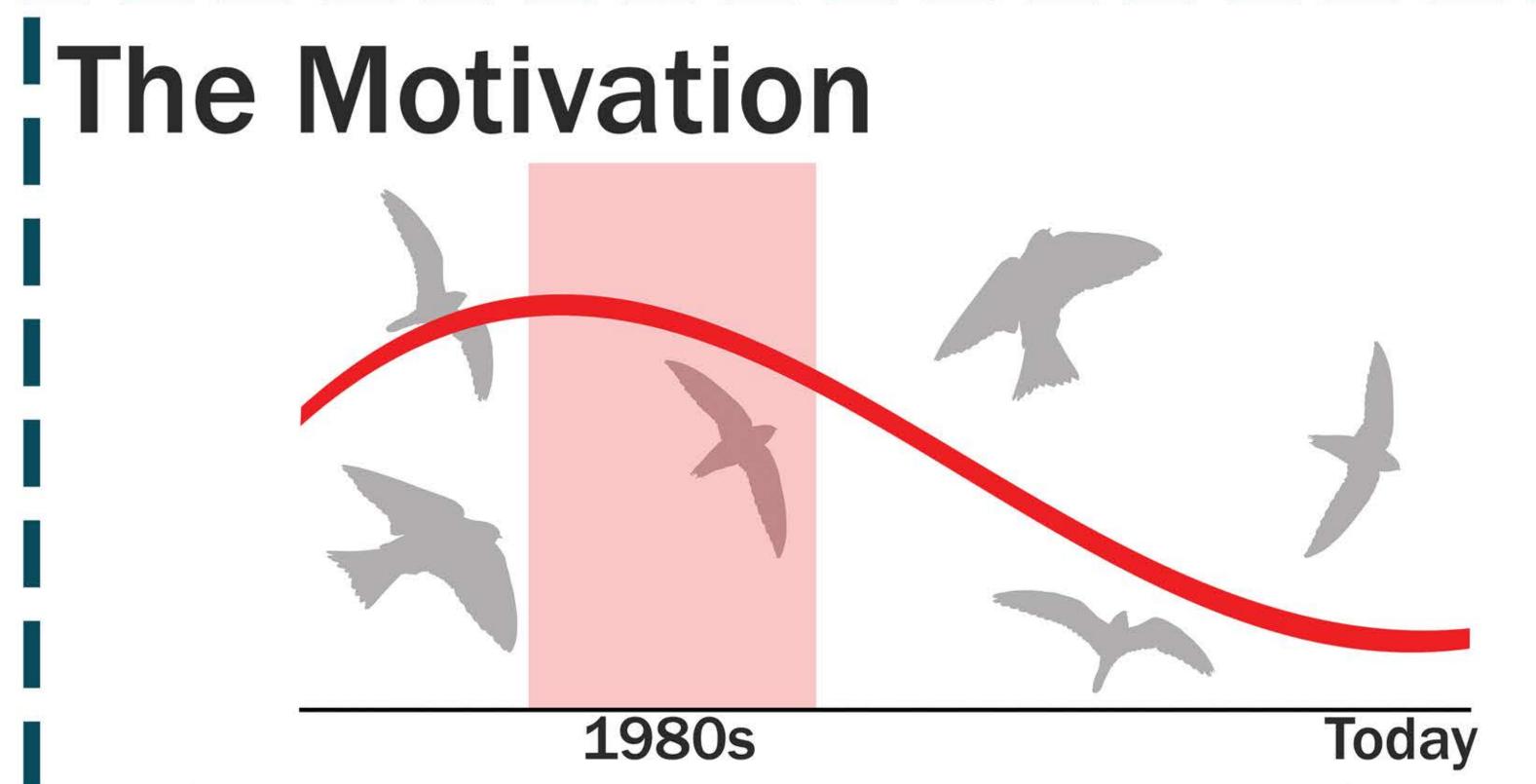# Improved population trajectories for North American swallows, swifts, and nightjars with a hierarchical Bayesian GAM

