Spring Forward at Your Own Risk

Daylight Saving Time and Fatal Vehicle Crashes

Austin C. Smith

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Presented by Timo Freyer

DST

- Originally introduced as a wartime measure to save energy.
- Idea: Align sunlight with wakeful hours to save energy used for lighting.
- Today $>$ 1.5 billion people are impacted by DST.
- Recent studies challenge the economic foundation of DST. (Kellogg, Wolff 2008; Kotchen, Grant 2011)

- Is DST a good practice from a social welfare pov?

DST

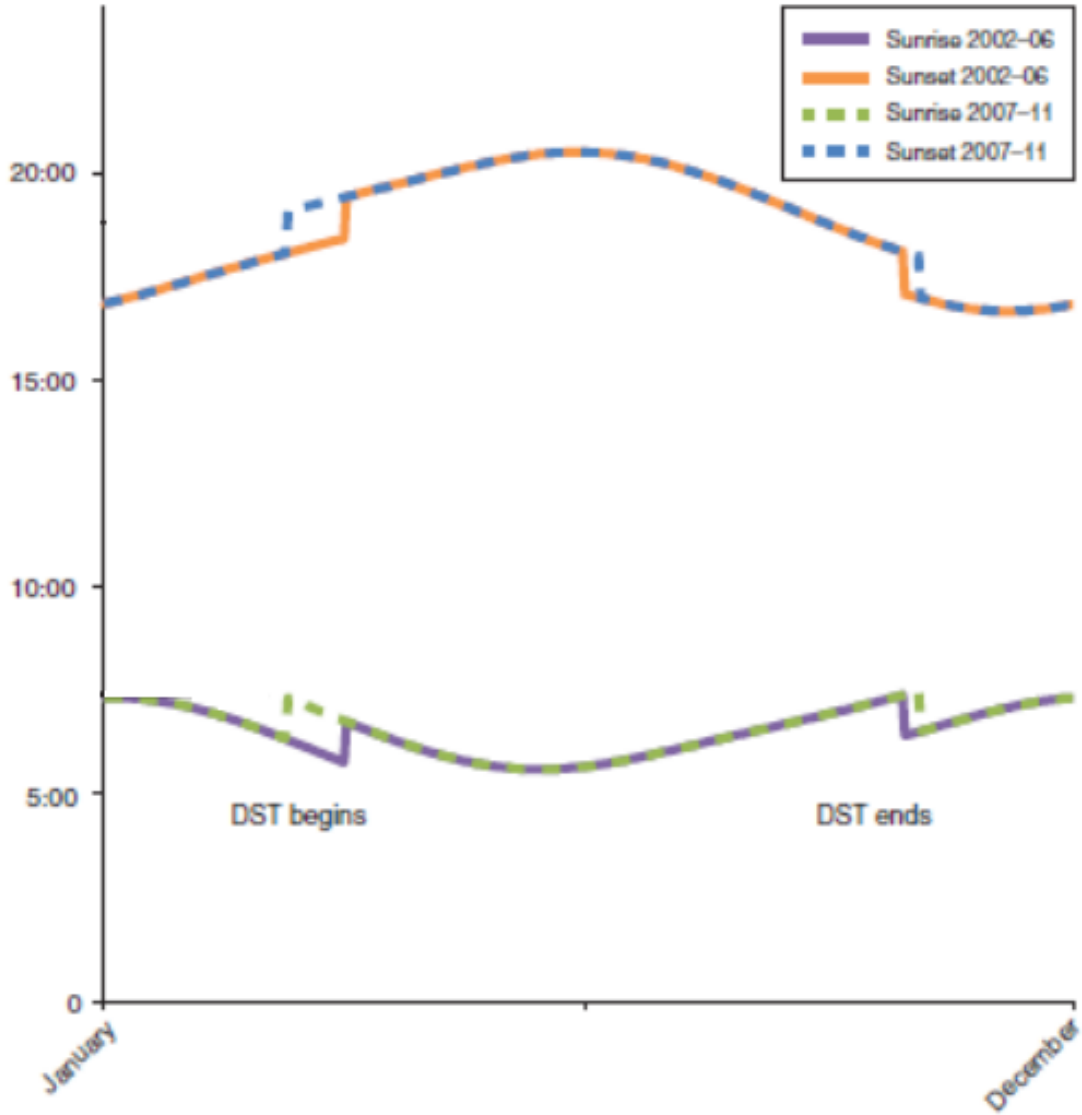

Figure: The Influence of DST on Ambient Light

This Study

Central Question

How does DST affect the number of fatal vehicle crashes?

