EC1340 Topic #6

Climate damage III

Matthew A. Turner
Brown University
Fall 2019

(Updated August 21, 2019)

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’

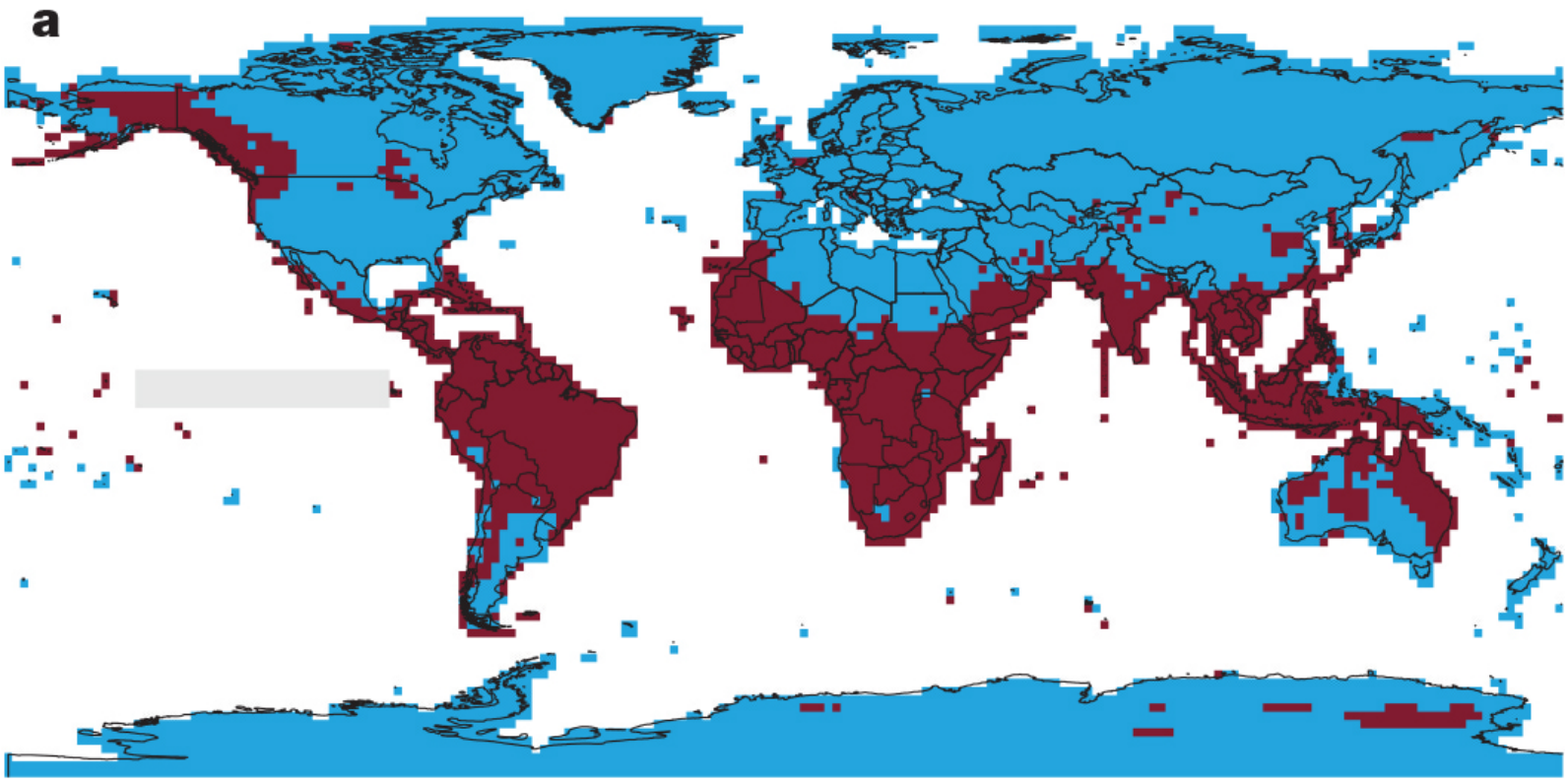
Civil conflicts and El Nino

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

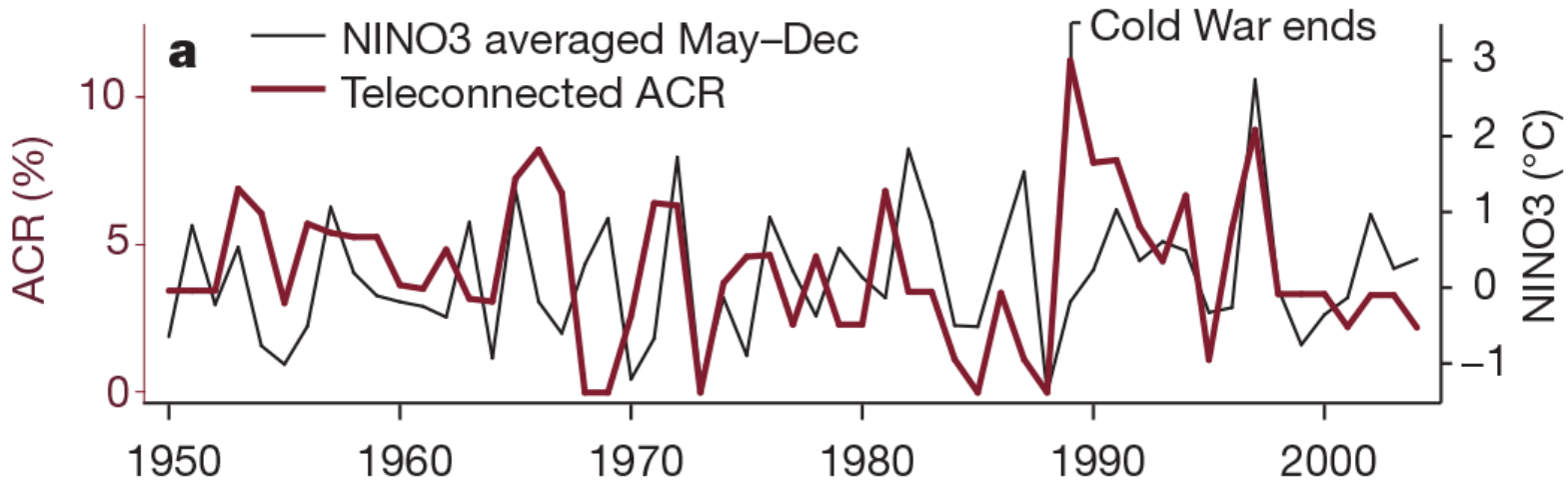
Data:

