The Impacts of the International Climate Policies on Global Temperature

Kevin Wu and Matthew Chen

University of Chicago

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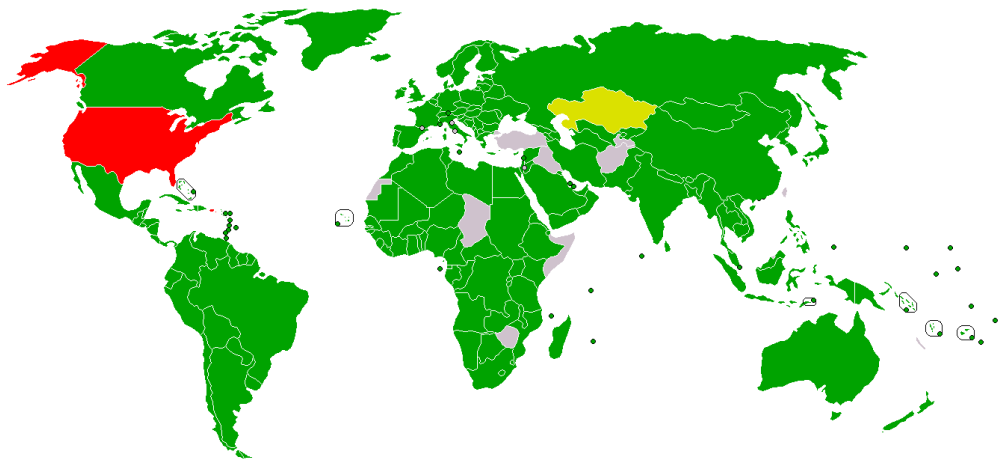
Theoretical Framework - Introduction

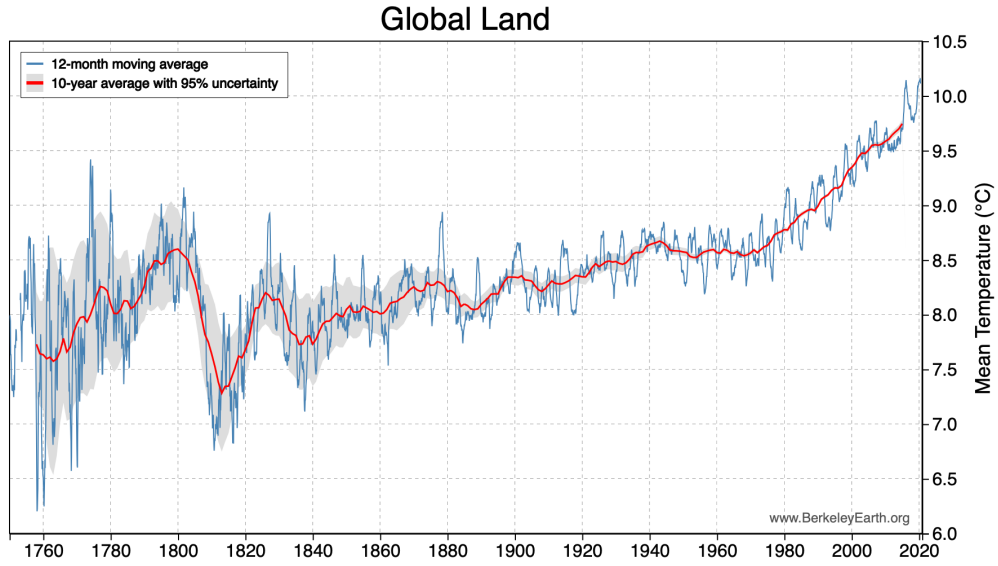
- Climate change is a major issue of academic interest, and trillions are spent every year to understand and combat it
- Kyoto Protocol: signed in 1997, went into effect in 2005, required all developed countries (except U.S.) to reduce emissions to 5% below 1990 levels
- How effective was Kyoto?



