A Bayesian View of Party Systems

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Model

Notation

Observed in-parties at t:

$$y(t) \in \{l, r\}$$

Latent party system at t:

$$\sigma(t) \in \{L, R\}$$

Belief of $\sigma(t)$ given history h:

$$\theta_L(t|h) = \Pr(\sigma(t) = L|\{y(s)|s \leq h\})$$
$$\theta(t|h) = (\theta_L(t|h), 1 - \theta_L(t|h))$$

State Space Form

Measurement Equations:

$$\mu_{l|L} = \Pr(y(t) = l|\sigma(t) = L)$$
$$\mu_{r|L} = 1 - \mu_{l|L}$$
$$\mu_{l|R} = 1 - \mu_{r|R}$$

Transition Equations:

$$\tau_{L|L} = \Pr(\sigma(t+1) = L|\sigma(t) = L)$$
$$\tau_{R|L} = 1 - \tau_{L|L}$$
$$\tau_{L|R} = 1 - \tau_{R|R}$$

Filtering

$$\theta_L(t|y(t) = l) = \frac{\mu_{l|L}\theta_L(t|t-1)}{\mu_{l|L}\theta_L(t|t-1) + \mu_{l|R}(\theta_R(t|t-1))}$$
$$\theta(t|t) \propto M_{y(t)}\theta(t|t-1)$$
$$M_l = \begin{pmatrix} \mu_{l|L} & 0 \\ 0 & \mu_{l|R} \end{pmatrix}$$
$$M_r = \begin{pmatrix} \mu_{r|L} & 0 \\ 0 & \mu_{r|R} \end{pmatrix}$$

Predicting

$$\theta(t+s|t) = T^s\theta(t|t)$$
$$T = \begin{pmatrix} \tau_{L|L} & \tau_{L|R} \\ \tau_{R|L} & \tau_{R|R} \end{pmatrix}.$$

Smoothing

$$\theta_L(t|y(t+1) = l) = \frac{(\mu_{l|L}\tau_{L|L} + \mu_{l|R}\tau_{R|L})\theta_L(t|t)}{(\mu_{l|L}\tau_{L|L} + \mu_{l|R}\tau_{R|L})\theta_L(t|t) + (\mu_{l|L}\tau_{L|R} + \mu_{l|R}\tau_{R|R})\theta_R(t|t)}.$$

