

Causal effect of Sleep on Health

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Question

- Studies in medical journals tell us sleep is one of the crucial factors in evaluating health but they usually ignore the socio-economic factors.
 - Sleep might affect BMI(Body Mass Index) by affecting eating habits.
- Economists have ignored the importance of Sleep until recently (2014) mostly because of the endogeneity problem and lack of good data to solve this issue.
- We want to evaluate the causal effect of sleep on some dimensions of health (BMI, Self reported health and health conditions like diabetes).

Literature Review (Economics)

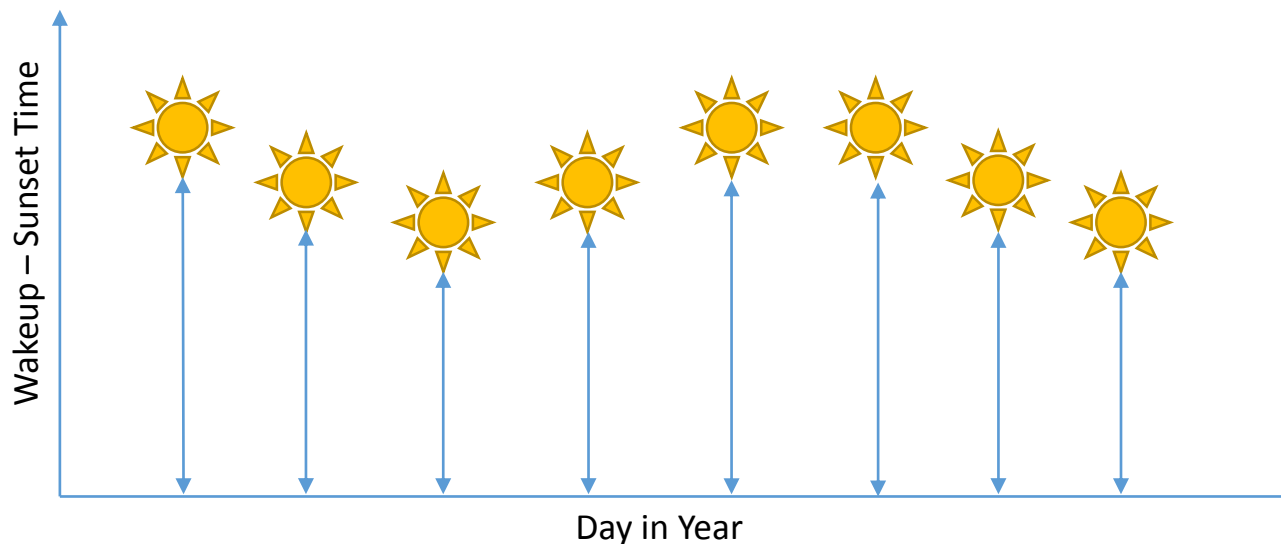
- Biddle & Hamermesh (1990)
 - Investigates effect of wage on Sleep.
- Gibson & Shrader (2016)
 - First to introduce sunset time as IV for sleep. Using this IV they explore the effect of sleep on wage.
- Perales & Plaige (2016)
 - They look at how leaving in poor neighborhood affects sleep.
- Sedigh et. Al (2016)
 - Investigate effect of wage on Sleep.
- Jin and Ziebarth (2015)
 - They exploit the effect of setting time 1 hour forward in spring on self reported health and hospital admissions.
- Giuntella and Mazzonna(2015)
 - Using regression discontinuity, they exploit the sleep variations around the time zone border induced by differences in sunset time.
- Heissel and Norris (2016)
 - They investigate effect of school starting time on academic performance by instrumenting sunrise time.

Looking for Exogenous Variation

- Sunset time varies in different locations and affects different decisions which might be made by people. (**Bed time**, Eating out, Watching TV, Exercising, and, etc)
- Wake up time is fixed if it is constrained by work time schedule.
- It may imply the variation induced by exogenous factor (Sunset time)