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

Hsiang, Meng and Cane, Nature 2011, ‘Civil conflicts are associated with the global climate’



Hsiang, Meng and Cane, Nature 2011, ‘Civil conflicts are associated with the global climate’



Zhang et al. PNAS 2007, ‘Global climate change, war and population decline in recent human history’

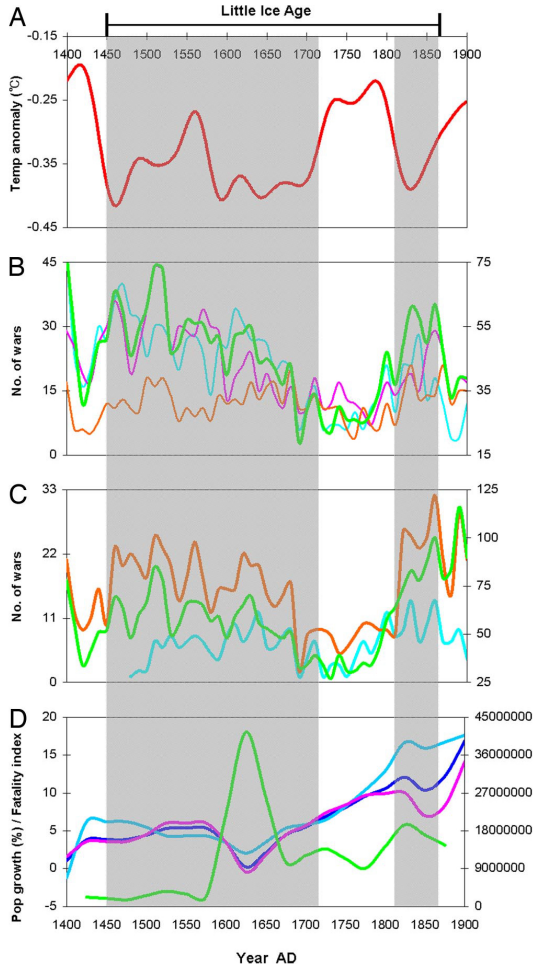


Fig. 1. Paleo-temperature variation, war frequency, and population growth rate, A.D. 1400–1900. (*A*) Temperature anomaly (°C) in the NH that is smoothed by 40-year Butterworth low pass filter (17). (*B*) Number of wars in the NH (bright green), Asia (pink), Europe (turquoise), and the arid areas in the NH (orange).‖ (*C*) Number of wars worldwide as recorded by Wright (39) (turquoise), Luard (38) (orange), and Brecke‖ (bright green). (*D*) Twenty-year population growth rate in Europe (turquoise), Asia (pink), and the NH (blue)‖ 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.

Zhang et al. PNAS 2007, ‘Global climate change, war and population decline in recent human history’

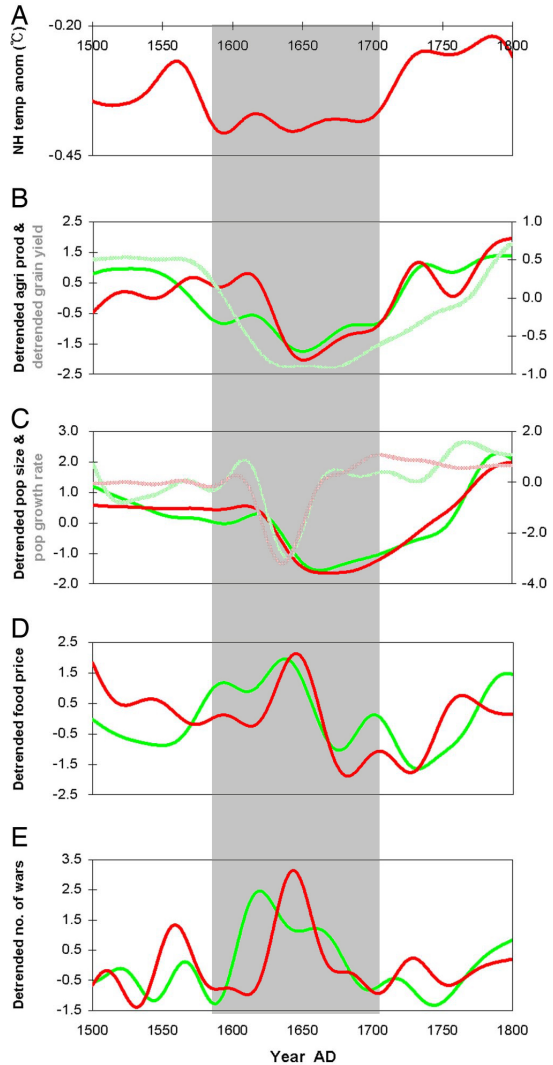


Fig. 2. Paleo-temperature variation and its impact on Europe and China A.D. 1500–1800. (*A*) Temperature anomaly (°C) in the NH (17). (*B–E*) Europear data are in green and Chinese data are in red. The data are in normalized unit: that indicate the relative amplitude of change only. (*B*) Detrended estimatec values of agricultural production (solid lines) and detrended grain yield ratic in Europe (green-dotted curve) (18). The estimated values of agricultura production are calculated by dividing population size by food price. (*C* Detrended population size (solid lines) and population growth rate (dottec curves) (22, 24). (*D*) Detrended wheat price index in Europe and detrended rice price in China (41, 42). (*E*) Detrended total war frequency (‖ and ref. 40). Al data are smoothed by 40-year Butterworth low pass filter. All of the dottec curves correspond to the right *y* axis.