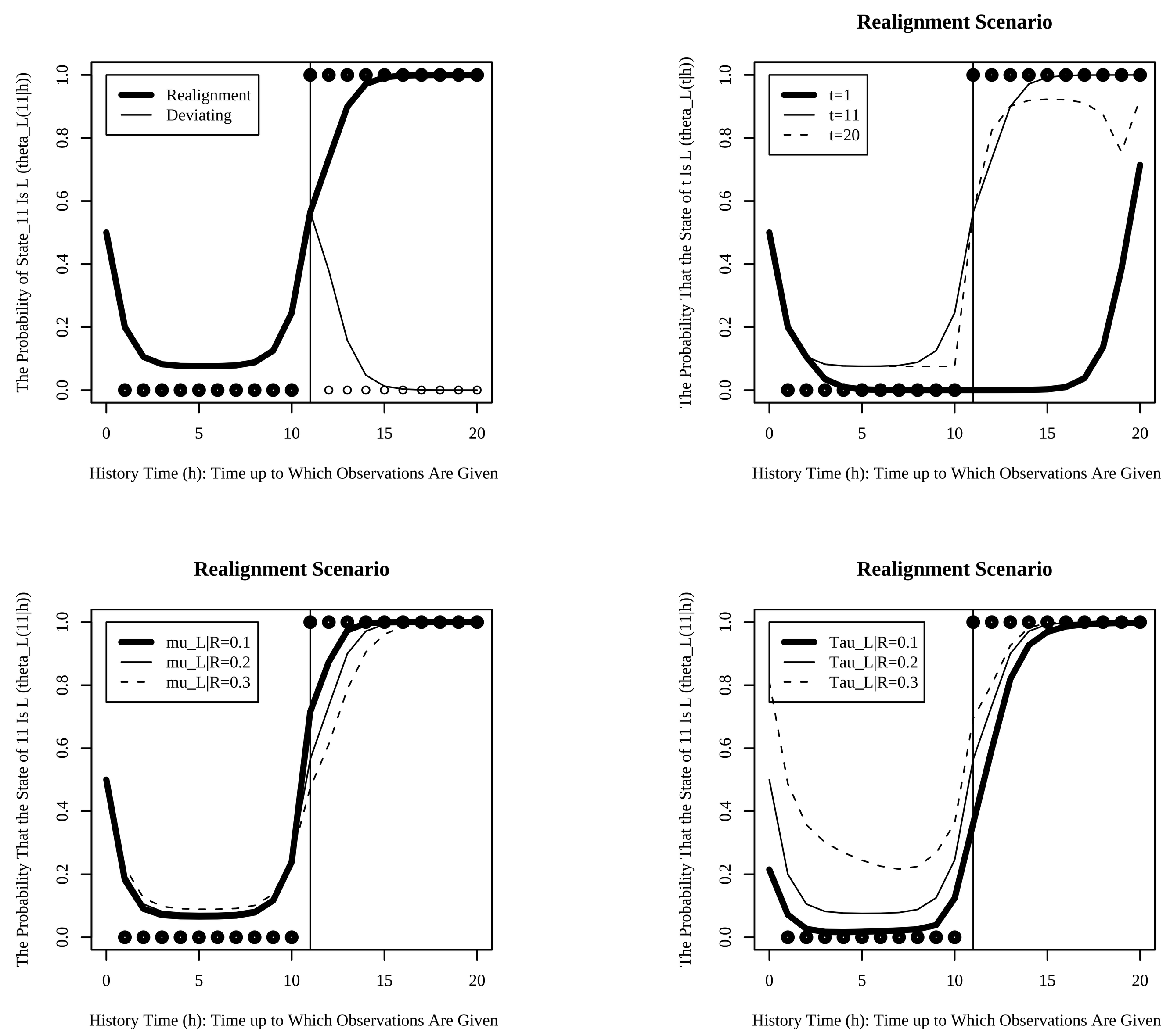
Thus,

$$\theta(t|t+1) \propto [M_{y(t+1)}T\Theta(t|t)]'(1,1)'$$
$$\Theta(t_1|t_2) = \begin{pmatrix} \theta_L(t_1|t_2) & 0 \\ 0 & \theta_R(t_1|t_2) \end{pmatrix}.$$
$$\theta(t|t+s) \propto [M_{y(t+s)}T^s\Theta(t|t+s-1)]'(1,1)'$$

Overview

This paper presents a Bayesian model to infer party system from sequence of actual in-parties, using state space form. The model assumes an unobserved and stochastic variable of party system which defines probabilities of each in-party (measurement equation). It also incorporates how often one party system changes to another (transition equation). After observing actual in-party, this Bayesian model updates prior belief about party system to obtain its posterior belief. The paper also provides a MCMC estimator using Kalman filter and applies it to the American party systems of the executive and both chamber of the legislature in both the federal and 50 state governments from Civil War to today. The results of U.S. President formally imply that the sixth party system began in 1968 or, at latest, 1980. The analysis also emphasizes uncertainty about party system during the Wilson, Eisenhower, Kennedy, Clinton and Obama administrations.

Examples



Estimation: MCMC

Priors

$$p(\tau) \sim Beta(\tau|t_0, t_1)$$
$$p(\mu) \sim Beta(\mu|m_0, m_1)$$
$$p(\theta(1|0)) \sim Beta(\theta(1|0)|s_0(0), s_1(0)).$$

Data Augmentation: sampling $\sigma(t)$'s.

