Adjusting Time Scales to Assess Temperature's Impact on Demand: A Case Study from U.S. Residential Electricity Consumption

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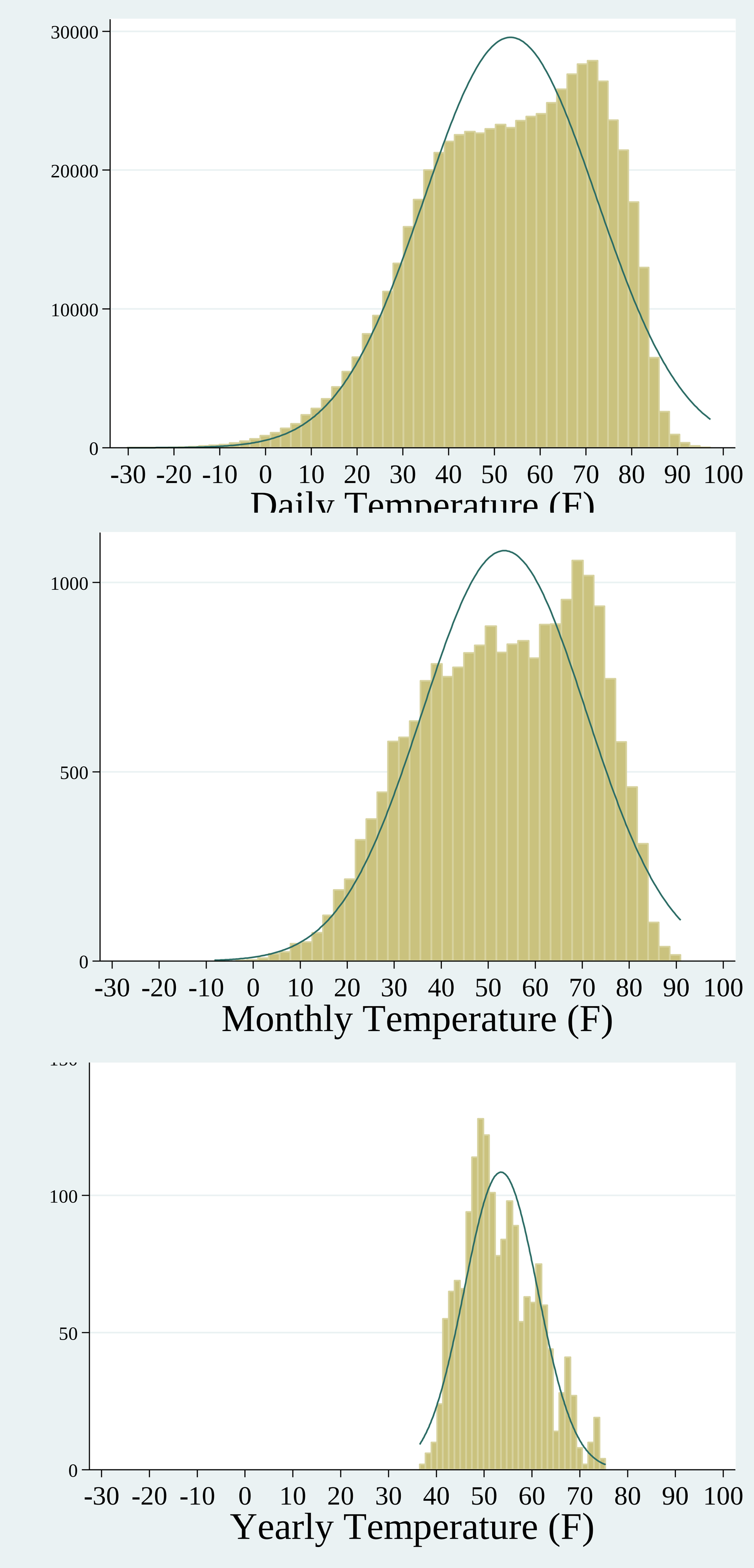
Summary

- Our study shows the difference of daily, monthly, and annual temperature in their distributions. We demonstrate how an empirical analysis of temperature impact might be affected by the choice of temporal temperature measurement unit.

Introduction

- In the context of changing climate, temperature impacts on human activities have been a hot topic in the past decade.
- The choice of temperature measurement in empirical studies is mostly implicit or arbitrary, even though in theory it might be short temperature shocks rather than the long term average that causes the impacts of interests. EX: Buhaug, 2009; Adhvaryu et al., 2017.
- Averaged temperature could be inappropriate: as it captures a long term trend, the dependent variable might be actually influenced by short term shocks of temperature variation.
- We verify this concern using residential energy consumption as an example.



Method

- The influence of short term temperature variation on residential energy consumption has been verified in many empirical studies. Insignificance, if any, in regression results using inappropriate temperature measurement unit is less likely due to other causes.
- We compare results from monthly and yearly residential electricity data. Monthly electricity data are summed to annul level for the regression using yearly temperature. Yearly temperature and electricity prices are measured at annual averaged level. We use empirical models similar to Lee et al. (2017). Eq. (1) is used for monthly temperature analysis while Eq. (2) is used for yearly temperature analysis.

(1) $E_{sym} = \alpha + \beta_1 T_{sym} + \beta_2 P_{sym} + \beta_3 C_{sym} + \beta_4 GDP_{sy} + \beta_5 year + \epsilon_s + \varepsilon_{sym}$

(2) $E_{sy} = \alpha + \beta_1 T_{sy} + \beta_2 P_{sy} + \beta_3 C_{sy} + \beta_4 GDP_{sy} + \beta_5 year + \epsilon_s + \varepsilon_{sy}$

Data

- Monthly residential electricity data by state (s), time (year *y* and month *m*) are from US EIA for contiguous US states and the District of Columbia, 2000 - 2014. (Daily use is not available). The electricity price (P), and number of consumers (C) are from the same source. We obtain temperature data from both PRISM (daily, monthly, and yearly records in 1981 - 2015) and NOAA (monthly and yearly records in 1895 - 2015). We use PRISM data for analyses and NOAA data for robustness check.

Difference in Temperature Distributions

- The daily temperature records have a similar distribution to that of monthly data. Their distributions, however, are very different from the distribution of yearly temperature records.
- Both daily and month temperatures are slightly left-skewed, but yearly temperature is slightly right-skewed. The range of yearly temperature is much smaller than daily and monthly temperatures.
- NOAA's monthly and annual temperature data from 1895 to 2015 show similar differences.

Regression Results

- Except for temperature, all other estimates from the two regressions have same direction and significance level.
- Monthly temperature is significant but yearly temperature is not.

	Coefficient	Robust Std. Err.	P>|t|
Yearly Temperature (From Eq. (2))	33.30	61.85	0.59
Monthly Temperature (From Eq. (1))	5.70	2.55	0.03

Conclusion

- Measurement unit of temperature does bias empirical results. The choice of temperature measures should consider the time span of shocks that influence the outcome variable.

References

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