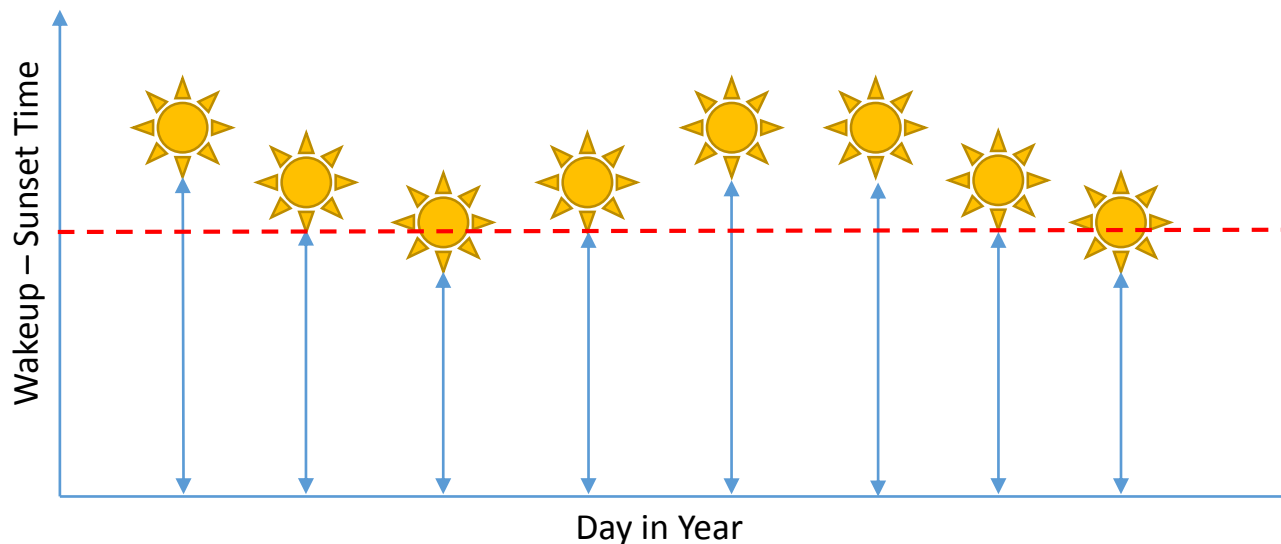
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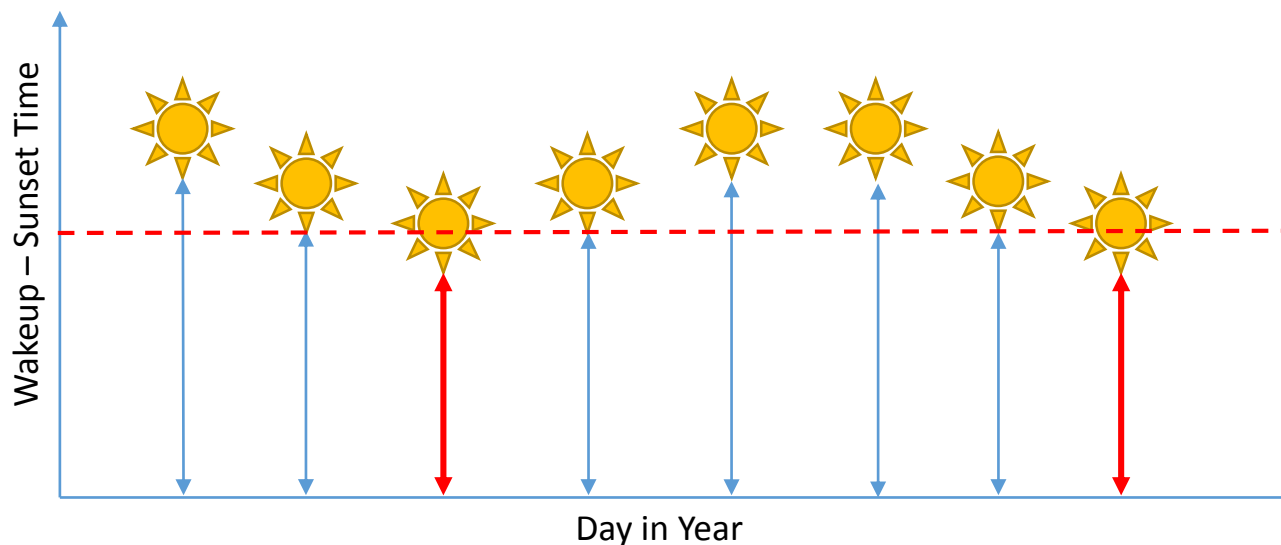