Oster, JEP 2004, 'Witchcraft, Weather and Economic Growth in Renaissance Europe'

Figure 1: Temperature and Trials over Time
1520-1770

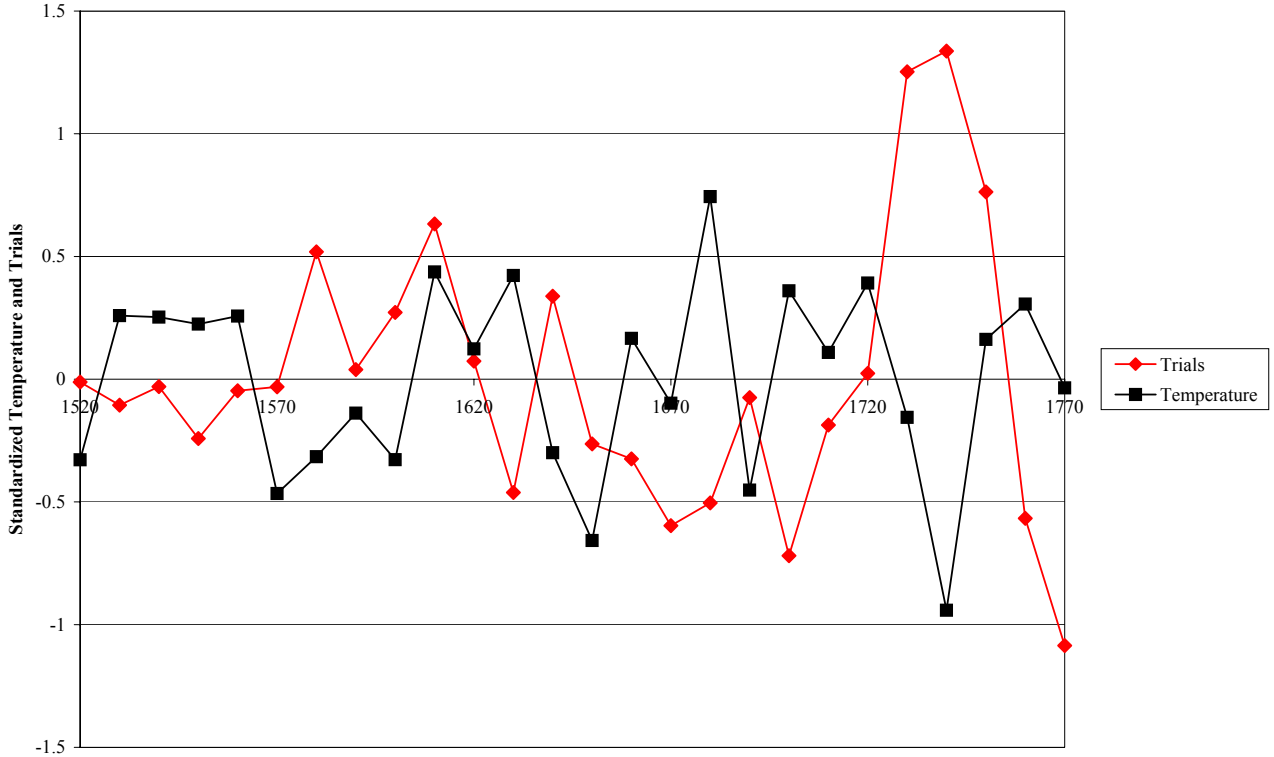


Table 1[a]