(No. 1 cause of accidental death in the US, on average 40.000 annual fatalities (2002-2011))

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Data

- FARS (Fatality Analysis Reporting System) data for 2002-2011, 5 years on each side of the 2007 DST extension.
- Records time + location of every fatal crash in the US since 1975.
- A crash is considered to be fatal if involving the death of a crash affected motorist/non-motorist within 30 days.

Potential Mechanisms

Ambient Light Mechanism

- DST shifts one hour of light from the morning to the evening.
- Fatal crashes are more prevalent in the evening than in the morning.

$\Rightarrow$ More ambient light in higher-risk evening hours might lead to a net reduction of fatal crashes.

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Sleep Mechanism

- Studies find that on the spring transition night Americans sleep ~ 40 min less but on the fall transition night only ~ 12 min more. (Barnes, Wagner 2009)

$\Rightarrow$ Sleep deprivation is likely to reduce driver alertness and might increase the number of fatal crashes.

RD Approach

Standard RD approach. (Imbens, Lemieux 2008)

- Exploit discrete transition between standard time and DST.
- Demean $ln(fatals_{dy})$ by day-of-week and year to eliminate persistent weekday effects and long term trends.

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Two major concerns in RD applications

- The forcing variable might be manipulable.
  $\Rightarrow$ Irrelevant here.
- A potential discontinuity might be caused by a change at the cutoff of the forcing variable other than the treatment.
  $\Rightarrow$ All other factors affecting fatal crash risk must be continuous at the transition date.