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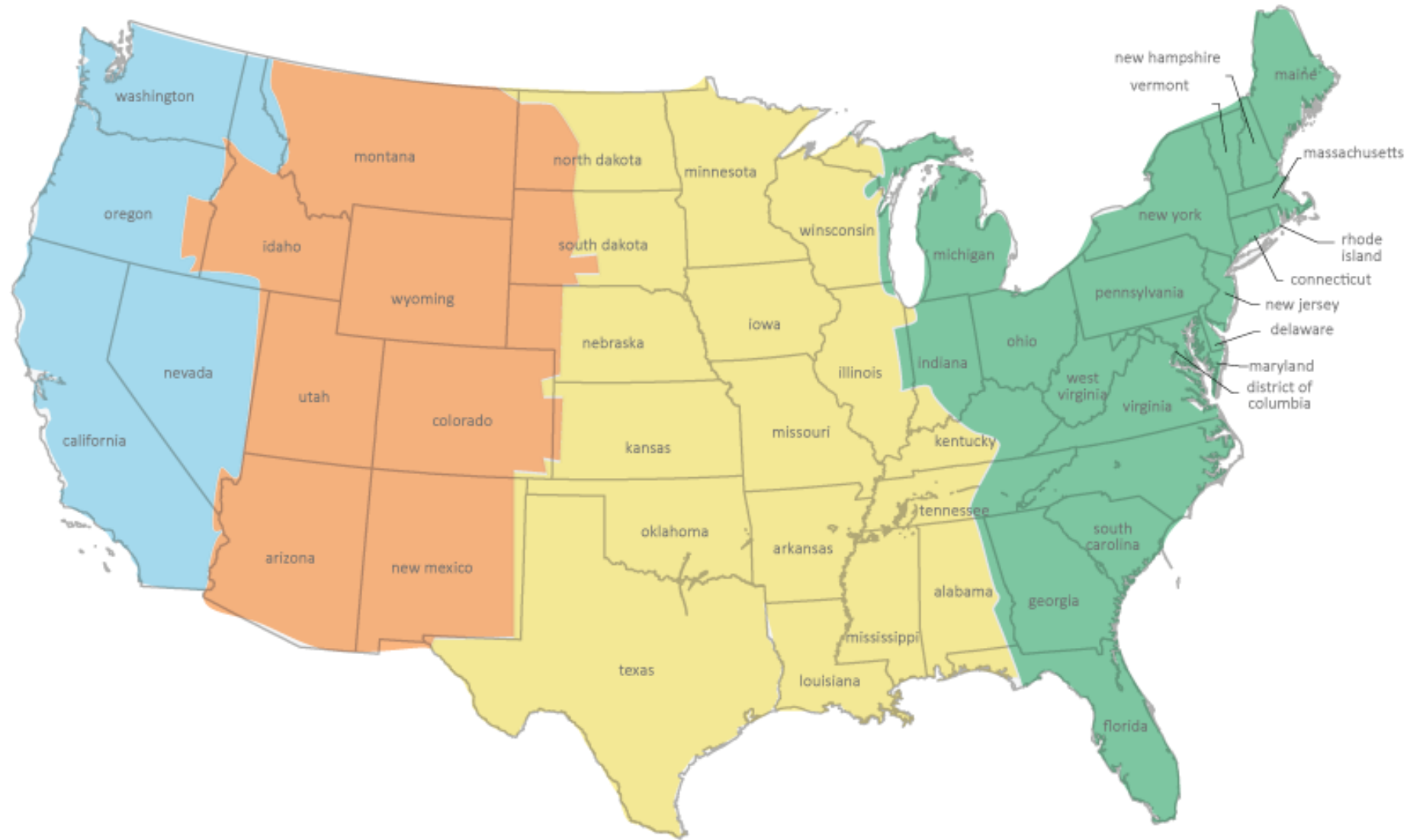


