

EC1340 Topic #6

## **Climate damage III**

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# Outline

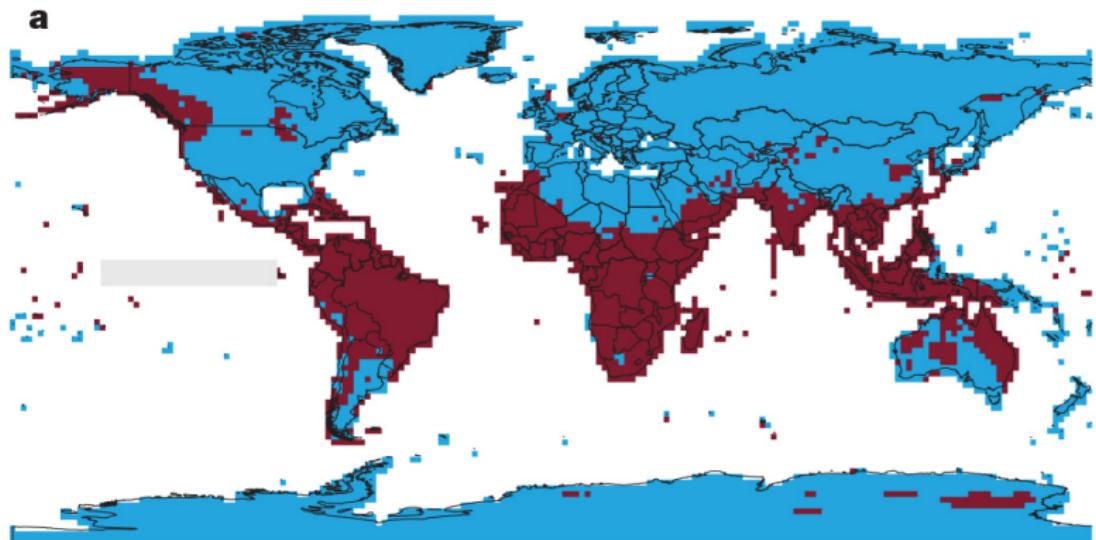
- 1 Hsiang, Meng and Cane, Nature 2011, ‘Civil conflicts are associated with the global climate’
- 2 Zhang et al. PNAS 2007, ‘Global climate change, war and population decline in recent human history’
- 3 Oster, JEP 2004, ‘Witchcraft, Weather and Economic Growth in Renaissance Europe’
- 4 Turner, AERPP 2012, ‘Adaptation to Climate Change in Preindustrial Iceland’
- 5 Zivin, Hsiang and Neidell Working Paper 2016. ‘Temperature and Human Capital in the Short- and Long-Run’
- 6 Adhvaryu, Kala, Nyshadham Working Paper, 2014. ‘The Light and the Heat: Productivity Co-benefits of Energy-saving Technology’