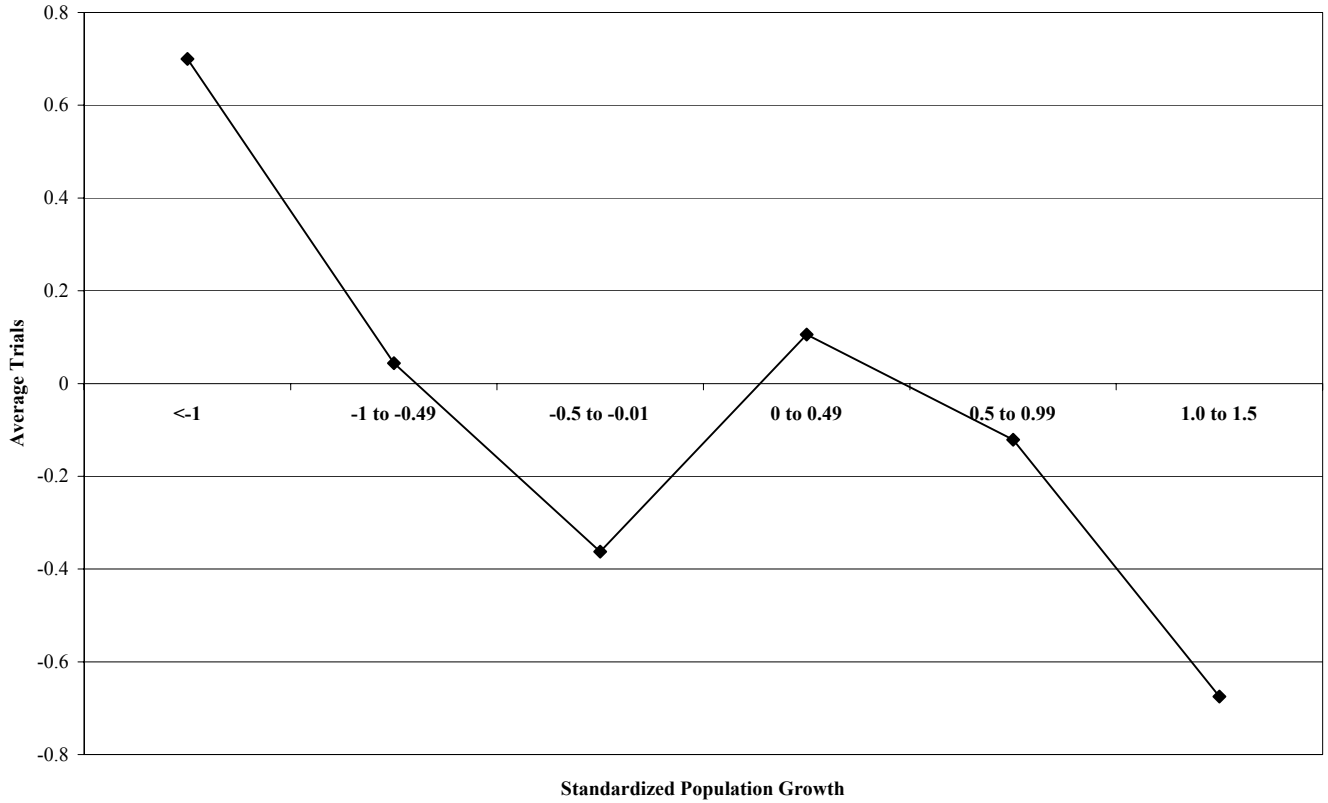
Witchcraft Trials and Temperature

Dependent Variable: Witchcraft Trials Standardized by Region

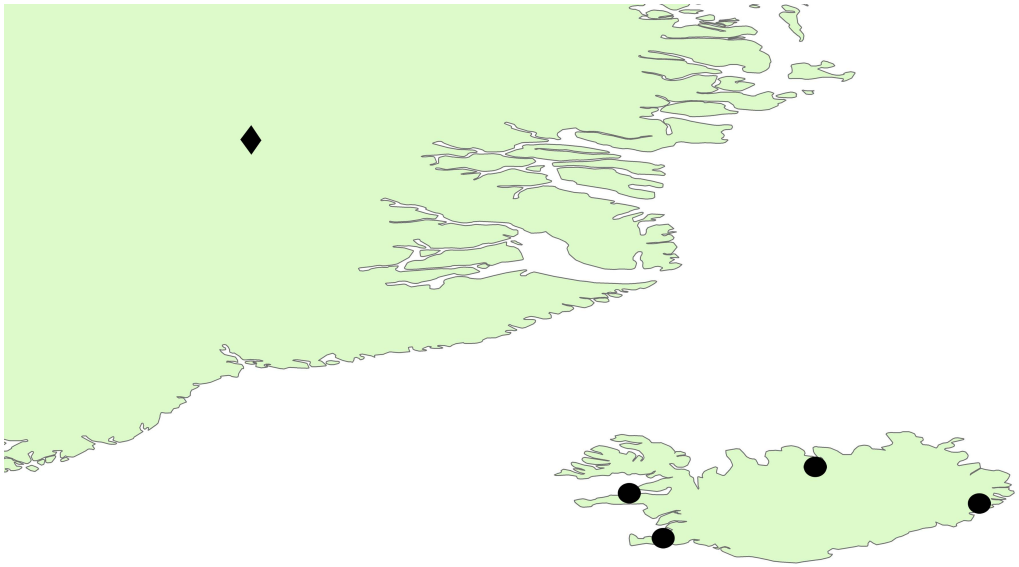
	(1)	(2)	(3)	(4)
Standardized Combined Index	-0.212***		-0.206**	
	(2.59)		(2.32)	
Standardized Winter Severity Only		-0.179**		-0.292***
		(1.96)		(2.84)
Date	0.096	0.233***		
	(1.96)	(3.43)		
Date-Squared	-0.003	-0.011***		
	(1.43)	(3.45)		
Constant	-0.645**	-1.037***	-0.019	-0.059
	(2.39)	(3.16)	(0.26)	(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%

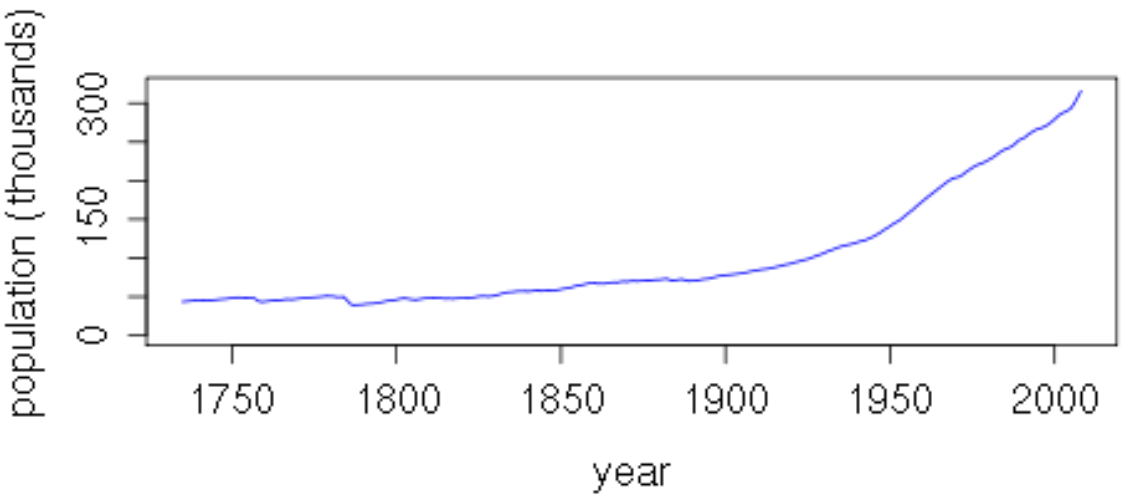
Figure 3: Population Growth and Trials



Turner, AERPP 2012, ‘Adaptation to Climate Change in Preindustrial Iceland’



Turner, AERPP 2012, ‘Adaptation to Climate Change in Preindustrial Iceland’



Turner, AERPP 2012, ‘Adaptation to Climate Change in Preindustrial Iceland’

