Examining deterrence of adult sex crimes: A semi-parametric intervention time-series approach

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ABSTRACT

Motivated by recent developments on dimension reduction (DR) techniques for time-series data, the association of a general deterrent effect with the registration and notification (SORN) policy of South Carolina (SC) for preventing sex crimes was examined. Using adult sex crime arrestee data from 1990 to 2005, the idea of a central mean subspace (CMS) is extended to intervention time-series analysis (CMS-ITS) to model the sequential intervention effects of 1995 (the year SC's SORN policy was initially implemented) and 1999 (the year the policy was revised to include online notification) on the time-series spectrum. The CMS-ITS model estimation was achieved via kernel smoothing techniques, and compared to interrupted auto-regressive integrated time-series (ARIMA) models. Simulation studies and application to the real data underscore our model's ability of achieving parsimony, and of detecting intervention effects not earlier determined via traditional ARIMA models. From a public health perspective, findings from this study draw attention to the potential general deterrent effects of SC's SORN policy. These findings are considered in light of the overall body of research on sex crime arrestee registration and notification policies, which remain controversial.

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1. Introduction

Sexual abuse and sex-related crimes are a major public health burden in the United States (US). Because many of these assaults go unreported and unrecognized, this situation has been rightfully termed a 'silent–violent' modern epidemic. The consequences of sexual abuse are far reaching, and include increased risk of physical and mental health problems for victims (Boney-McCoy and Finkelhor, 1996; Letourneau et al., 1996). Massive fiscal costs are incurred on society as a direct result of these crimes and their consequences (Post et al., 2002). Consequently, prevention of sexual violence has been a public health priority for decades (Mercy et al., 1993).

Yearly rates/counts of any criminal arrests yield autocorrelated time-series data, where the major objective is to infer something about the conditional distribution (or moments) of the current observation given the past value(s) for studying the underlying dynamics and providing efficient future forecasts. In an attempt to reduce sexual recidivism rates of targeted sex crime arrestees (i.e., specific deterrence) and rates of first-time sex arrests by potential perpetrators (i.e., general deterrence), the US relies mainly upon state-wide sex crime arrestee registration and notification (SORN) policies, or interventions. In this context, evaluating the effectiveness of these interventions for criminal justice settings (Loftin et al., 1983;

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McCleary and Hay, 1980; Vásquez et al., 2008) are typically handled through an interrupted/intervention time-series (Box and Tiao, 1975) approach, which discriminates between the behavior of the time series 'before' and 'after' the intervention (possibly known, or unknown). A growing body of research suggests that SORN policies fail to reduce sexual recidivism (Letourneau and Levenson, 2010). Moreover, research on the SORN policy of South Carolina (SC) further indicates that registration and notification were each associated with significant and substantial increases in plea bargains, and online notification was associated with significant reductions in findings of guilty for adult sex crimes (Letourneau et al., 2010a). Sometimes, these policies resulted in much harsher consequences. For example, SC's SORN policy subjects arrestees convicted of virtually any sex crimes to lifetime registration and lifetime notification requirements, which since 1999 have included online notification. There are no mechanisms to reduce the duration of the requirement or to remove oneself from the online registry. Because general deterrent effects depend, in part, on the certainty and noxiousness of the consequence (Wikström, 2008), it is conceivable that harsher and more widely applied SORN policies such as SC's policy might exert general deterrent effects.