Looking for Exogenous Variation

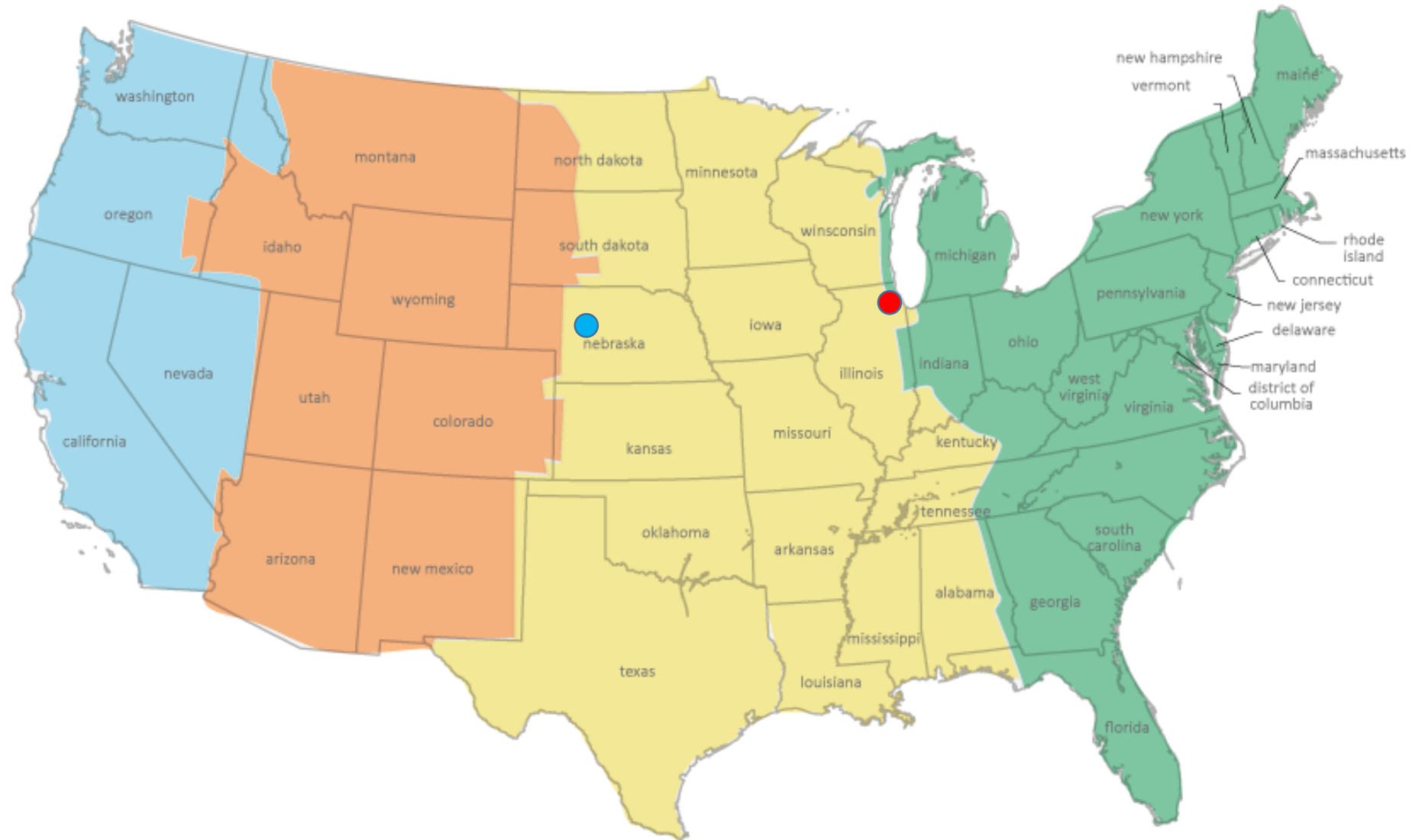
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