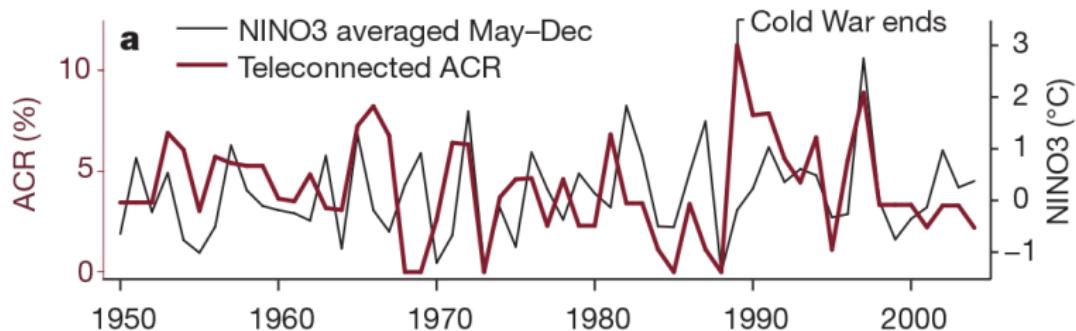
## Civil conflicts and El Nino

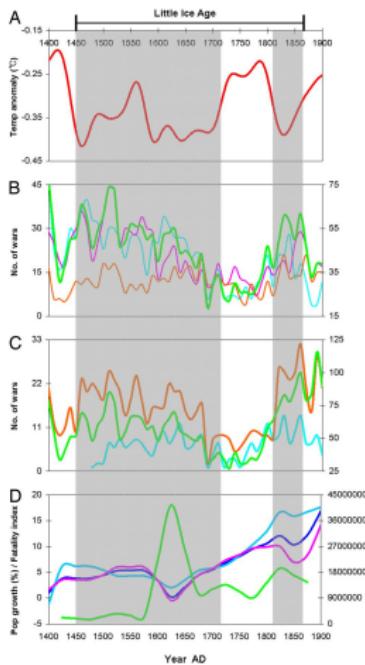
This paper estimates the effects of climate change on civil conflict.

Data:

- Annual conflict data from 1950-2004.
- Data on El Nino events over the same period.

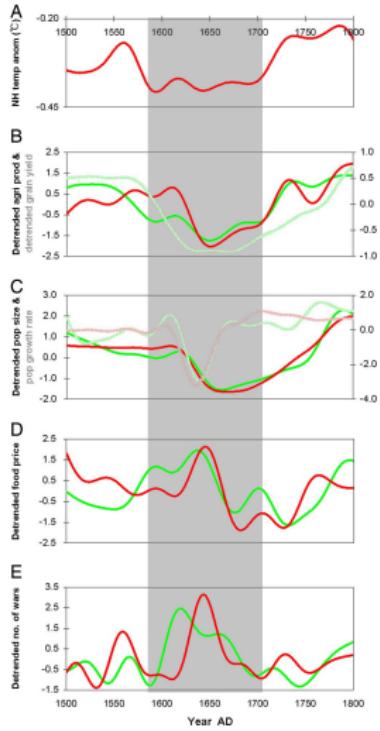






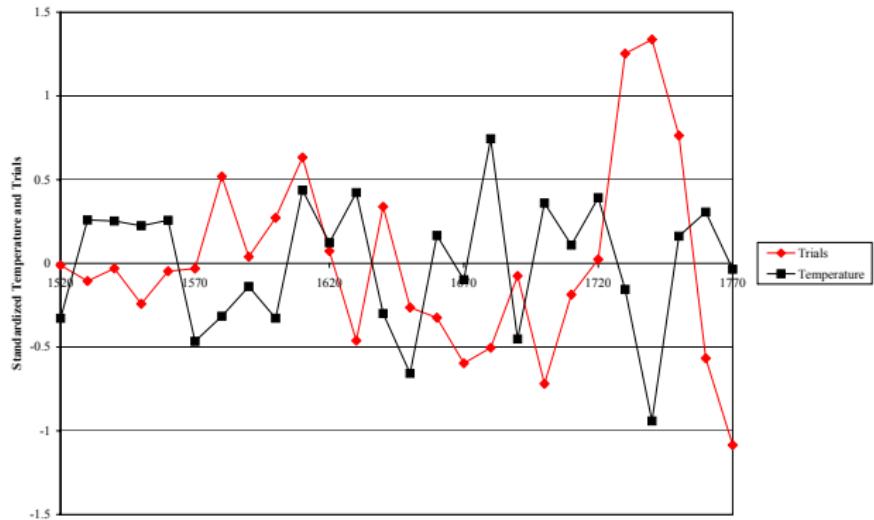
**Fig. 1.** Paleo-temperature variation, war frequency, and population growth rate, A.D. 1400–1900. (A) Temperature anomaly ( $^{\circ}\text{C}$ ) in the NH that is smoothed by 40-year Butterworth low pass filter (17). (B) Number of wars in the NH (bright green), Asia (pink), Europe (turquoise), and the arid areas in the NH (orange).<sup>1</sup> (C) Number of wars worldwide as recorded by Wright (39) (turquoise), Luard (38) (orange), and Breke<sup>1</sup> (bright green). (D) Twenty-year population growth rate in Europe (turquoise), Asia (pink), and the NH (blue)<sup>1</sup> and the NH 50-year fatality index (bright green). Cold phases are shaded as gray stripes. All war time series are in 10-year units, and the data are listed in [SI Table 1](#). The bright green curves correspond to the right y axis.