Posteriors

Thanks to conjugacy between beta and Bernoulli distributions, posteriors are also beta:

$$p(\mu|y_1^n, \sigma_1^n)$$
$$\sim Beta(\mu|\Big(m_0 + \sum_{t=1}^n I(y(t) = \sigma(t))\Big), \Big(m_1 + \sum_{t=1}^n I(y(t) \neq \sigma(t))\Big))$$
$$p(\tau|y_1^n, \sigma_1^n)$$
$$\propto Beta(\tau|\Big(t_0 + \sum_{t=2}^n I(\sigma(t) = \sigma(t-1))\Big), \Big(t_1 + \sum_{t=2}^n I(\sigma(t) \neq \sigma(t-1))\Big))$$
$$p(\theta(1|0)|y_1^n, \sigma_1^n)$$
$$\sim Beta(\theta(1|0)|\Big(s_0(0) + 1 - \sigma(1)\Big), \Big(s_1(0) + \sigma(1)\Big))$$

Application: (United) States of America

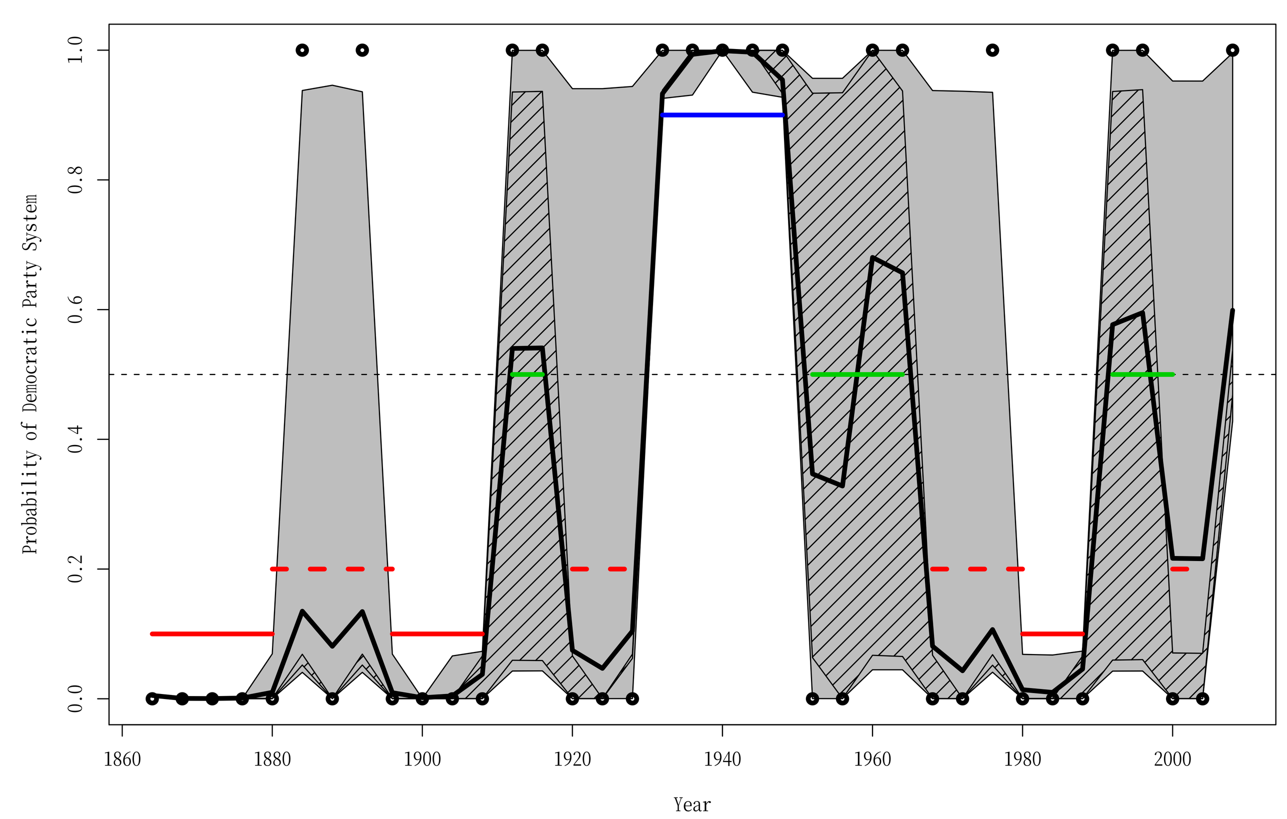
Data

- r and R are Republican, while l and L: Democratic
- Cicil War to Today
- 153 Chains = (Federal+50 States)$\times$(President/Governor, House, Senate)
- 9515 observations

