

Disaggregating Crime Statistics via Bayesian Regression

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1. Introduction

Crime is a major concern of any civilized society. In the Philippines, media reports have led the public to construe that the frequency of crimes are on the rise. Government has intensified its efforts to monitor and curb crime. This paper shows that, over the years, there has actually been a decrease in crimes for the (15) regions of the country. Some regions existed fairly recently than others so that a yearly comparison across the different regions is not actually possible. Crime statistics for these recently established regions are imputed via Bayesian regression modeling.

2. Modeling Gaps in Official Crime Statistics

Official crime statistics for selected regions of the country are listed in Table 1 (for more data details see, e.g., Albert and Solosa, 2000). Note that the Autonomous Region of Muslim Mindanao (ARMM), its land being allocated from selected areas of Regions IX and XII, came into existence only in 1991. Hence, for 1989 and 1990, the listed values for Regions IX and XII (as indicated by *) actually comprise the combined crime statistics of the region, plus shares taken from the ARMM. These values should be adjusted to represent the existing political divisions, as well as to provide disaggregated levels for the ARMM.

Table 1. Crime Statistics per Region from 1989 to 1995

Region	1989	1990	1991	1992	1993	1994	1995
IX	193*	199*	193	156	142	161	145
XII	181*	158*	150	157	149	169	204
ARMM	NA	NA	90	69	61	64	42

Note that when considering the logarithm of the crime statistics per region, a linear pattern across time is apparent. That is, we may assume that $y = \mathbf{a} + \mathbf{b}t$, where t denotes time and y the log crime statistics. Assuming that the structural parameters α and β of this regression model vary across regions, these parameters may be viewed as random variables with a prior and posterior distribution.

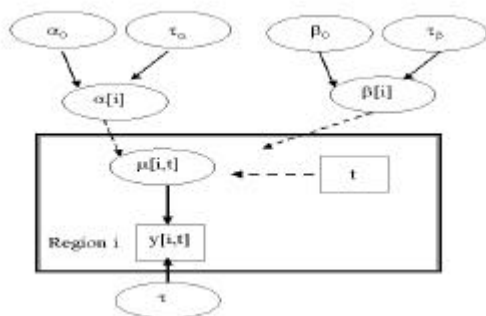


Figure 1. Directed Acyclic Graph (DAG) for log crime statistics per region

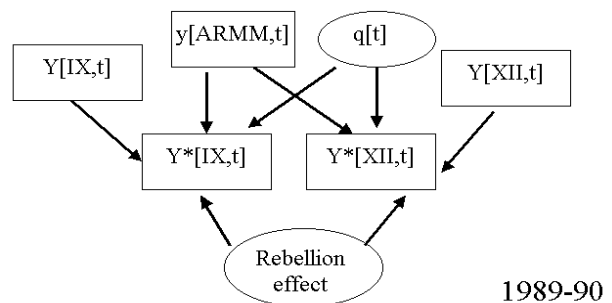


Figure 2. Graphical representation of latent crime statistics in Regions IX, XII and ARMM for 1989-90

The Directed Acyclic Graph (DAG) in Figure 1 describes a Bayesian hierarchical model for the crime statistics data. Although the crime statistics for Regions IX, XII and ARMM in 1989 and 1990 are latent (cf. Figure 2), estimates of their respective posterior distributions may be obtained say, thru Markov Chain Monte Carlo simulation (see, e.g. Gilks, *et al.* 1996).

Table 2 lists the resulting the summary statistics of the posterior distribution of the desired latent crime statistics. A useful set of point estimates of the latent crime statistics would be the antilogs of their respective posterior medians, the estimates indicated in the last column, which can be used as adjustments to the data in asterisks listed in Table 1 earlier, as well as the missing data for the ARMM.

Table 2. Summary Statistics of Posterior Distribution of Latent Log Crime Statistics

Region	Year	Mean	St. Dev.	MC Error	Median	Exp(Median)
IX	1989	5.328	0.2398	0.003280	5.326	206
	1990	5.260	0.2142	0.003069	5.260	192
XII	1989	4.966	0.2608	0.003598	4.967	144
	1990	4.998	0.2146	0.003175	4.999	148
ARMM	1989	4.788	0.2388	0.003446	4.786	120
	1990	4.633	0.2544	0.003873	4.246	70

Note that the computed value for Region IX during 1989 is significantly higher than the value indicated in Table 1, suggesting a possible underreporting of crimes here. Further inspection and evaluation of the posterior means and medians of the parameters revealed that, except for Regions II and XII, all regional crime rates have decreasing trends over the years. While there is much uncertainty regarding the crime statistics in the different regions, Regions II and XII do not appear to have very good rates of change in log crime rates, while Regions V, VI, VII, VII, X and XI have considerable improvements in the rate of change in their crime rates.

3. Concluding Remarks

In effect, the results seem to refute the public impression that, over the years, crimes have become rampant in the country. Perhaps, the past and present anti-crime programs have been effective enough in curtailing the over-all increase of crime. Nevertheless, a further examination must be done on the crime situation of Regions II and XII, and newer, more effective programs must still be implemented in the future to further lessen criminality in the Philippines.

REFERENCES

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