**Fig. 2.** Paleo-temperature variation and its impact on Europe and China A.D. 1500–1800. (A) Temperature anomaly ( $^{\circ}\text{C}$ ) in the NH (17). (B–E) European data are in green and Chinese data are red. The data are in normalized unit that indicate the relative amount or rate of change only. (B) Detrended estimated values of agricultural production (solid lines) and detrended grain yield ratio in Europe (green dashed curve) (18). The estimated values of agriculture production are calculated by dividing population size and food price. (C) Detrended population size (solid lines) and population growth rate (dotted curves) (22, 24). (D) Detrended wheat price index in Europe and detrended rice price in China (11, 42). (E) Detrended total war frequency (1 and ref. 40). All data are smoothed by 40-year Butterworth low pass filter. All of the dotted curves correspond to the right y-axis.

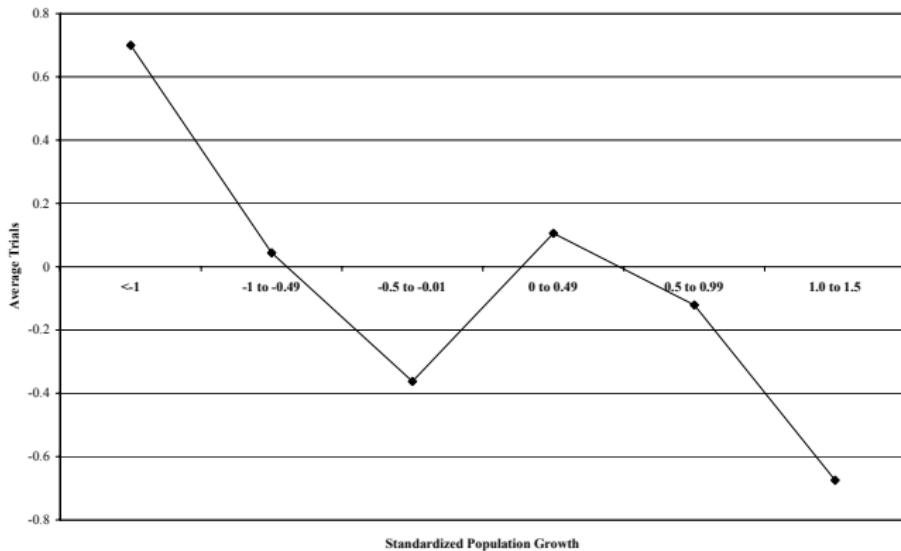
Figure 1: Temperature and Trials over Time  
1520-1770



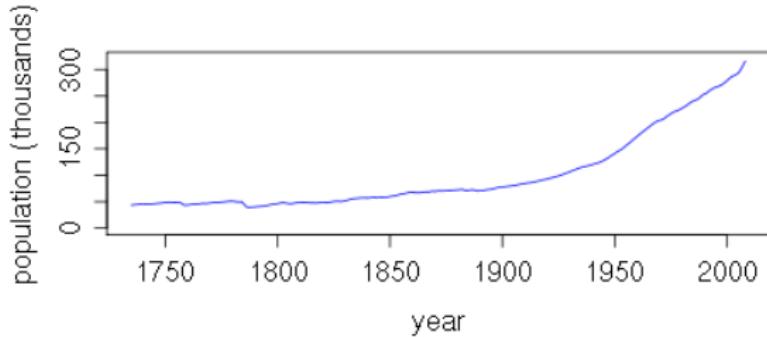
**Table 1<sup>a</sup>**  
**Witchcraft Trials and Temperature**  
*Dependent Variable: Witchcraft Trials Standardized by Region*