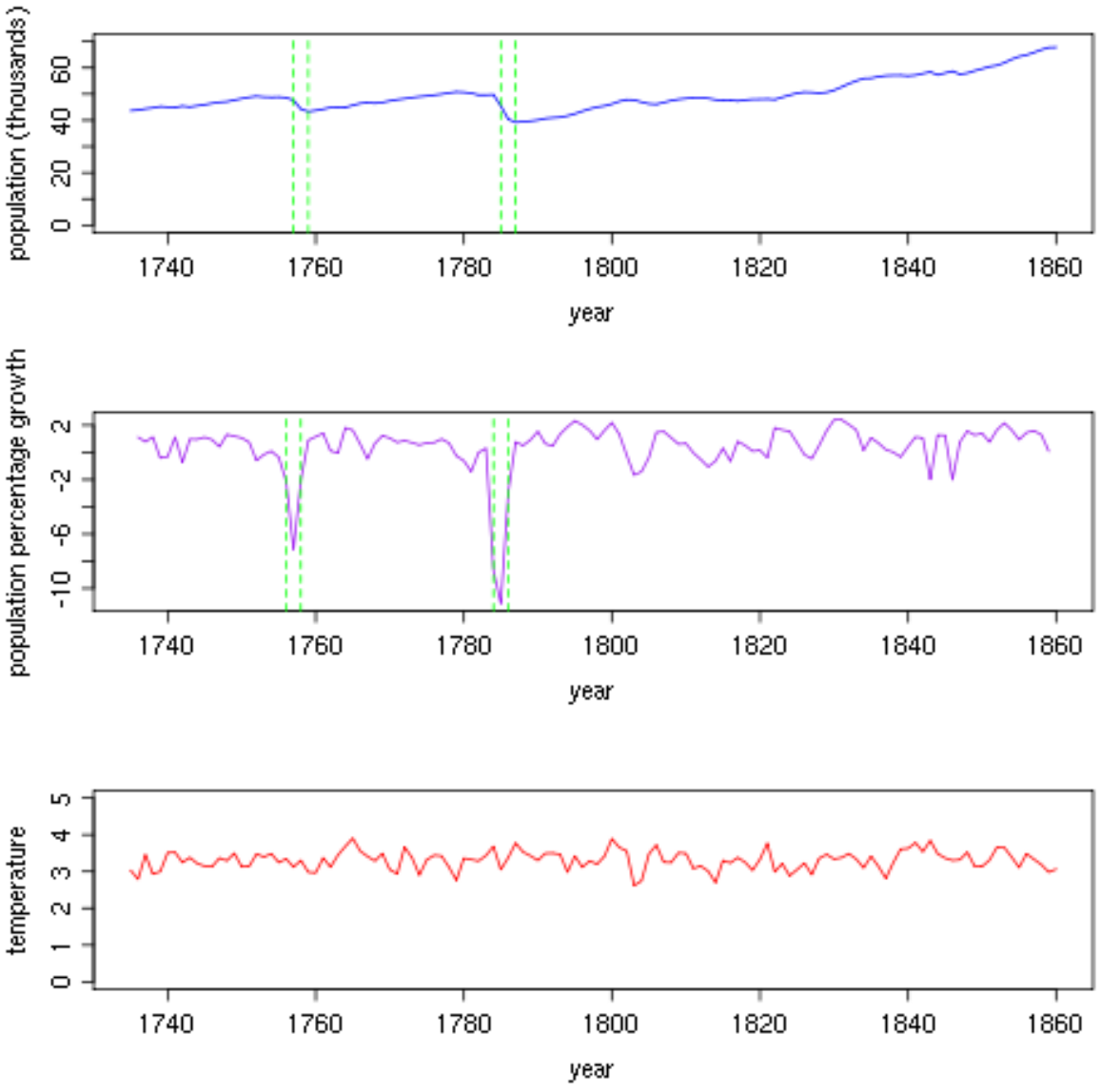


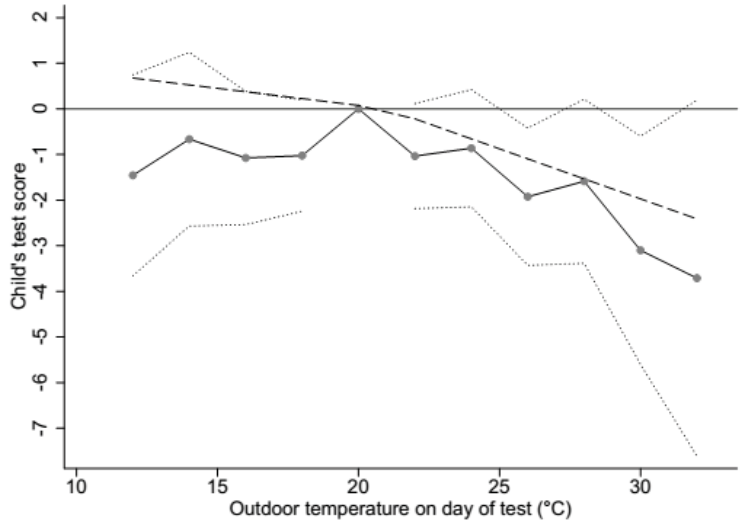
TABLE 1—NINE REGRESSIONS (ONE PER COLUMN) PREDICTING $(\Delta pop)_t$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MA2_t	1.143***					1.153***	1.133***	1.084***	1.104***
	(0.359)					(0.355)	(0.353)	(0.323)	(0.298)
MA5_t		0.582							
		(0.721)							
MA10_t			1.172						
			(0.971)						
MA10_{t-4}				0.364		0.485		0.710	
				(1.051)		(1.017)		(1.044)	
MA20_{t-4}					-0.897		-0.208		-0.005
					(1.590)		(1.572)		(1.544)
$\text{MA2}_t \times \text{MA10}_{t-4}$								7.690*	
								(4.454)	
$\text{MA2}_t \times \text{MA20}_{t-4}$									11.10*
									(5.960)
pop_t	-0.089***	-0.091***	-0.086***	-0.090***	-0.093***	-0.087***	-0.089***	-0.092***	-0.093***
	(0.027)	(0.025)	(0.026)	(0.025)	(0.026)	(0.026)	(0.027)	(0.026)	(0.028)