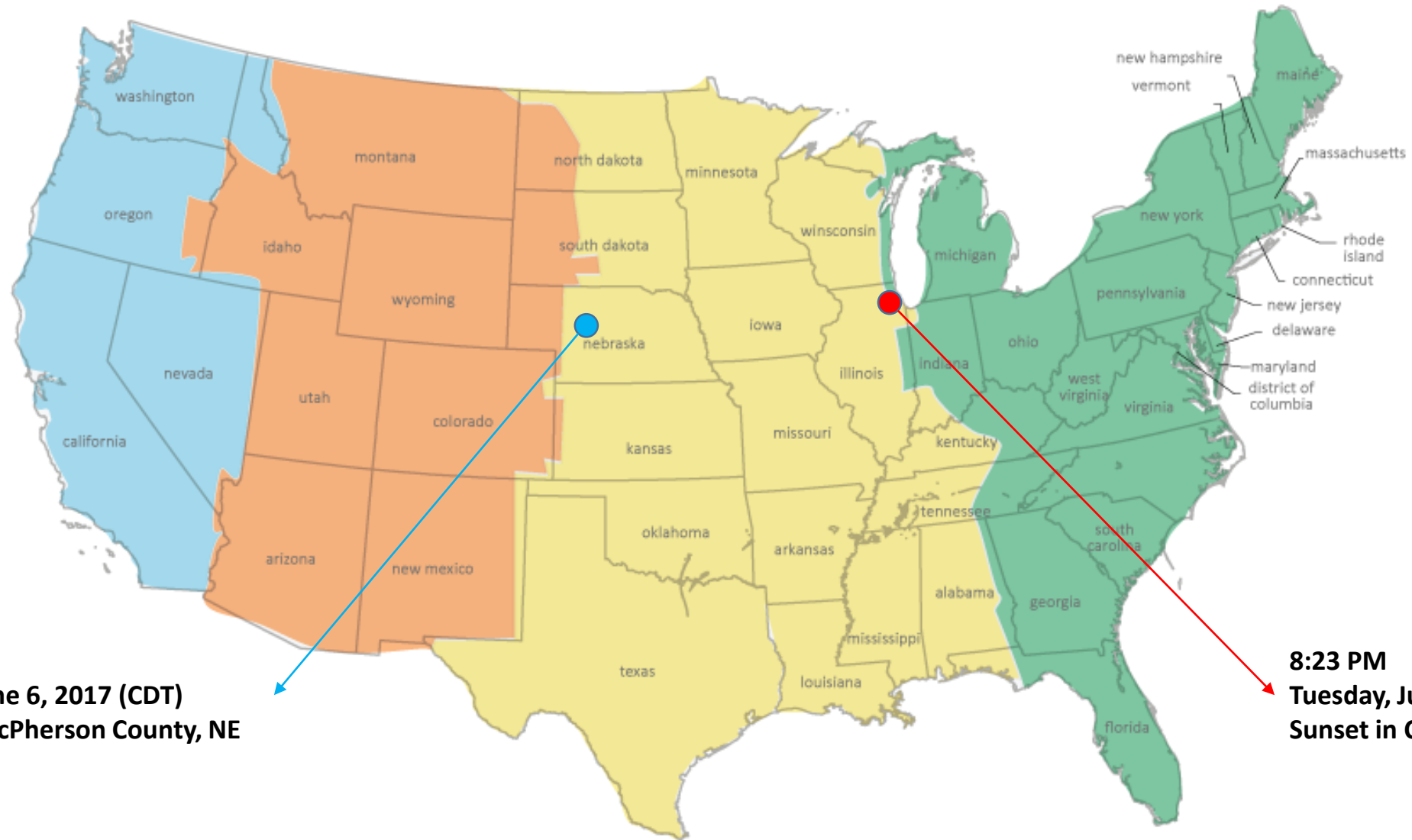
Looking for Exogenous Variation