	(1)	(2)	(3)	(4)
Standardized Combined Index	-0.212*** (2.59)		-0.206** (2.32)	
Standardized Winter Severity Only		-0.179** (1.96)		-0.292*** (2.84)
Date	0.096 (1.96)	0.233*** (3.43)		
Date-Squared	-0.003 (1.43)	-0.011*** (3.45)		
Constant	-0.645** (2.39)	-1.037*** (3.16)	-0.019 (0.26)	-0.059 (0.71)
Decade Fixed Effects (1520-1770):	NO	NO	YES	YES
Observations	170	128	170	128
R-squared	0.10	0.15	0.24	0.28
Absolute value of t-statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

Figure 3: Population Growth and Trials







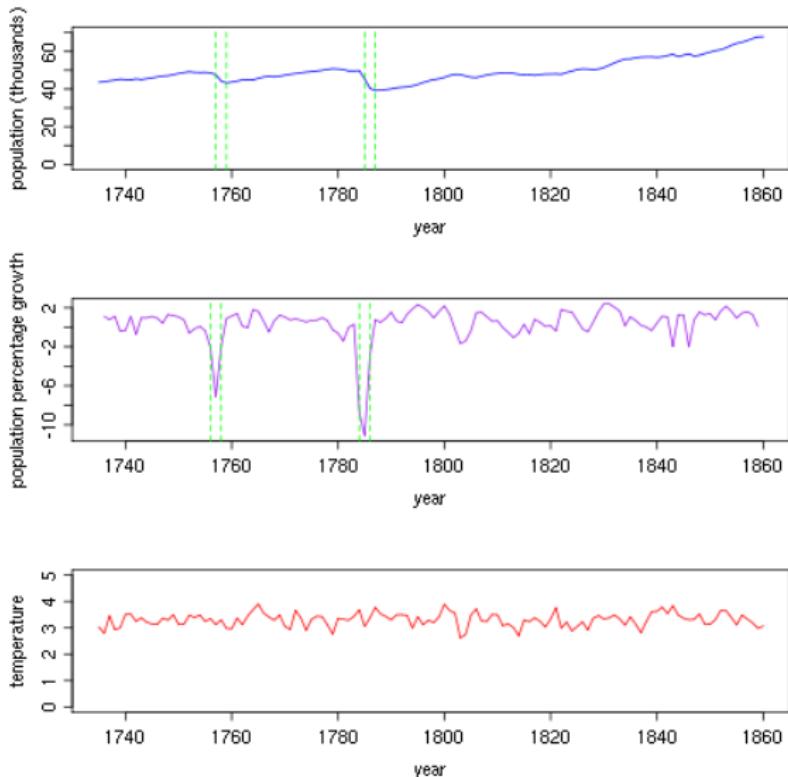
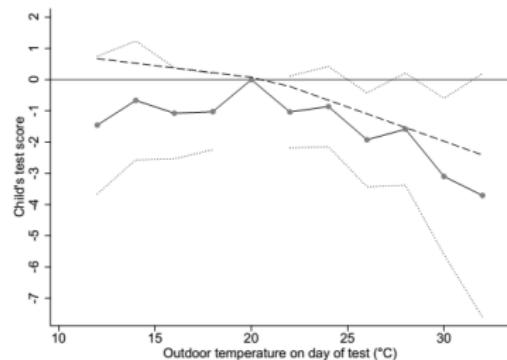


TABLE 1—NINE REGRESSIONS (ONE PER COLUMN) PREDICTING  $(\Delta pop)_t$ .

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MA2 <sub>t</sub>	1.143*** (0.359)					1.153*** (0.355)	1.133*** (0.353)	1.084*** (0.323)	1.104*** (0.298)
MA5 <sub>t</sub>		0.582 (0.721)							
MA10 <sub>t</sub>			1.172 (0.971)						
MA10 <sub>t-4</sub>				0.364 (1.051)		0.485 (1.017)		0.710 (1.044)	
MA20 <sub>t-4</sub>					-0.897 (1.590)		-0.208 (1.572)		-0.005 (1.544)
MA2 <sub>t</sub> × MA10 <sub>t-4</sub>							7.690* (4.454)		
MA2 <sub>t</sub> × MA20 <sub>t-4</sub>								11.10* (5.960)	
pop <sub>t</sub>	-0.089*** (0.027)	-0.091*** (0.025)	-0.086*** (0.026)	-0.090*** (0.025)	-0.093*** (0.026)	-0.087*** (0.026)	-0.089*** (0.027)	-0.092*** (0.026)	-0.093*** (0.028)

Control variables in all regressions are: *time*, *time*<sup>2</sup>,  $(\Delta pop)_t$  and a constant.  
 Newey-West standard errors in parentheses. p-values: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.