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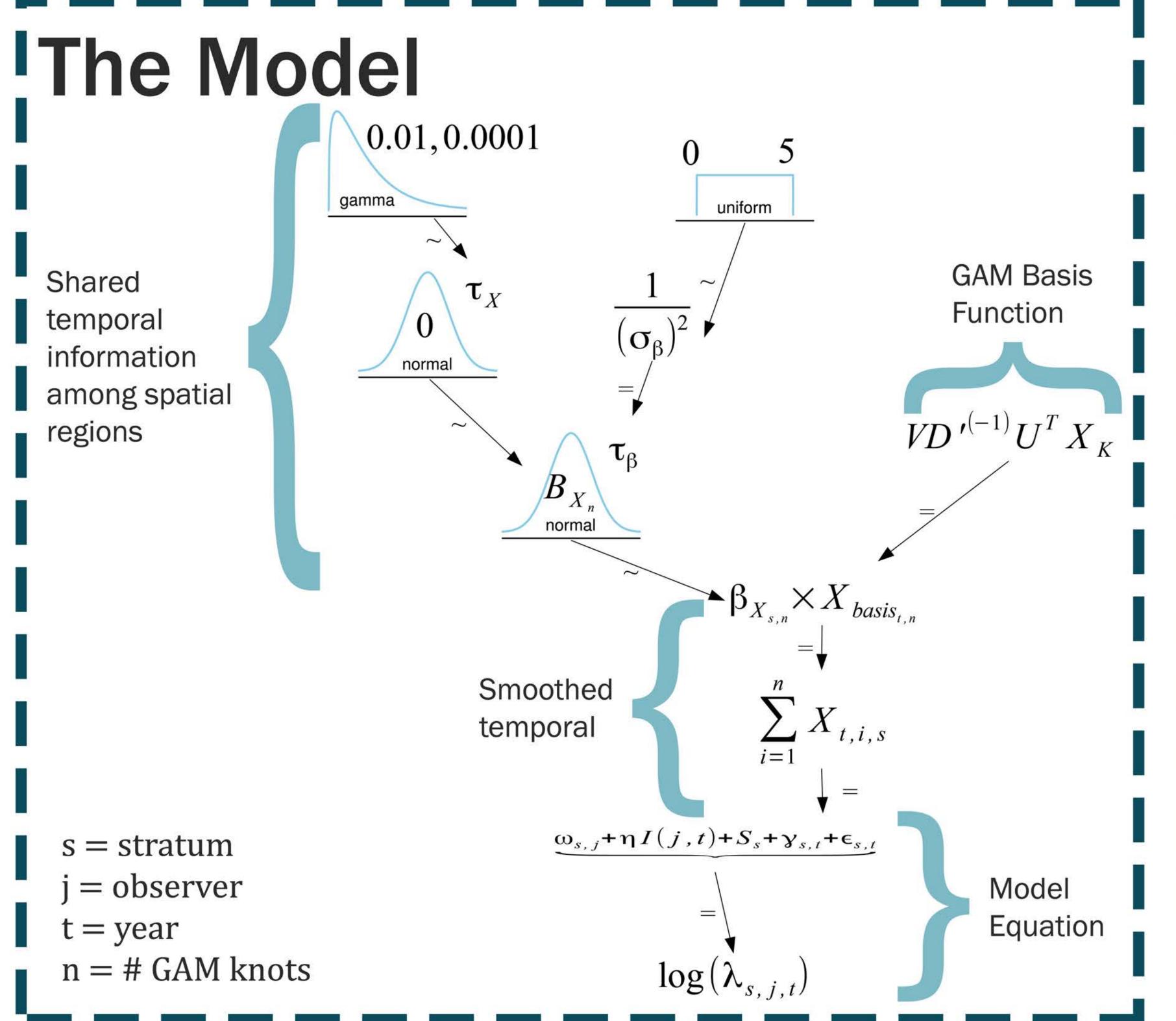
@bedwards144