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

Zivin, Hsiang and Neidell Working Paper 2016. ‘Temperature and Human Capital in the Short- and Long-Run’

A. Mathematics



B. Reading comprehension

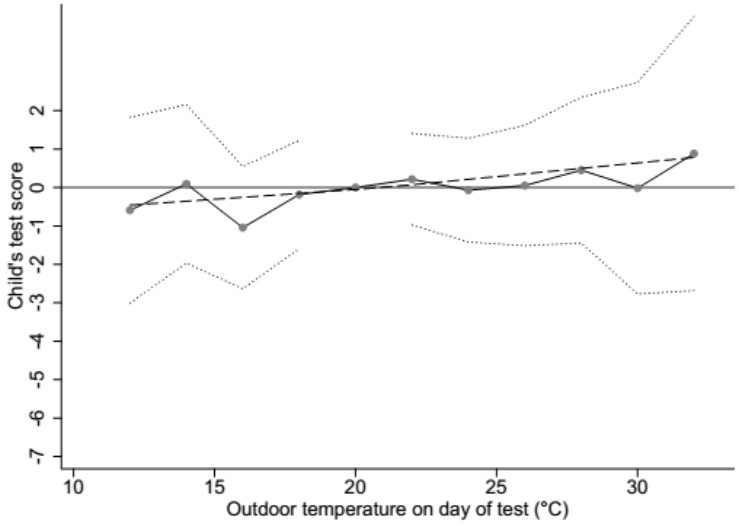
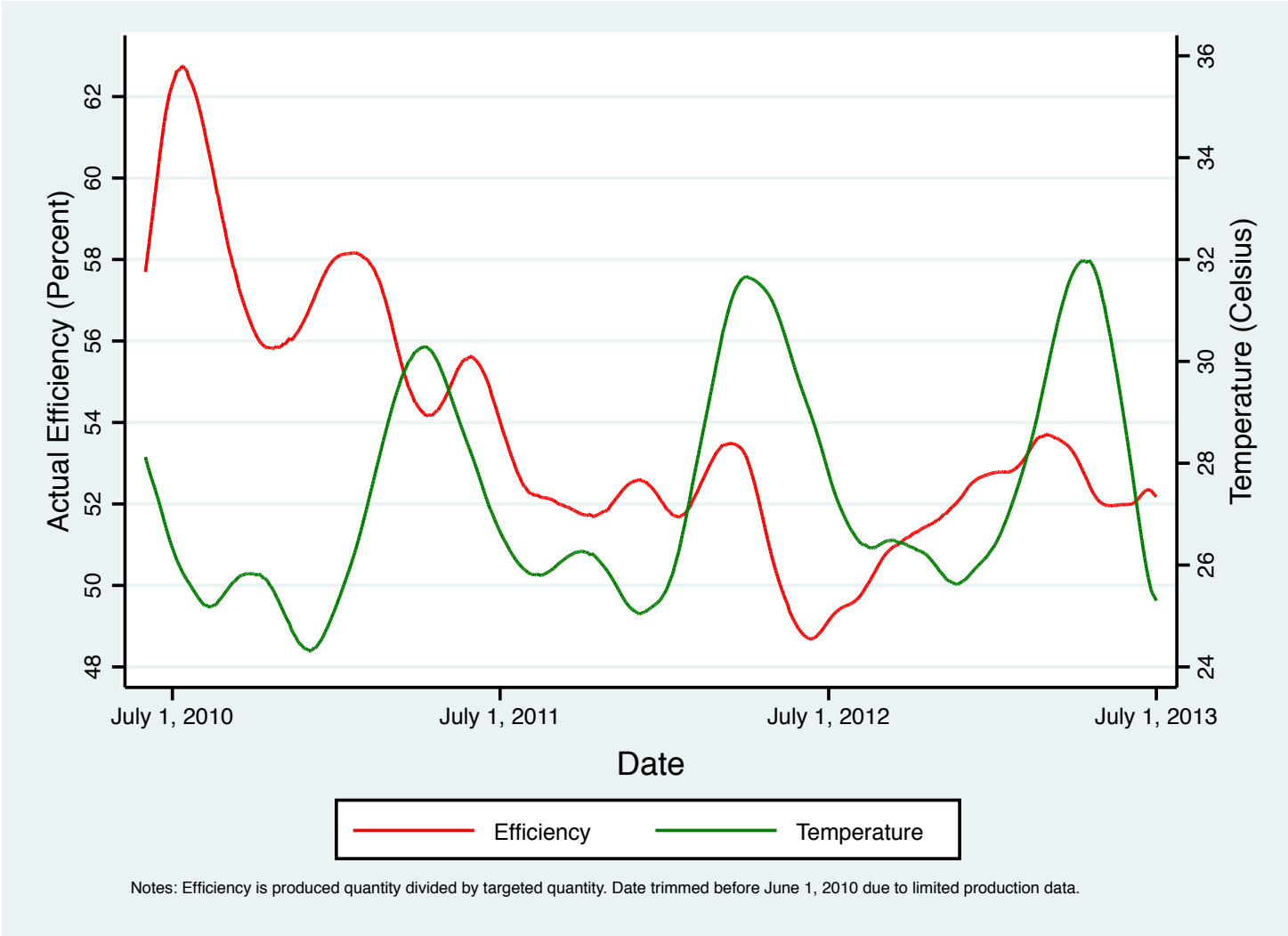


FIGURE 1: EFFICIENCY AND TEMPERATURE TIME SERIES



Notes: Efficiency is produced quantity divided by targeted quantity. Date trimmed before June 1, 2010 due to limited production data.