Looking for Exogenous Variation



Looking for Exogenous Variation



9:16 PM
Tuesday, June 6, 2017 (CDT)
Sunset in McPherson County, NE

8:23 PM
Tuesday, June 6, 2017 (CDT)
Sunset in Chicago, IL

Looking for Exogenous Variation

- But people choose where they live and it means Sunset time is not exogenous (People choose their sunset time!)
- Even if they are not aware of the sunset time, they choose the place in accordance with their lifestyle. Needless to say city's environment and style is shaping around the environmental factors like sunset time and absorbs people who want same lifestyle.
- → migration might contaminate this source of variation.
 - Example: People who choose to live in a place with later sunset also tend to work out.
- Reverse Causality Problem.

Looking for Exogenous Variation

- Other source of exogenous variation is Daylight Saving Time (DST).
- **DST in the United States** is the practice of setting the clock forward by one hour. As a result, evenings have more daylight and mornings have less (Except Arizona and Hawaii).
- Beginning in 2007 DST was extended such that, DST begins on the second Sunday of March (Instead of April) and ends on the first Sunday of November (Same as before).
- This change in practicing DST adds 28 days with later sunset (by 1 hour) to each year.

Looking for Exogenous Variation

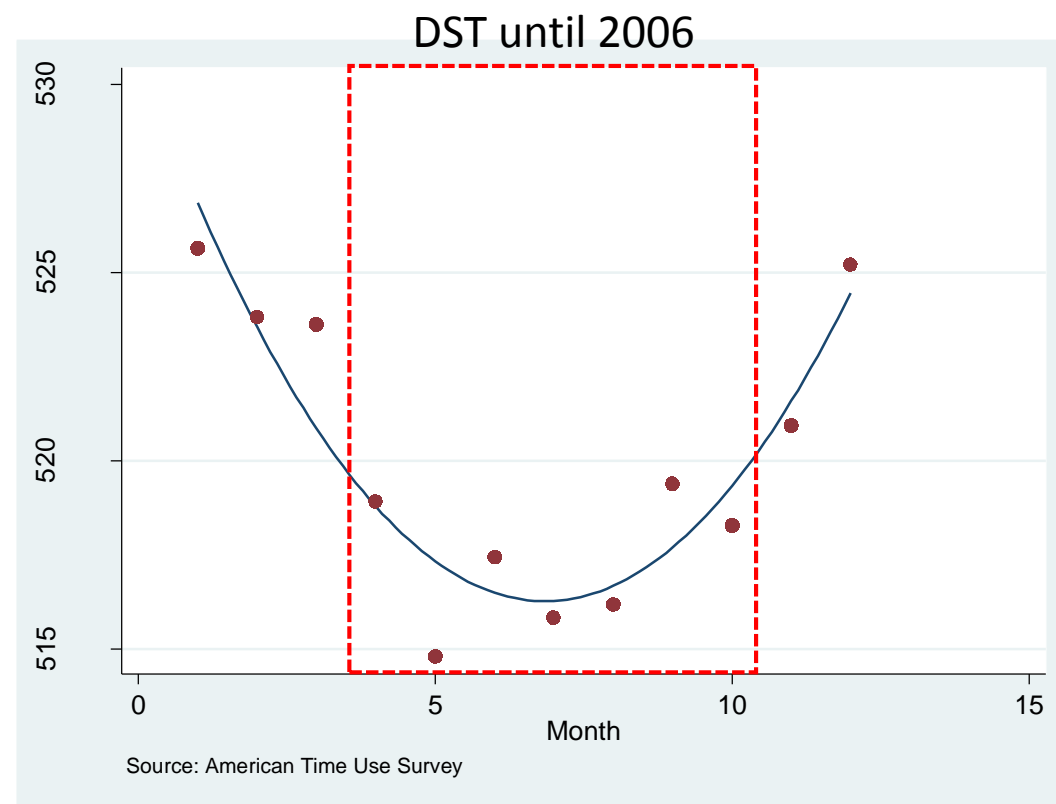
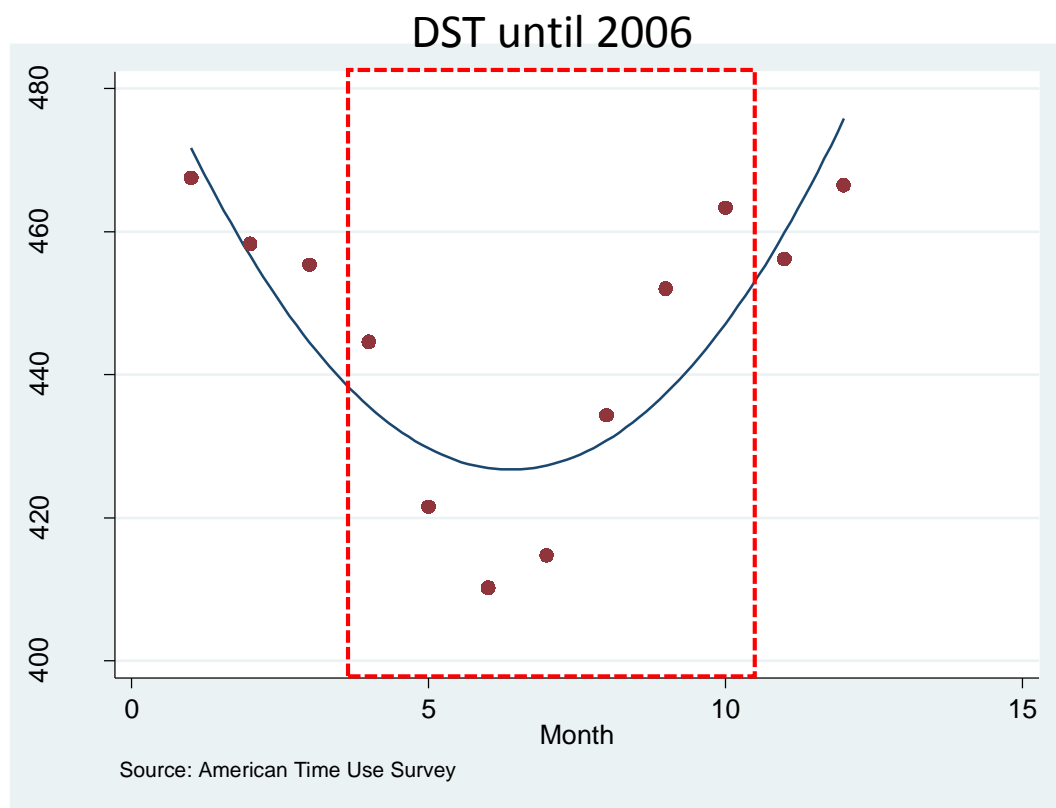
year	start	end	Duration
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2005	3-Apr	30-Oct	210
2006	2-Apr	29-Oct	210
2007	11-Mar	4-Nov	238
2008	9-Mar	2-Nov	238
2009	8-Mar	1-Nov	238
2010	14-Mar	7-Nov	238
2011	13-Mar	6-Nov	238
2012	11-Mar	4-Nov	238
2013	10-Mar	3-Nov	238
2014	9-Mar	2-Nov	238
2015	8-Mar	1-Nov	238
2016	13-Mar	6-Nov	238
2017	12-Mar	5-Nov	238