## The Motivation

**Aerial Insectivores**

Changepoint

- A declining family of birds
- Population trends changed for the worse in the 1980s (Smith et al. 2015)
- **Trajectories using the standard BBS model do not show the inflection point well**
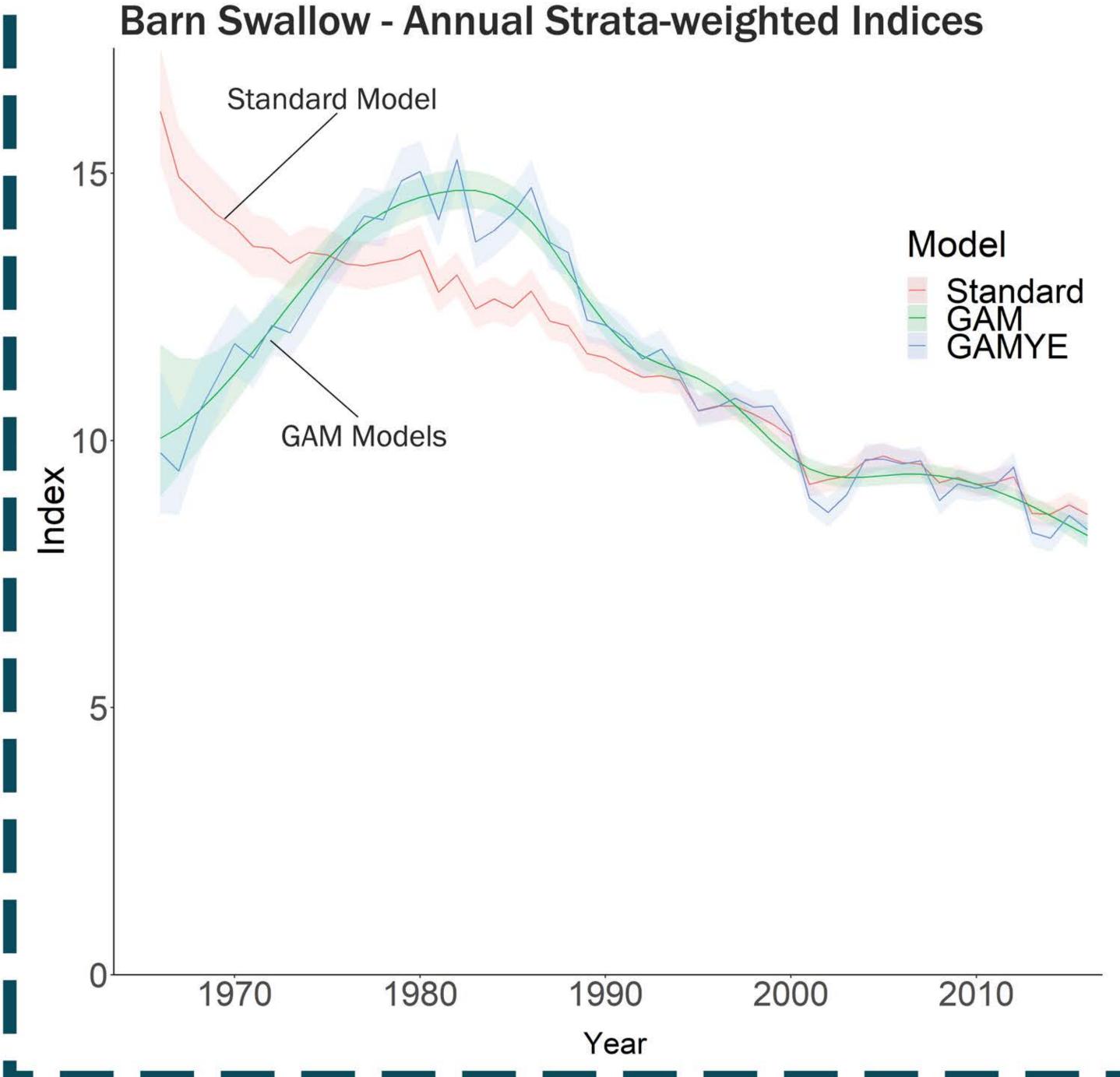
1980s    Today

**Generalized Additive Model**

- Rather than fitting data to a fixed slope, allow for temporal flexibility
- Depend on fitted smooth functions
- Information on the shape of the population trajectory can be shared among even the most data-sparse regions (mixed model)