Theoretical Framework - Our Theory

- Our metric of success: overall rates of global warming before and after Kyoto Protocol
- Independent variable: rate of warming
- Dependent variable: time in years
- Causal mechanisms: reduction in greenhouse gas emissions, climate oscillations (sunspot cycles, El Niño, La Niña)
- Previous time-series analyses have shown that the Earth is warming at a significant rate; we add on to this fact by considering a major landmark event
- Theory: Kyoto has successfully decreased the rate of warming by
  1. lowering yearly rate of change
  2. lowering impact of previous years negative effects

Data Source



- Berkeley Earth, an independent U.S. non-profit organization affiliated with the Lawrence Berkeley National Laboratory
- Data from 39,000 unique weather stations, combining 1.6 billion reports from 16 preexisting archives, then cleaned and filtered
- Can filter by country/major city - we will use global and U.S.
- Key variables
  1. Date: starts in 1750, but only require 1850 - present
  2. LandAverageTemperature: global average land temperature (°C)
  3. LandAverageTemperatureUncertainty: the 95% confidence interval around the average, accounting for statistical and spatial under-sampling effects

Empirical Framework - ARMA Model

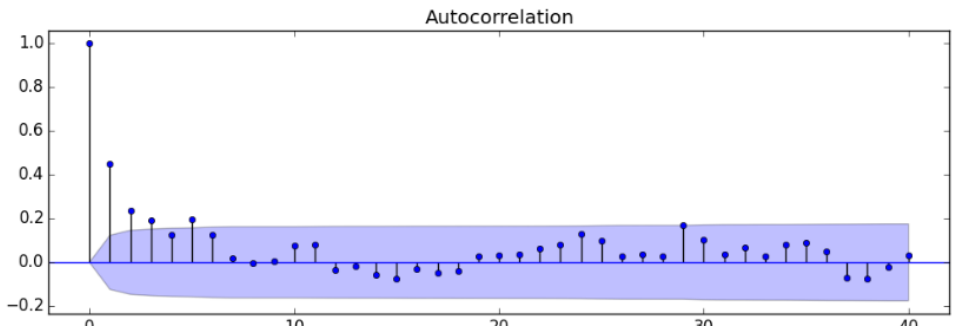
- Time-based model: $y_t = a_1 y_{t-1} + a_2 y_{t-2} \cdots + a_n y_{t-n} + w_t + \epsilon_t$
- Introduce backshift operator: define B to be an operator on any time-related variable y_t such that $By_t = y_{t-1}$. Then we can write

$$y_t = a_1 By_t + a_2 B^2 y_t \cdots a_n B^n y_t + w_t$$

- Isolate w_t in terms of y_t: $y_t - (a_1 By_t + a_2 B^2 y_t \cdots a_n B^n y_t) = w_t$
- Write our backshift operator as a polynomial expression in terms of B to get $\phi(B)y_t = w_t$, model will determine the best-fitting $\phi(B)$
- Drift term, w_t may also be affected by past drift terms
- Using same logic as before, we can incorporate this: $\phi(B)y_t = \theta(B)w_t + \epsilon_t$
- This is called ARMA (autorregressive moving average), which tries to determine the polynomials ϕ, θ that best model this result

Empirical Framework - Tests for Significance

- Unit root test - we need to test that our model converges well enough to predict past data (i.e. that variance isn't infinite). This occurs when the "roots" of $\phi(B)$ can be bounded. We can do a statistical test of significance on this
- ACF test - autocorrelation function measures the correlation and significance of each given coefficient to determine whether or not it belongs in the model



- AIC / BIC - Akaishe information criterion and Bayesian information criterion - they are a test of complexity to determine the optimal model - i.e. are we overfitting? accounting for too many factors? is our model simple enough?

Empirical Framework - Our Model and Controls

- Our empirical method will compare two models
  1. ARMA(n_1, m_1) model built on data from 1850-present
  2. ARMA(n_2, m_2) model built on data from 2000-present
     *n_1, m_1, n_2, m_2 determined by ACF/PACF tests
  3. Determine if the rate of warming over the past 20 years has a statistically significant ($p < 0.05$) decrease from the predicted values
- We can control for is the existence of alternative mechanisms that impact global climate temperature, such as sunspot cycles, El Niño, La Niña, and other climate oscillation patterns
- We can use a psuedo-control on Kyoto to look at warming rates locally within the U.S., the last major developed nation to engage in climate change control, and the only one not in Kyoto