In an evaluation of the general deterrent effect of SC's SORN policy, Letourneau et al. (2010b) conducted a univariate Box–Jenkins interrupted auto-regressive integrated moving average (ARIMA) analysis (Box et al., 1994) to understand the general deterrence of SC's SORN policies on sex crime arrestees, separately for the initial implementation of registration in 1995 and the subsequent implementation of online notification in 1999. They reported a significant intervention effect for 1995, but not for 1999. In comparison to first-time sex crime arrests from 1990 to 1994 (i.e., prior to initial implementation), results indicated an approximately 11% reduction in first-time sex crime arrests in the post-SORN period from 1995 to 2005. This decline equated to averting approximately three new sex crime arrests per month. This finding supports the argument that harsher more widely applied SORN policies can achieve a general deterrent effect. However, it seems counter-intuitive that online notification would fail to enhance a general deterrent effect, given that this mechanism equates with public shaming of arrestees who themselves attribute serious consequences to public notification, including loss of employment, housing, friends, and support of family (Levenson and Cotter, 2005; Wikström, 2008). We argue that Letourneau et al. (2010b)'s original study was limited in that the separate analysis of registration versus notification implementation might not have captured a sequential (and progressive) effect of these interventions. Moreover, their analyses adhered to traditional Box–Jenkins intervention ARIMA models and did not consider investigating the relevancy (or redundancy) of the information content of the time-series inputs (past values of the series) to arrive at a desirable prediction/forecasting model (Lendasse et al., 2001).

Our current focus in this paper is to examine the general deterrence of SC's SORN policy via nonlinear intervention time-series models, overcoming the limitations mentioned above. Driven by the primary goal of forecasting, development of nonlinear time-series models (such as our case of intervention time series which might include features such as nonlinearity, asymmetric cycles, conditional heteroscedasticity) took both parametric (Tiao and Tsay, 1994) and nonparametric regression routes (Tong, 1995; Härdle et al., 1997; Cai et al., 2000; Fan and Yao, 2003). In the quest of *reducing* the number of time-series input variables without sacrificing information and achieving parsimony, Park et al. (2009) considered a formal dimension reduction (DR) technique through a *central mean subspace* (CMS) as a viable nonparametric alternative for nonlinear time-series analysis, motivated by the approach adopted by Cook and Li (2002) for regression. For a typical time series x_t, where the focus is deriving inference on the conditional distribution $x_t | \mathbf{X}_{t-1}$, where $\mathbf{X}_{t-1} = (x_{t-1}, x_{t-2}, \ldots, x_{t-p})^T$ for some $p \geq 1$, this DR approach focuses on the conditional mean function $E(x_t | \mathbf{X}_{t-1})$ instead of the *time-series central subspace* (TSCS) (Park et al., 2010) which studies the dependence of x_t on $\mathbf{X}_{t-1}$. We follow that route in establishing a CMS for nonlinear time series (CMS-ITS) analysis of SC's sex crime activities which provides an unified framework to accommodate multiple interventions/changepoints, and seek parsimony in using time-series inputs for attaining reliable forecasts.

The paper proceeds as follows. Section 2 provides further details of the motivating dataset. Section 3 develops the CMS-ITS methodology and the estimation strategies. In Section 4, we present a small numerical study to assess the performance of CMS-ITS for various types of intervention and change in the mean function, and also apply the methodology to determine the effect of SC's SORN policy on general deterrence. Section 5 discusses the salient features of our methodology with some concluding remarks.

2. Motivation: data

The data on SC's sex crime arrestees were extracted from SC's computerized criminal history records (CCHR) with assistance from the SC Budget and Control Board, Office of Research and Statistics. The CCHR data originated from individual precincts and courts, where initial charges were filed and adjudication decisions rendered, respectively. This information was forwarded to the SC Law Enforcement Division and added to the CCHR database. The current analysis focuses on first (initial) arrests for sex crimes by adult male arrestees (defined as 18 years of age or older) that occurred between 1 January 1990 and 31 December 2005. To capture general deterrence, any second (and subsequent) sex crime by an arrestee within this time span was dropped, retaining only their first crime arrest. This resulted in 19,060 unique arrestees with a mean age (standard deviation) of 33.96 (11.00) years, with race composition as 53.3% Whites, 44.3% African-Americans, and 2.4% others. Hence, our time-series data spans the period from 1990 to 2005: we record average annual charges (or rates) for sex crime arrests per 10,000 adult male population. Population estimates were obtained from SC's Community Assessment Network population data tables, available at http://scangis.dhec.sc.gov/scan/index.aspx. Fig. 1 plots the time-series profile of the rate of sex crime arrests, decomposed into trend, seasonal, and error terms. Visual inspection reveals that the crime rates after 1995 appear to be smaller than those before 1995. There is also the effect of the internet-based notification of