Four Essays in Bayesian Inference for Political and Sociological Methodology

Inaugural dissertation submitted by Dominik Hangartner in fulfillment of the requirements for the degree of Doctor rerum socialium at the Faculty of Business, Economics and Social Sciences of the University of Bern.

Submitted by
Dominik Hangartner
from Altstätten, St. Gallen

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Abstract

This dissertation contains four essays in Bayesian modeling for the social sciences, with a strong emphasis on political science. Together, the four chapters highlight several advantages of Bayesian inference: the power of MCMC optimization techniques to explore highly non-concave posterior distributions when gradient-based hill-climbers fail (see Chapter 1), the availability of uncertainty estimates on virtually any parameter of interest as a simulation by-product (see Chapter 2), the possibility to include qualitative expert knowledge and to combine it with likelihood information in a rigorous and transparent way (see Chapter 3), and the use of priors to stabilize and regularize only weakly identified parameters (see Chapter 4).

The first chapter, which is based on a paper joint with Jeff Gill (Washington University in Saint Louis), focuses on statistical models for circular data. There has been no attention to circular (purely cyclical) data in political science research. In this chapter, we show that such data exist and is mishandled by models that do not take into account the inherently recycling nature of some phenomenon. Clock and calendar effects are the obvious cases, but directional data exist as well. We describe a regression modeling framework based on the von Mises distribution, develop a general Bayesian regression procedure for the first time, and provide an easy-to-use Metropolis-Hastings sampler for this approach. Applications include the analysis of U.S. domestic terrorism, and party preferences in a two-dimensional ideological space for the German Bundestag. The results demonstrate the importance of circular models to handle periodic and directional data in political science.

The second chapter, which is based on a working paper joint with Skyler Cranmer (University of North Carolina at Chapel Hill), applies a Reversible Jump Markov Chain Monte Carlo algorithm to estimate change points in time series data on public approval for candidates in US presidential elections. Bayesian change point models, in their most basic form, allow for the estimation of multiple change points whose locations are unknown. This is advantageous because it avoids the chief shortcoming of the indicator variable approach to modeling change points: that the locations of the change points must be known a priori. While the ability of Bayesian models to

estimate the location of change points is an improvement, researchers will often not know the number of change points to be estimated or have theoretical reasons for estimating a particular number of them. We build on previous implementations of the Reversible Jump Markov Chain Monte Carlo algorithm to create a stable, efficient, and straight forward way to estimate Bayesian change point models where both the number and locations of change points are estimated.

The third chapter, which is based on a working paper joint with Thomas Gautschi (University of Mannheim), develops and applies capture-recapture models to hidden human populations. Researchers' access to hidden populations such as e.g. drug users, sex workers and their clients, right-wing extremists, homeless people, or illegal immigrants is limited at best. Even the simple estimation of the size of such a population becomes a challenging endeavor. In this chapter, we discuss the estimation of a population size based on the fraction of individuals which are sampled only once and the subset of repeatedly sampled individuals – i.e. the capture-recapture model. We then generalize this basic capture-recapture model frequently used in biology and demography to allow for (i) multiple recapture stages and (ii) heterogenous populations via stratification and hierarchical random effects. In addition, we propose a Bayesian version of the capture-recapture model (iii) to improve on the estimation by incorporating qualitative expert knowledge. We apply these models to recently collected data on drug users visiting four low-threshold day centers in the city of Zurich (Switzerland). The results show both the relevance of the model extensions and the advantages of using Bayesian methods.

The fourth chapter, which is based on a working paper joint with Marco Steenbergen (University of Bern) and Catherine de Vries (University of Amsterdam), develops and empirically substantiates a heuristic-systematic model of electoral behavior, in which we understand vote choice as a two-stage decision making process. In the first stage voters use broad-based heuristics, such as partisanship, to narrow down all possible choice options to a few viable choices. This subset of choice alternatives constitutes the choice set. In a subsequent second stage voters engage in more systematic processing behavior using campaign issues to select a final alternative from the choice set. We apply these ideas to the 1992 US presidential elections and introduce a choice set logistic regression (CSLR) model which allows for the examination of both stages of electoral choice. The empirical results demonstrate that the heuristic-systematic model of electoral choice allows us both to better understand the electoral competition between Bush, Clinton and Perot in 1992 and to discover which voters are more inclined to consider more than one choice option. Consequently, this study has important implications for students of voting behavior and electoral competition and enriches our understanding of voters' choices in third- or multi-party races.