B. Reading comprehension

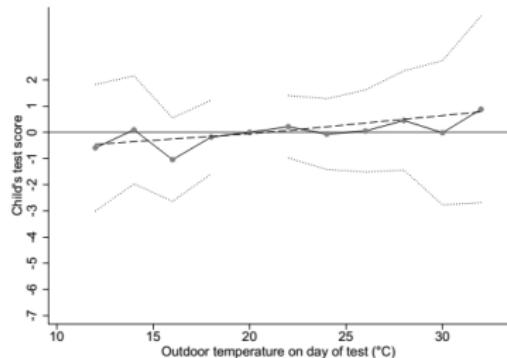


FIGURE 1: EFFICIENCY AND TEMPERATURE TIME SERIES

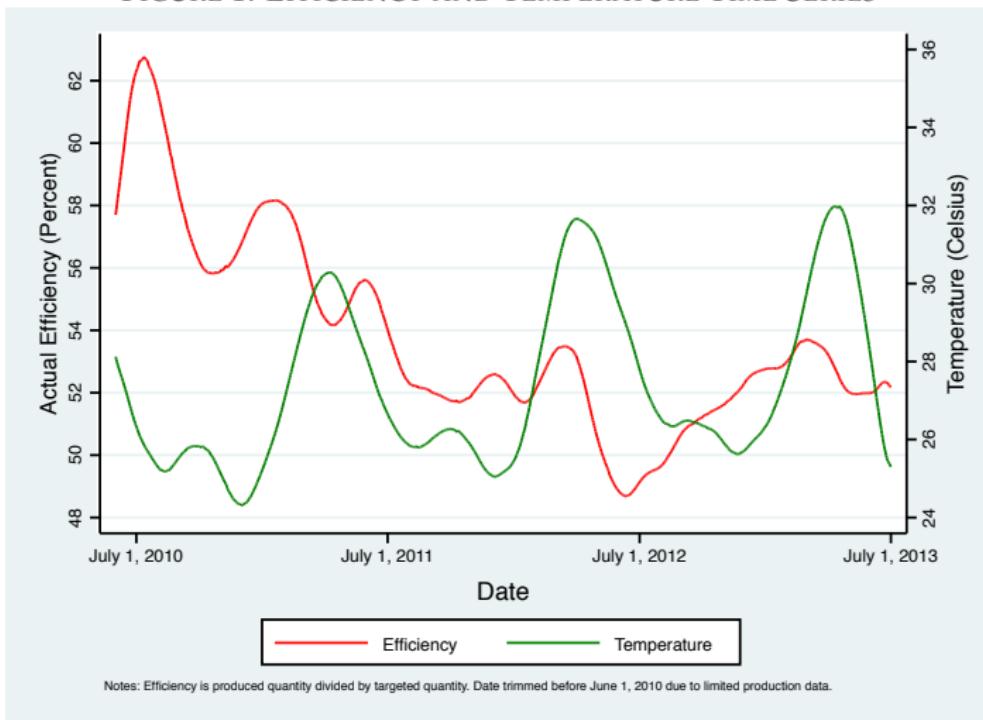


FIGURE 2: EFFICIENCY AGAINST TEMPERATURE

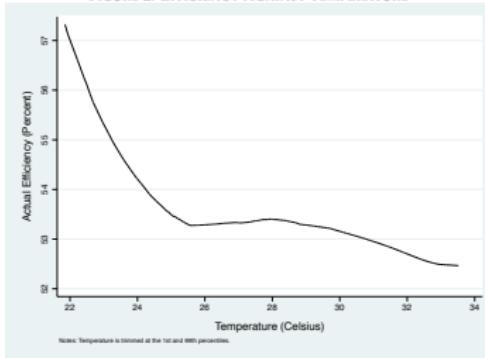


FIGURE 3: EFFICIENCY AGAINST TEMPERATURE BY LED

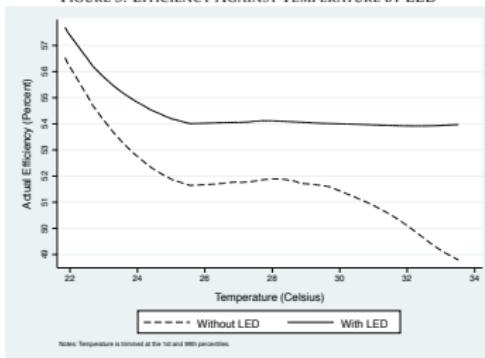


FIGURE 4: EFFICIENCY AND TEMPERATURE TIME SERIES BY LED

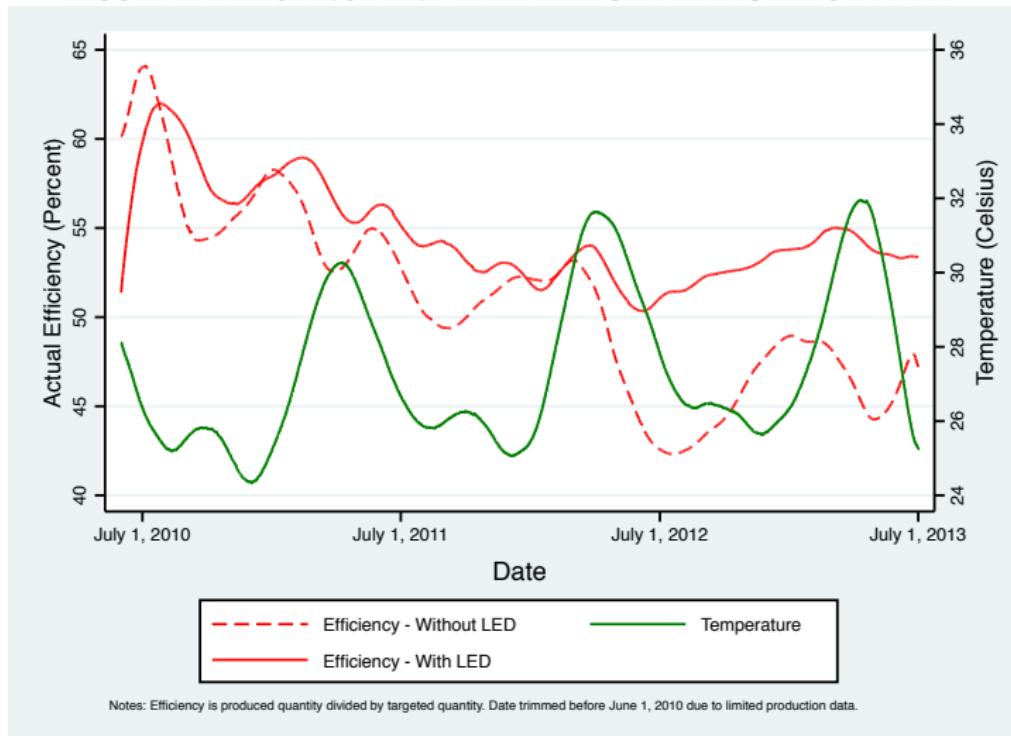


FIGURE 5: EFFICIENCY BEFORE AND AFTER LED

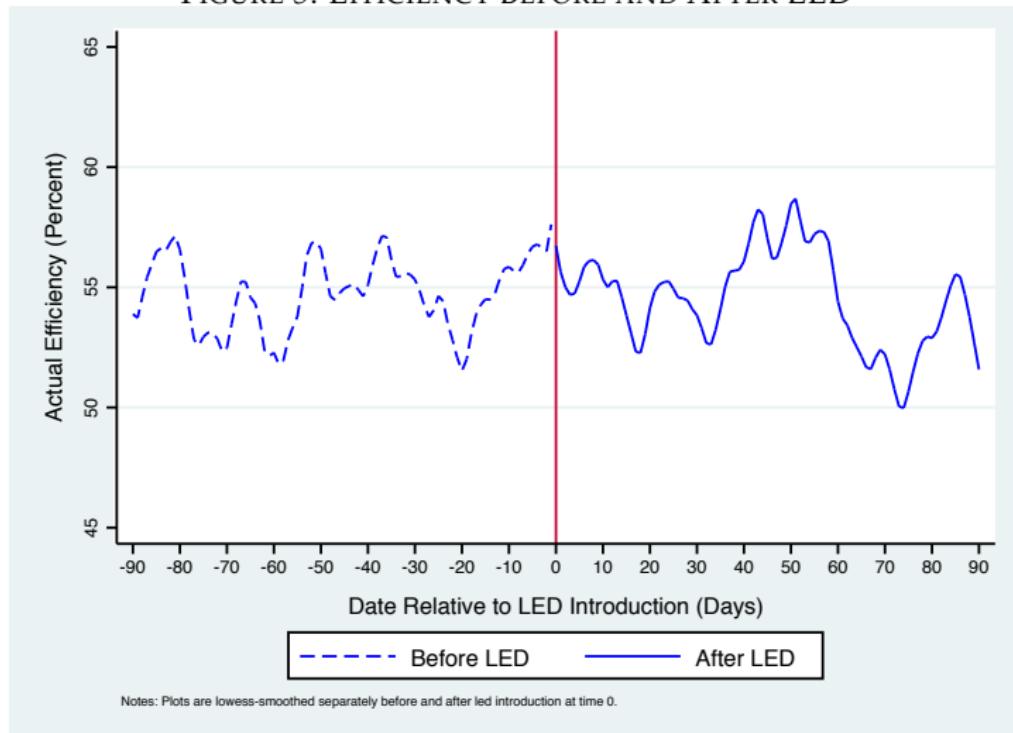


Table 2  
Impact of Temperature on Production Efficiency

Panel A: Without LED	(1)	(2)	(3)	(4)
	Actual Efficiency (Actual Production / Targeted Production)			
Temperature	-0.232** (0.0963)	-0.211** (0.0970)		
Heat Index		-0.161*** (0.0587)		
Wet Bulb Globe Temperature			-0.263** (0.109)	