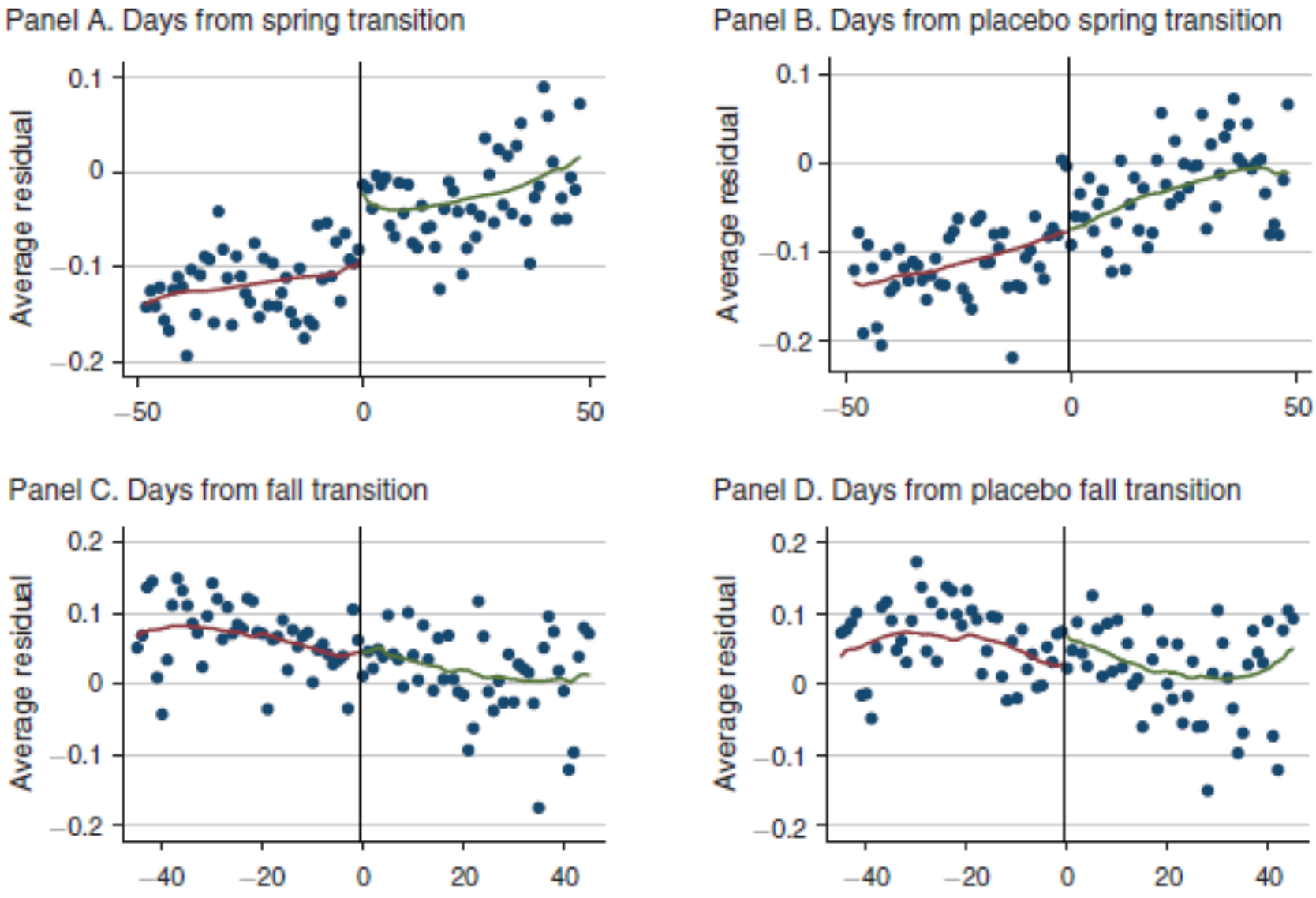

Figure: Residual Plots - Spring, Fall and Placebo Transitions

Basic RD Estimates

Spring

		Placebo
	(1)	(2)
DST	0.0649***	0.000536
	(0.0231)	(0.0225)
Observations	550	550

Fall

		Placebo
	(1)	(2)
Leaving DST	0.00114	0.0361*
	(0.0236)	(0.0218)
Observations	381	381

$\Rightarrow$ Significant increase ($\approx 6.5\%$) in fatal vehicle crashes due to spring transition, no change due to fall transition.

FE Approach

Exploit Variation in DST Coverage

- The 2007 extension shifted the spring transition by three weeks and the fall transition by one week.
- The DST rule (transition on Sundays) causes additional 7 days of variation.

$\Rightarrow$ Compare crash counts of a certain date under DST/ST.

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$$ln(Fatals_{dy}) = \beta_0 + \beta_1 SpDST_{dy} + \beta_2 FaDST_{dy} + DayofYear_d + DayofWeek_{dy} + Year_y + \epsilon_d y$$

- β_1 measures the average effect of DST across all spring switching dates.
- β_2 measures the average effect of DST across all fall switching dates.

Investigation of the Two Mechanisms in the FE Model

Decomposing Spring DST

- Effect due to sleep mechanism should vanish as we move on away from the spring transition date.
- Decompose time period after spring transition, compare average effect on days close to the transition to days further away from the transition.

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Subsampling

- Daylight (nighttime) hours distant from sunrise/sunset would be light (dark) both under ST and DST. (Negligible light effect.)

Decomposing Spring DST in the FE Model

FE Estimates - Decomposing Spring DST

	All Hours		Least light impacted
	(1)	(2)	(3)
Spring DST	0.0319*		
	(0.0165)		
First six days of DST		0.0565**	0.0574**
		(0.0231)	(0.0272)
Next eight days of DST		0.0245	0.0289
		(0.0201)	(0.0234)
Remainder of spring DST		0.0142	0.00907
		(0.0197)	(0.0230)
Fall DST	0.0228	0.0218	0.0446
	(0.0249)	(0.0250)	(0.0303)
Observations	3,341	3,341	3,341
Adjusted R^2	0.734	0.735	0.753

Wrap-Up & Take Away

- Spring transition (temporarily) increases crash risk by well over 5% while there is no significant overall effect due to the fall transition.
- The sleep mechanism is driving the overall results, whereas the ambient light mechanism reallocates crash risk within a day.

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- Clear design/good data (often) comes at the cost of a more limited relevance/scope of the question under scrutiny.