Looking for Exogenous Variation

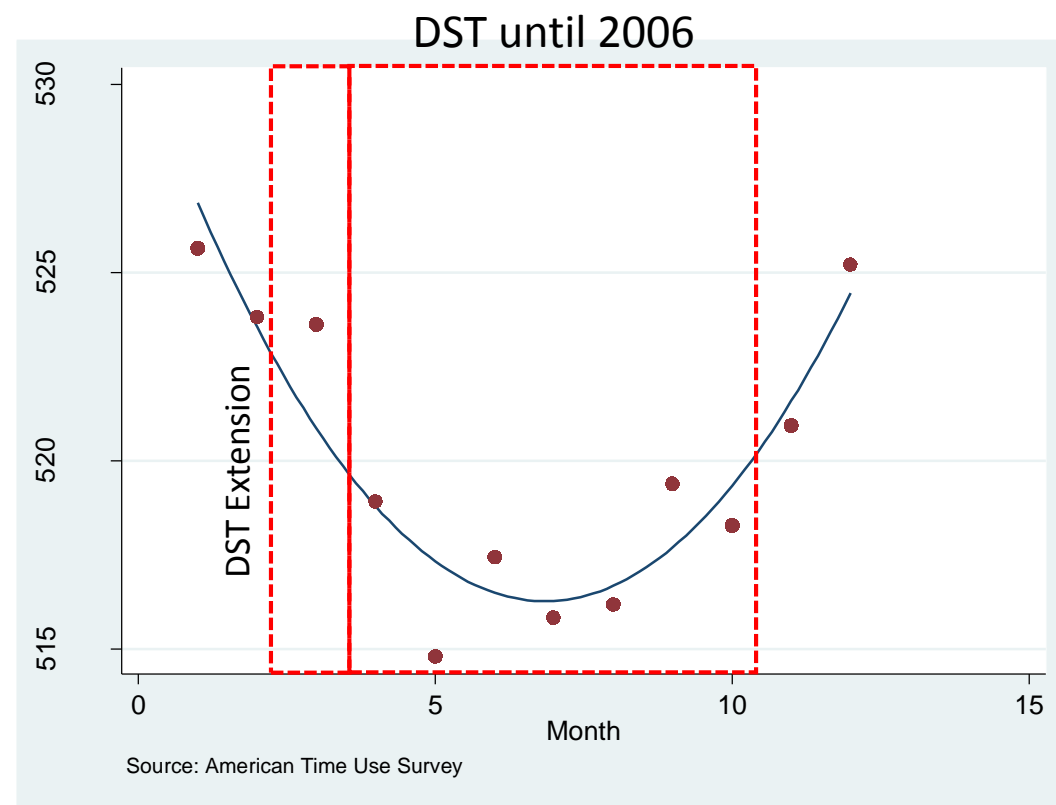
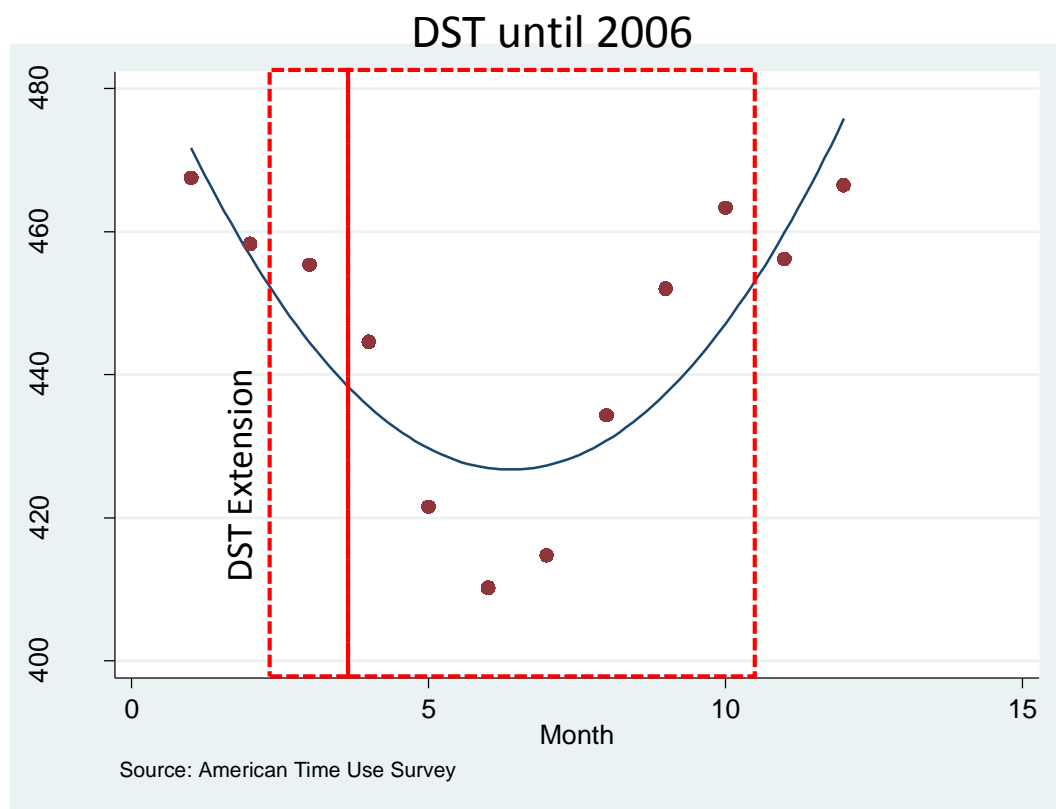
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DST and Night Sleep/Sleep



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Data

- I use American Time Use Survey (ATUS) waves 2005-2015.
- Sunset, Sunrise and length of day data, which I produced using sunrise equation which is a function of Latitude, Longitude, Sun declination and time zone.
- Linking two datasets I have sunset time (sunrise and length of day) for each individual in ATUS using the interview date.
- Health outcome is from Eating and health module of ATUS 2006-08 and 2014-15.

