %</th>
<th>d (if Eastern zone)</th>
<th>d (if Central zone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern - 39</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Central - 25</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Mountain - 11</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Pacific - 25</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>122</td>
<td>100</td>
</tr>
</tbody>
</table>

(Source: Indiana Chamber of Commerce)
common economic alignment, in other words. More narrowly and industry-specifically, Indiana’s Eastern time proponents have also stressed the presumed advantage of temporal consistency with the financial markets of the U.S. East Coast. That argument is weakened or even overcome, however, not only by the preceding more comprehensive perspective, but by the instantaneous information transfer of modern e-technology. Frankly, it should have been diminished by the telephone and telegraph, as well.

Finally, Kellogg and Wolff (2008) and Kotchen and Grant (2011) have found that extended afternoon and evening light at the cost of more morning darkness produces a net loss in terms of energy consumption, contrary to a widespread prior belief (California Energy Commission 2001; U.S. Department of Transportation 1975). A major reason is understood to be the more ubiquitous late night use of air conditioning.

COROLLARY ISSUE: THE ECONOMICS-SAFETY NEXUS

The U.S. DoT is guided by “convenience of commerce” as its supreme criterion in deciding time zone boundaries (Federal Register 2006, 3230). Business and economic concerns rightfully have received heavy weight in the department’s time zone decisions, including the Indiana 2006 Eastern zone imposition. Yet the DoT acknowledges that “safety is the number one priority of the Department and we are committed to improving safety of school children” (U.S. Department of Transportation 2006, 27). Consider also that perhaps the most fundamental and important commerce of all is that which occurs between families and schools. Education, whether public or private, is a product (specifically, a service-type product). The upshot of this realization is that the DoT, in its Indiana rulings, erred in concluding that a controlling federal Executive Order #13045, “Protection of Children from Safety Risks,” does not apply on the grounds of no economic significance (U.S. DoT 2006, 59). Because the family-school relationship is inherently an economic transaction, at least in large part, an economic and safety-based order is directly germane. The DoT’s negligent misconstrual of this connection therefore amounts to a crucial abdication, and is further grounds for vacating the 2006 Indiana Final Rule.

CONCLUSION AND CONFLICT RESOLUTION PLAN

The most critical long-term political implication of the Indiana time-zone/DST controversy apparently has never been accurately apprehended by the state politicians who legislated Eastern DST despite widespread public opposition. (Polls at the time verified majority support for Central time throughout Indiana; SurveyUSA 2005.) The problem is this: Those who wanted daylight-saving time for Indiana also generally supported Eastern time (just like six decades earlier). The Central time advocates also tended to be opposed to DST, because they were afraid that their state would get stuck with both Eastern and daylight-saving. By ordaining the Eastern with DST parlay, the result is that one side gets everything and the
other camp, in this case a statewide plurality at least, gets nothing. That is not fair, objectively. That is a prescription for endless political strife and disequilibrium over the time issue, an inherently unstable condition, but it also points the way to resolution: neo-compromise.

An enlightened solution to the decades-long Indiana time dilemma is what may be called “the grand compromise.” That is, let the Eastern DST side decide between Eastern time or DST, but not both. Invite them to choose one, and then the state government will enact the results. If they select Eastern time, then Indiana would go back to the old regimen and repeal DST. If DST would be the choice, the state would then move to Central time.

But the state cannot dictate time zone, can it? Sure it can, sort of. If the Indiana government would support a time zone petition for all or most of the state’s counties, or whatever number would request zone reassignment, the U.S. DoT would be hard-pressed to deny it. Historically, the DoT does defer to such a jurisdiction’s consensus preference (Advisory Committee on the Time Zone 2010, 14-15, 20). And, obviously, those pockets of counties in the northwestern, southwestern, and southeastern corners of Indiana are special cases that should be allowed to continue to go their own way. As mentioned, the counties around Evansville and near Chicago have operated on Central time all along. Those near Cincinnati and Louisville, Kentucky, were traditionally permitted to observe DST unofficially to remain synchronous with their metropolitan area practice (Fig. 4).

Thus concludes a multi-dimensional analysis of a rare public policy controversy in the realm of geography, one that has provoked intense intramural conflict. The motor vehicle hazard of extended morning darkness, the cognitive debilitation resulting from clock time contravening psycho-biology, and the summary trade flow numbers all point to the optimal choice of Central time for Indiana.

NOTES

1. The neighboring state of Michigan has had an erratic time zone experience itself, along with DST variations, straddling the Central and Eastern zones in a variety of ways in different periods. In 1968 the Michigan state government, against the popular will in the western half of the state, decided to unify its territory (except for part of the Upper Peninsula) on Detroit’s Eastern time, including DST. Through a close referendum outcome, exemption from DST prevailed from 1969 until 1972, but was then repealed.