Relative Humidity		0.0980 (0.0887)		
Fixed Effects	Month, Day of Week, Factory x Year, Production Line			
Observations	71,969	71,969	71,969	71,969
R-squared	0.228	0.229	0.228	0.229

Panel B: Whole Sample	(1)	(2)	(3)	(4)
	Actual Efficiency (Actual Production / Targeted Production)			
Temperature	-0.152*** (0.0591)	-0.135** (0.0590)		
Heat Index		-0.102*** (0.0388)		
Wet Bulb Globe Temperature			-0.170** (0.0680)	
Relative Humidity		0.0622 (0.0513)		
Fixed Effects	Month, Day of Week, Factory x Year, Production Line			
Observations	214,968	214,968	214,968	214,968
R-squared	0.209	0.209	0.209	0.209

Notes: Cameron, Gelbach, Miller (2011) two-way clustered standard errors in parentheses (\*\* p<0.01, \*\* p<0.05, \* p<0.1). Clustering is done at the production line and day level. All measures of temperature are in degree Celsius. All regressions include daily budgeted efficiency as a control variable.

# Adhvaryu, Kala, Nyshadham Working Paper, 2014. 'The Light and the Heat: Productivity Co-benefits of Energy-saving Technology'

Table 4  
Impact of Lagged Temperature on Attendance

Panel A: Without LED	(1)	(2)	(3)	(4)
	Attendance 1[Present for Full Work Day]			
Temperature	0.000529 (0.00132)	0.000375 (0.00135)		
Temperature (1 Week Lag)	-0.00449* (0.00248)	-0.00510** (0.00240)		
Heat Index		0.000483 (0.000732)		
Heat Index (1 Week Lag)		-0.00139 (0.00130)		
Wet Bulb Globe Temperature			0.000388 (0.00150)	
Wet Bulb Globe Temperature (1 Week Lag)			-0.00484* (0.00277)	
Relative Humidity		-0.00169* (0.000905)		
Fixed Effects		Month, Day of Week, Factory x Year		
Observations	6,097,947	6,097,947	6,097,947	6,097,947
R-squared	0.006	0.006	0.006	0.006