Design

I am going to exploit the sunset variation and 2007 DST extension using continuous Diff-in-Diff.

The outcome Equation is:

$$H_{ict} = \alpha_0 + \alpha_1 S_{ict} + \alpha_2 Post_t + \alpha_3 Post_t.Treatment_{ct} + X'_{ic} \cdot \alpha + u_{ict}$$

Treatment equation is:

$$S_{ict} = \gamma_0 + \gamma_c C_c + \gamma_1 Post_t + \gamma_2 Post_t.Treatment_{ct} + X'_{ic} \cdot \gamma + v_{ict}$$

Substituting treatment into the outcome equation we get reduced for equation:

$$\begin{aligned} H_{ict} &= \alpha_0 + \alpha_1(\gamma_0 + \gamma_c C_c + \gamma_1 Post_t + \gamma_2 Post_t.Treatment_{ct} + X'_{ic} \cdot \gamma) + \alpha_2 Post_t + \alpha_3 Post_t.Treatment_{ct} + X'_{ic} \cdot \alpha = \\ &(\alpha_0 + \alpha_1 \gamma_0) + (\alpha_1 \gamma_c) C_c + (\alpha_2 + \alpha_1 \gamma_1) Post_t + (\alpha_3 + \alpha_1 \gamma_2) Post_t.Treatment_{ct} + X'_{ic} (\alpha + \alpha_1 \gamma) + \epsilon_{ict} = \\ &\theta_0 + \theta_1 C_c + \theta_2 Post_t + \theta_3 Post_t.Treatment_{ct} + X'_{ic} \theta + \epsilon_{ict} \end{aligned}$$

Where H_{ict} is health outcome of individual i in county c and time t . C_c is county fixed effects, S is sleep duration, treatment is sunset time and X_{it} is vector of individuals socio-economic characteristics. u, v, ϵ are error terms.

We are interested in α_1 . By estimating reduced form and treatment equation and knowing that $\theta_1 = \alpha_1 \gamma_c \rightarrow \alpha_1 = \theta_1 / \gamma_c$

Reduced Form

	2007	2007	2008	2008
	BMI	Self Reported Health	BMI	Self Reported Health
Post*Treatment	0.118	-0.00556	-0.0541	-0.00099
	-0.151	-0.0262	-0.16	-0.03
Post	-0.203	-0.0419	0.16	-0.0202
	-0.496	-0.0796	-0.479	-0.0887
Total family income	-0.00154*	-0.000456***	-0.00104	-0.000434**
	-0.00061	-0.00011	-0.00058	-0.00013
Education	-0.0214***	-0.00864***	-0.0234***	-0.00915***
	-0.00468	-0.00085	-0.00596	-0.00096
Big City	-0.423	-0.0873	-0.962	-0.0959
	-0.343	-0.0528	-0.5	-0.067
In Metro Area	0.0496	0.0347	0.674**	0.0427
	-0.269	-0.0468	-0.237	-0.0403
Female	-0.721**	-0.0154	-1.169***	-0.0826*
	-0.254	-0.0405	-0.249	-0.0378
Constant	26.04***	3.342***	28.18***	3.654***
	-1.698	-0.245	-1.263	-0.22
County	Yes	Yes	Yes	Yes
Race	Yes	Yes	Yes	Yes
Day of week	Yes	Yes	Yes	Yes
Age Category	Yes	Yes	Yes	Yes
Marital Status	Yes	Yes	Yes	Yes
Observations	4477	4477	4548	4548
Adjusted R-squared	0.041	0.156	0.063	0.137

1st Stage

	2007	2008
	Night Sleep	Night Sleep
Post*Treatment	-14.70***	-14.90***
	-2.711	-2.634
Post	47.40***	50.03***
	-9.127	-7.887
Total family income	-0.0007	-0.00209
	-0.00785	-0.00755
Education	-0.365***	-0.298***
	-0.0631	-0.0621
Big City	-8.327*	-9.107*
	-3.457	-3.706
In Metro Area	-2.001	-1.31
	-2.965	-4.009
Female	4.977	6.748*
	-2.576	-2.877
Constant	470.4***	465.3***
	-18.15	-15.89
County	Yes	Yes
Race	Yes	Yes
Day of week	Yes	Yes
Age Category	Yes	Yes
Marital Status	Yes	Yes
Observations	6565	6636
Adjusted R-squared	0.035	0.037

Effect of Sleep on Health

By estimating reduced form and treatment equation and knowing that $\theta_1 = \alpha_1 \gamma_c \rightarrow \alpha_1 = \theta_1 / \gamma_c$

	BMI	Self Reported Health
Pre 2007 and 2007	-1.01	-0.067
Pre 2007 and 2008	-0.015	-1.2