2. While on Eastern Standard Time, Indianapolis, in the middle of the state, aver-

Figure 4. Indiana Time Zone and DST Geographic Segmentation. Shaded areas represent counties that, officially or unofficially, have been permitted to observe different time standards than the rest of the state.
ages 45 minutes ahead of astronomical solar time. The city is 1:45 out of phase, on average, during the daylight-saving portion of the year, for an annual average of 1:24 ahead of true solar time. (This is not a rounding difference but due to slight orbital anomalies between earth and sun, and unequal DST and standard time segments of the calendar.) If on Central time, the respective averages would be 15 minutes (behind), 45 minutes (ahead), and 24 minutes (ahead) (Sagarin 2011; U.S. Naval Observatory 2011). The meridian of the true geographic (vs. statutory) Eastern time zone, 75° west longitude, passes through Eastern New York state, New Jersey, and the city of Philadelphia. The zone’s natural western boundary is Central Ohio longitude.

3. Moreover, Becker (2005, 284-285) warns of the inclusion of pro forma or numerous control variables because of potential to act as “spurious suppressors” increasing Type II error. (Respect for main effects is still a mainstream scientific philosophy; see Lehmann, McAlister, and Staelin 2011, 162.) Then, as mentioned, the restricted number of observations discourages entry of more variables on degrees of freedom grounds, especially when the children’s fatality data serve as a dependent variable. With leading control variable possibilities derogated somewhat as questionable, per the above argument, the streamlined autoregression model employed is tendered as reasonable for an inaugural, quasi-exploratory effort. Hence the justification for analysis that otherwise could be seen as naïve due to limited data cases, model specification, or both. In view of the results, it seems the year variable may have proxied well for the composite set of unmodeled predictors.

4. A Durbin-Watson statistic only slightly out of the normal range ($D = 2.96$), which is surprising given the preceding caveats, mitigates the spuriousness concern. The Durbin-Watson is a test of time-series model adequacy through expressing the magnitude of residual autocorrelation. The larger the difference between a $D$ value and 2.0, on a zero to 4.0 scale, the higher the likelihood of unmodeled covariates inflating the measured results. Ideal range is generally from 1.5 to 2.5 (Johnston 1972, 251-252, 430).

5. If any alleged empirical benefits of Eastern time or DST would not materialize for Indiana because of dissimilar geographic characteristics between Indiana and the research locales (i.e., relative time zone position), then the detriments, e.g., traffic accidents, might not either, by the same reasoning. However, the extreme case of year-round DST, as repudiated nationally in 1974 for good cause, does roughly equate to Indiana’s new condition, as would its ill effects. So Indiana likely gets the worst of worlds: the downside of disharmony with astronomical or solar time, but without corresponding benefit.

To help readers keep the DST and time zone issues disentangled, a refresher: Indiana’s DST acceptance in 2005 was the fulcrum for temporal and political disequilibrium; now Eastern versus Central time is the main issue. The real problem is excessive early morning darkness, and repeal of either DST or Eastern time would help to ameliorate this. (From Indiana’s natural Central time perspective—or otherwise—Eastern Standard Time is the same as Central DST, but Eastern DST is the same as Atlantic Standard. That poignant reality symbolizes why the Eastern-with-DST opponents regard the new time environment as untenable, even absurd.) Because the DST decision now seems more entrenched, the practical target of the Indiana time “resistance movement” is time zone assignment, specifically a return to Central time. So the primary subject matter here is comparative as-
essment of the Eastern and Central time zones as applied to Indiana geography. Yet the change to DST is an aggravating factor.

6. This actually is a very conservative estimate because two-hour delays must anticipate the unknown, and therefore tend to be cautious. With an extra hour of weather knowledge, many delays would be averted entirely, instead of reduced to the estimated single hour (Fort Wayne Journal Gazette 2010, 2).

7. To more fully explain the Table 3 weighting scheme: Is an hour’s worth of difference from any other geographic area or locality (or time zone) of equal commercial value? Clearly not. It would depend upon the economic potency or value of the other area. An alternative expression in this context is the market potential of each time zone, proxied by the export trade numbers. Therefore, value-weighting the zonal time difference by export volume captures the effect.

8. The 2005 Indiana DST law required the state government to support any county petition for Central time. When it came time for that support to be given, the state’s chief executive redefined “what the meaning of the word ‘support’ is.” The governor, in defiance of the law he had signed, actively opposed the Central time zone applications of several counties.

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