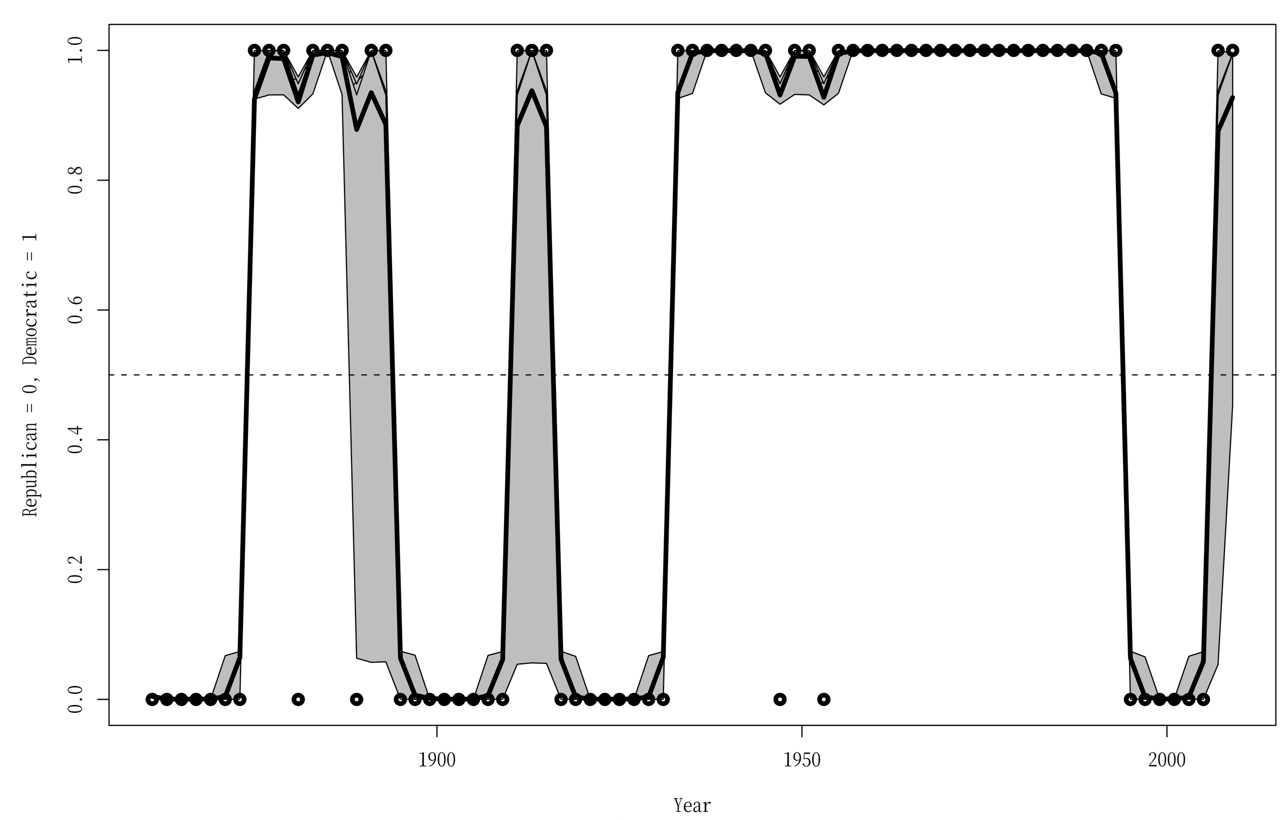
Results

	Mean	95% CI		Geweke	Heidel
μ	0.066	0.058	0.074	-2.160	0.609
τ	0.062	0.054	0.070	1.358	0.744

U.S. President



U.S. House



Washington Governor