Can a hierarchical Bayesian GAM be used to improve inferences about population trajectories of aerial insectivores?
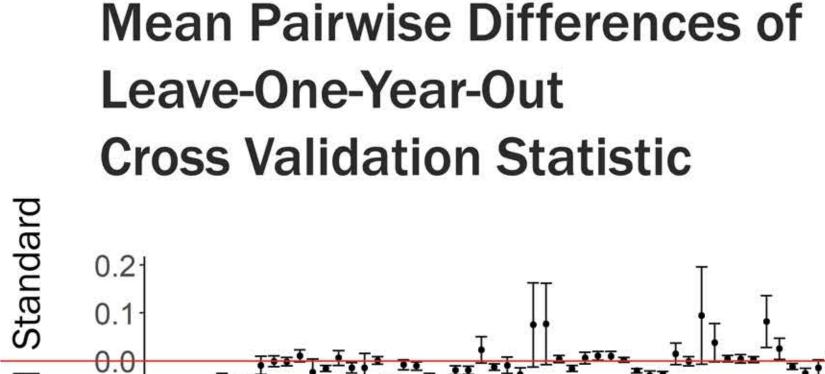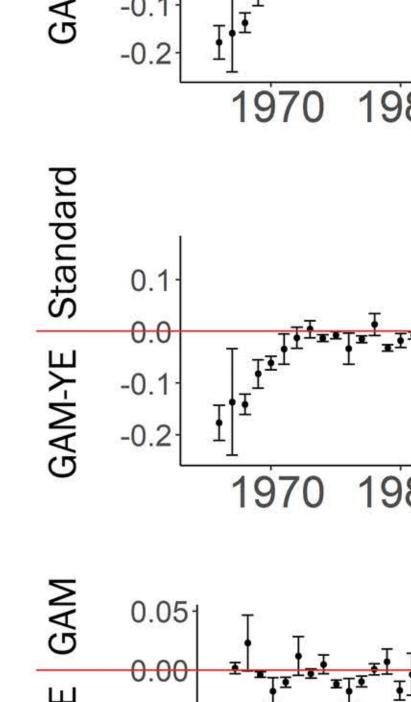
## The Model

0.01, 0.0001

gamma

0    5

uniform

Shared temporal information among spatial regions

$\tau_X$

0

normal

$\frac{1}{(\sigma_\beta)^2}$

$= \tau_\beta$

GAM Basis Function

$VD'^{(-1)}U^T X_K$

$B_{X_n}$

normal

$\beta_{X_{s,n}} \times X_{basis_{t,n}}$

Smoothed temporal

$\sum_{i=1}^{n} X_{t,i,s}$

$\omega_{s,j} + \eta I(j,t) + S_s + \gamma_{s,t} + \epsilon_{s,t}$

Model Equation

s = stratum
j = observer
t = year
n = # GAM knots

$\log(\lambda_{s,j,t})$

## The Results

**Barn Swallow - Annual Strata-weighted Indices**

Standard Model

GAM Models

Model
— Standard
— GAM
— GAMYE

Index / Year

**Population Change Across Models**

|  | Standard | GAM | GAMYE |
|---|---|---|---|
| **Overall Pop. Change** 1966 - 2016 | -47.35 % | -18.44 % | -14.96 % |
| **Changepoint Pop. Change** 1983 - 2016 | -31.65 % | -44.97 % | -40.16 % |
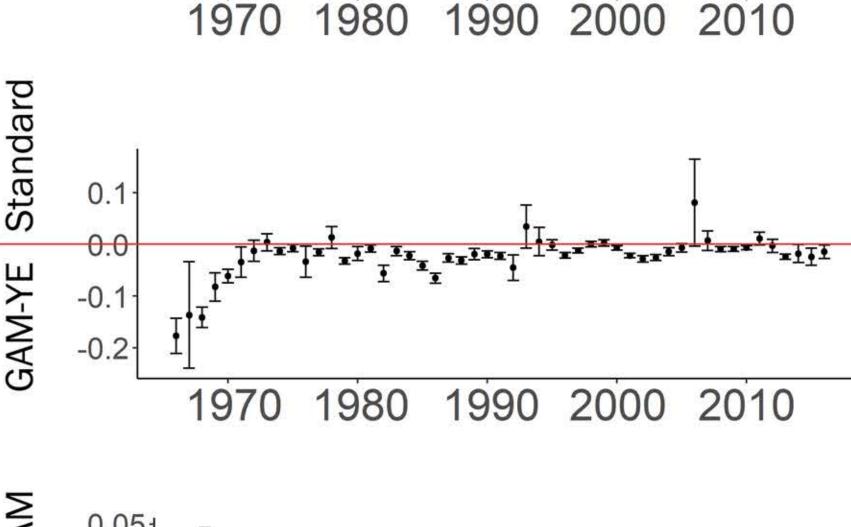
**Scaled Leave-one-year-out Cross Validation Statistic**

Worse Model

Better Model

618000  Standard
616000
614000  GAM
612000  GAMYE

**Mean Pairwise Differences of Leave-One-Year-Out Cross Validation Statistic**

GAM - Standard

GAM-YE - Standard

GAM-YE - GAM

1970 1980 1990 2000 2010 / Year

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