Panel B: Whole Sample	(1)	(2)	(3)	(4)
	Attendance 1[Present for Full Work Day]			
Temperature	-0.000874 (0.00151)	-0.00105 (0.00154)		
Temperature (1 Week Lag)	-0.00559*** (0.00226)	-0.00624*** (0.00218)		
Heat Index		0.000376 (0.000910)		
Heat Index (1 Week Lag)		-0.00236* (0.00137)		
Wet Bulb Globe Temperature		-0.00120 (0.00177)		
Wet Bulb Globe Temperature (1 Week Lag)		-0.00657** (0.00269)		
Relative Humidity		-0.00132 (0.000921)		
Fixed Effects		Month, Day of Week, Factory x Year		
Observations	21,463,467	21,463,467	21,463,467	21,463,467
R-squared	0.005	0.005	0.005	0.005

Notes: Cameron, Gelbach, Miller (2011) two-way clustered standard errors in parentheses (\*\* p<0.01, \*\* p<0.05, \* p<0.1). Clustering is done at the individual and day level. All measures of temperature are in degree Celsius.

Table 5

## LED Lighting and the Temperature-Productivity Gradient

	(1)	(2)	(3)	(4)
Actual Efficiency (Actual Production / Targeted Production)				
Temperature x LED	0.237** (0.102)	0.244** (0.102)		
Heat Index X LED		0.150** (0.0608)		
Wet Bulb Globe Temperature x LED			0.415*** (0.123)	
Temperature	-0.314*** (0.0899)	-0.300*** (0.0903)		
Heat Index			-0.199*** (0.0535)	
Wet Bulb Globe Temperature				-0.446*** (0.104)
LED	-5.917** (2.900)	-6.117** (2.891)	-3.870** (1.918)	-9.493*** (3.047)
Relative Humidity		0.0712 (0.0513)		
Fixed Effects Month, Day of Week, Factory x Year, Production Line				
Observations	214,968	214,968	214,968	214,968
R-squared	0.209	0.209	0.209	0.209
Temperature Impacts Net of LED	-0.078 (0.069)	-0.056 (0.068)	-0.049 (.045)	-0.031 (0.082)

Notes: Cameron, Gelbach, Miller (2011) two-way clustered standard errors in parentheses (\*\* p<0.01, \*\* p<0.05, \* p<0.1). Clustering is done at the production line and day level. All measures of temperature are in degree Celsius. All regressions include daily budgeted efficiency as a control variable.

Table 6

## Impacts on Production Efficiency and LED Attenuation (Above and Below Median Temperature)

	(1)	(2)	(3)
	Actual Efficiency (Actual Production / Targeted Production)		
	Without LED	Whole Sample	Whole Sample
Temperature x 1(Above Median)	-0.308*** (0.115)	-0.145** (0.0693)	-0.594*** (0.146)
Temperature x 1(Below Median)	-0.332*** (0.128)	-0.143* (0.0753)	-0.352** (0.161)
Temperature x 1(Above Median) x LED			0.479*** (0.163)
Temperature x 1(Below Median) x LED			0.542*** (0.197)
Fixed Effects	Month, Day of Week, Factory x Year, Production Line		
Observations	71,969	214,968	214,968
R-squared	0.229	0.209	0.209

Notes: Cameron, Gelbach, Miller (2011) two-way clustered standard errors in parentheses (\*\* p<0.01, \*\* p<0.05, \* p<0.1). Clustering is done at the production line and day level. Heat Index is measured in degree Celsius. All regressions include daily budgeted efficiency as a control variable. Column 3 also includes additional regressors: 1(Above Median) x LED, 1(Below Median) x LED and 1(Above Median).