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

FIGURE 2: EFFICIENCY AGAINST TEMPERATURE

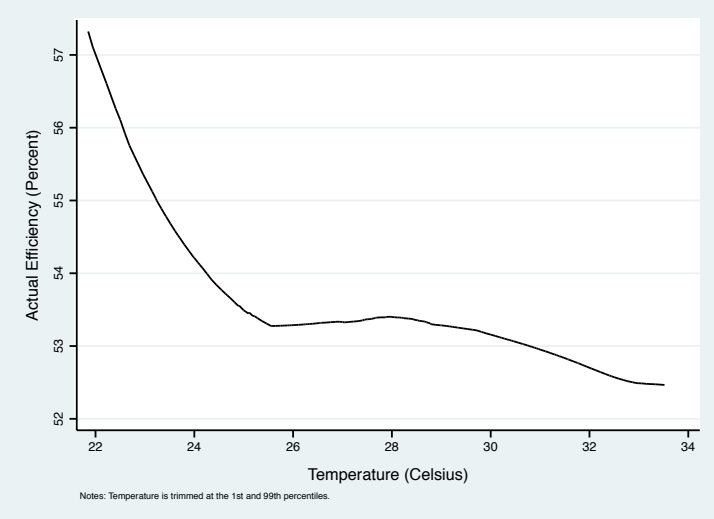


FIGURE 3: EFFICIENCY AGAINST TEMPERATURE BY LED

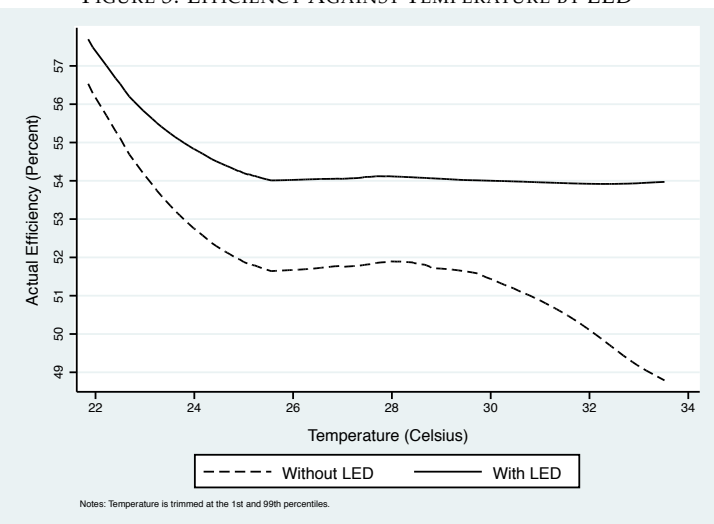
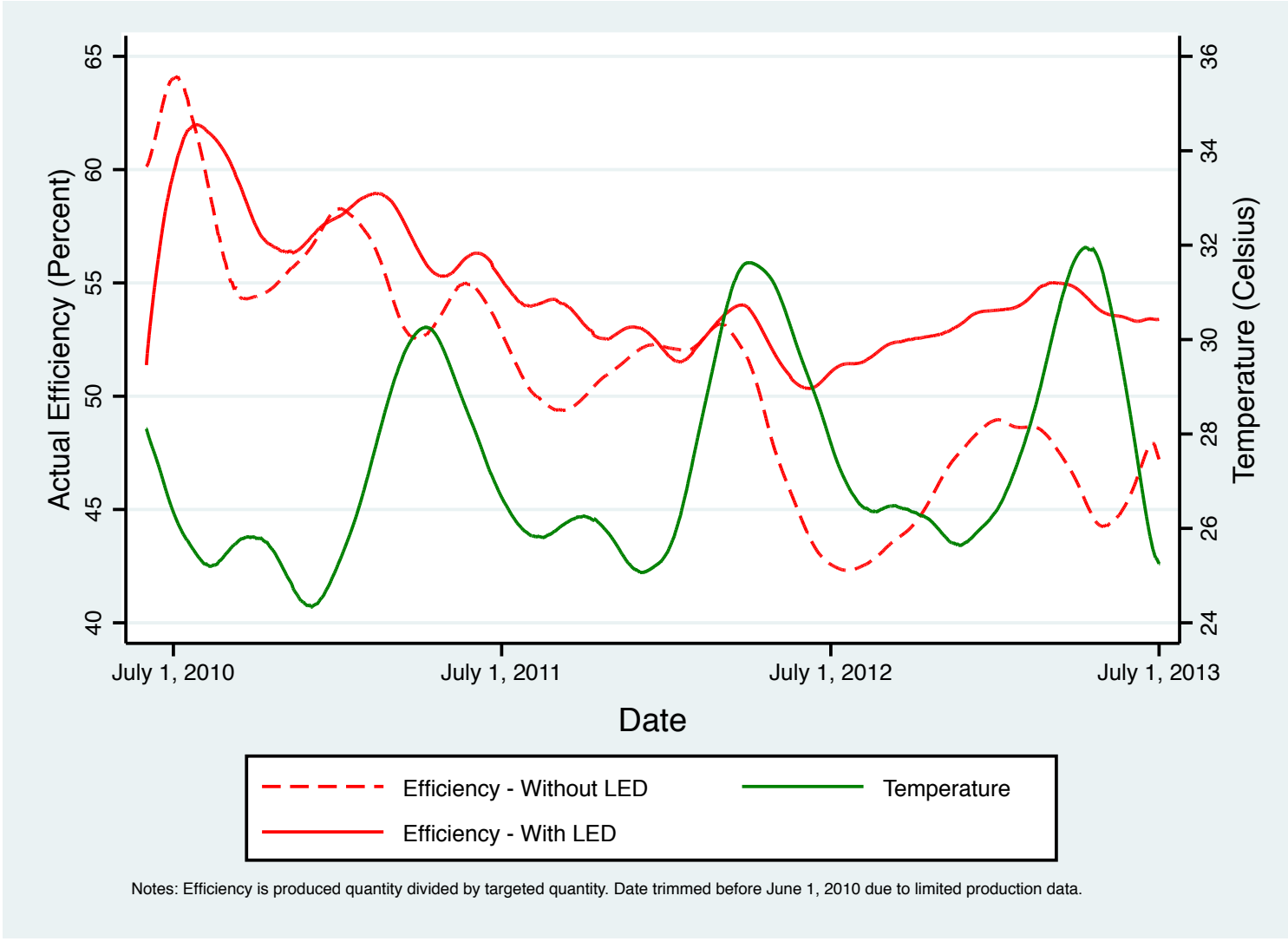
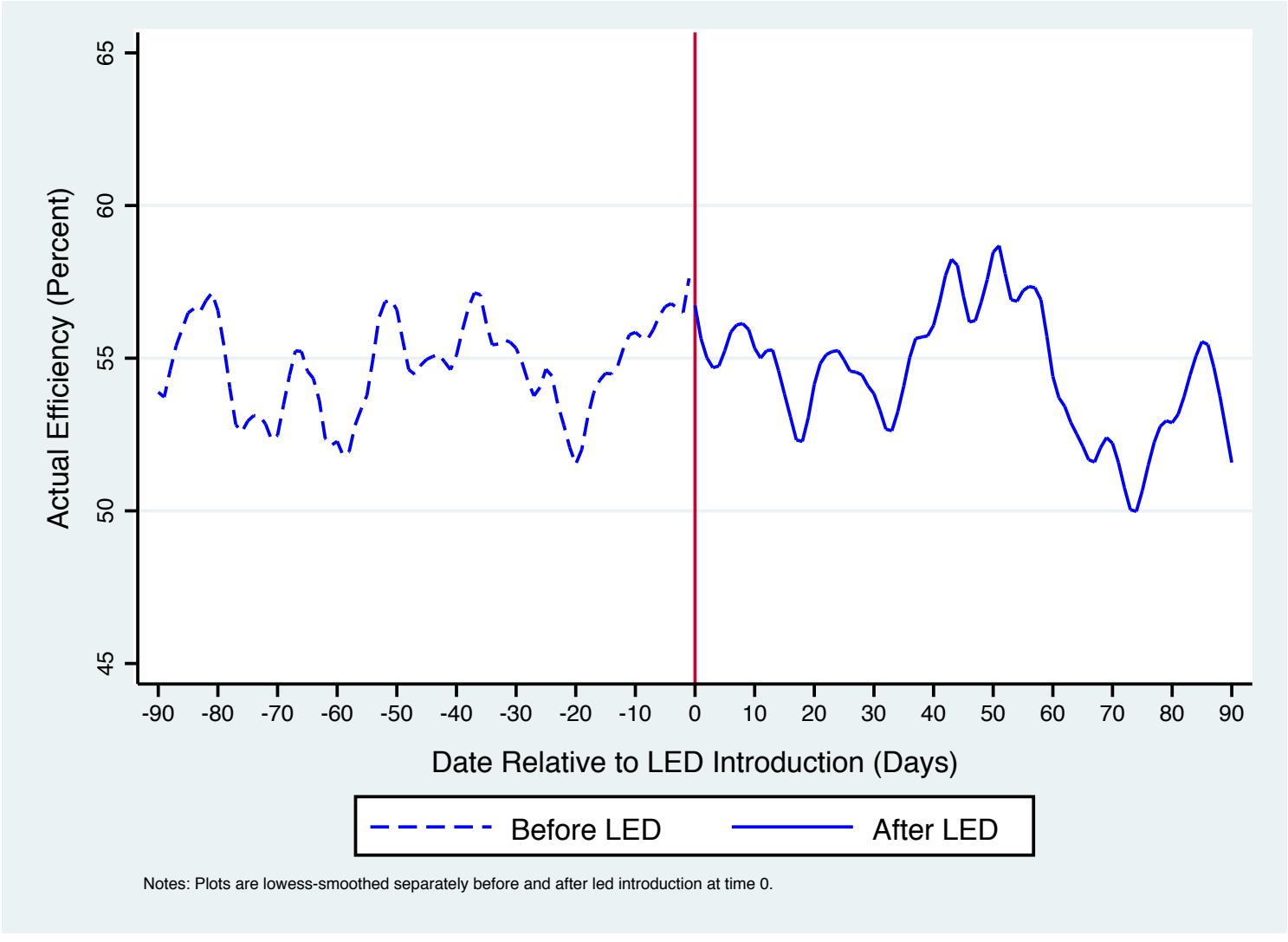


FIGURE 4: EFFICIENCY AND TEMPERATURE TIME SERIES BY LED



Notes: Efficiency is produced quantity divided by targeted quantity. Date trimmed before June 1, 2010 due to limited production data.

FIGURE 5: EFFICIENCY BEFORE AND AFTER LED



Notes: Plots are lowess-smoothed separately before and after led introduction at time 0.

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**	-0.211**		
	(0.0963)	(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***	-0.135**		
	(0.0591)	(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.

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	0.000375		
	(0.00132)	(0.00135)		
Temperature (1 Week Lag)	-0.00449*	-0.00510**		
	(0.00248)	(0.00240)		
Heat Index			0.000481	
			(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	-0.00105		
	(0.00151)	(0.00154)		
Temperature (1 Week Lag)	-0.00550**	-0.00624***		
	(0.00226)	(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**	0.244**		
	(0.102)	(0.102)		
Heat Index X LED			0.150**	
			(0.0608)	
Wet Bulb Globe Temperature x LED				0.415***
				(0.123)
Temperature	-0.314***	-0.300***		
	(0.0899)	(0.0903)		
Heat Index			-0.199***	
			(0.0535)	
Wet Bulb Globe Temperature				-0.446***
				(0.104)
LED	-5.917**	-6.117**	-3.870**	-9.493***
	(2.900)	(2.891)	(1.918)	(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
	-0.078	-0.056	-0.049	-0.031
Temperature Impacts Net of LED	(0.069)	(0.068)	(.045)	(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***	-0.145**	-0.594***
	(0.115)	(0.0693)	(0.146)
Temperature x 1(Below Median)	-0.332***	-0.143*	-0.352**
	(0.128)	(0.0753)	(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) .