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Breaks and Convergence in U.S. Regional Crime Rates: Analysis of Their Presence and Implications

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Abstract: The literature examining the relative properties of U.S. regional crime rates is extended. Using a novel method, convergence in alternative classifications of crime is detected over the period 1965 to 2009. Subsequent statistical analysis identifies distinct epochs in the evolution of crime which match those noted anecdotally in the literature. The findings concerning convergence within these epochs prove interesting, with results found to vary both between the alternative crime classifications and through time. In particular, evidence of divergence is noted which contrasts starkly with other results for earlier and later periods. Potential explanations for the observed results, their importance for policy and their implications for theory and future research are discussed.

Keywords: crime; convergence; breaks

1. Introduction

Recent research in the criminology literature has concerned the extent to which there is a ‘national trend’ present in geographically disaggregated crime rates in the United States of America.¹ Clearly the extent to which regional crime rate data exhibit similarities (or differences) has implications for both whether crime fighting policies should operate at a national or regional level, and also the relative

¹ It should be noted that the term ‘trend’ is clearly not being used here in its statistical sense, but rather refers to a shared pattern or similarity.

importance of theories emphasising the role of local or national factors. To explore the issue of a potential similarity in crime rates, a range of approaches has been considered including consideration of potential similarities between crime and its possible explanatory factors across alternative regions (see [1,2]), the extent to which modelling methods capture similar properties in city-level homicide rates ([3,4]) and ranking and correlation analyses of state level crime data [5,6]. Beyond these studies, an interesting difference in the stance taken towards the issue of a national trend is provided by the studies of [7,8]. While the former considers the extent to which a national trend exists in regional crime series, the latter study views differences in levels of criminal activity in alternative regions as evidence that it cannot be present. Consequently, the issue explored by [8] is not whether a trend is *present*, but instead whether it is *emerging*. Using regression methods and measures of variation, the study provided evidence in support of the hypothesis of convergence in regional crime rates.

The present study extends the existing analysis of convergence in regional crime rates in two regards. First, a more informative method is employed which allows direct examination of the probabilities of high and low growth rates in crime across regions. Second, the analysis considers the issue of potential breaks in crime rate series to permit sub-sample analysis. This formalises discussion of changes in the evolution of crime noted anecdotally in the literature (see [9–13]). With three clear epochs in the evolution of crime identified, the second extension of the existing literature is provided by the analysis of convergence within these distinct periods.

To achieve its objectives, this paper proceeds as follows. In Section 2, the relevant previous literature concerning the presence of a national trend in U.S. crime data is considered and the manner in which the current study extends this research is outlined. In Section 3 the data to be examined are discussed, along with the method utilised to identify alternative sub-samples of differing behaviour within the overall sample available. Section 4 presents the statistical method employed to examine the presence of convergence in regional crime series. The approach employed essentially examines whether there is evidence of a ‘catching up effect’ across regions, with those with initially lower (higher) crime rates experiencing higher (lower) growth in crime. Obviously, it possible that statistically insignificant results may be obtained, as might evidence of divergence via the observation of regions pulling further apart. Section 5 presents and discusses the results of the empirical analyses, with Section 6 providing concluding remarks.

2. Previous Research on the ‘National Trend’ in U.S. Crime Rates

From an inspection of the literature exploring potential linkages between crime and its various possible determinants, it is apparent that empirical analysis has been conducted at a variety of levels of aggregation. At one end of the disaggregation spectrum, many studies have employed national data (see, *inter alia*, [14–18]), while examples of research at the other end of the spectrum include the studies of [19–24] which undertake highly regionally disaggregated analyses for Florida, Seattle, North Carolina and New York State respectively. Clearly, it is possible that studies which have utilised national level data may have missed potential variation, and hence information, present in disaggregated series. This point is recognised by [7] where the extent to which a national trend exists in U.S. crime rates, and the hence this issue is of relevance, is considered.

Before undertaking their own analysis, [7] note the limited support for the presence of a national trend in U.S. crime rates provided in the earlier studies of Cork [3,4]. Moving beyond the analysis of homicide only presented in the above studies, [7] consider the seven major classifications of criminal activity (homicide, rape, robbery, assault, burglary, larceny, motor vehicle theft) for 139 U.S. cities. The results obtained from application of a vector autoregressive (VAR) model provide limited evidence of a national trend, with national factors estimated to explain roughly between one-fifth to one-third of the variation in changes in city-level crime rates.

In addition to the work of [7], further research has considered the relative properties of regional crime series. Using simple correlation analysis, [5] explores the relationships between national and state level crime rates for violent and property crimes. The high degrees of correlation noted are taken as evidence of a similarity in behaviour of crimes across regions. However, such results have to be interpreted with care given the nature of correlation and the misleading impression it can generate (see [25] for a more recent discussion of this issue). In contrast, [6] employs ranking techniques and panel data analysis to examine state-level crime rates, finding limited evidence of a similarity in behaviour of regional crime rates, with the downturn of the early 1990s downturn experienced by some, but not all, States.

Given the above analyses which have provided limited evidence of the *presence* of a national trend in U.S. crime rates, [8] have explored the issue of whether a national trend might be *emerging*, if not present already. Using Barro-Baumol regressions (see [26,27]) and analysis of cross-sectional variation, [8] provided clear evidence of convergence in measures of criminal activity using state-level data. The detection of convergence in crime rates has clear importance and implications. Clearly, the presence of a national trend provides support for criminological theories emphasising the importance of national factors in the determination of criminal activity (see, *inter alia*, [28]) and the importance of national, rather than local, crime-fighting policies. Consequently, *convergence* in crime rates suggests an increasing relevance of these issues as a movement towards a national trend occurs. Further to this, evidence of convergence in crime rates relates directly to a number of theories. For example, while convergence supports modernization theory which predicts a drawing together of crime rates, it undermines conflict theory which predicts their divergence (see [18] for a discussion). Similarly the presence or absence of convergence can be drawn upon to evaluate theories such as the Gastil-Hackney thesis (see [29,30]) which suggests differing levels of criminal activity in alternative regions (in this case, higher rates of violent crime in Southern States).

In the present study the issue of convergence is revisited, with the seminal analysis of [8] extended using an alternative more informative statistical method and consideration of sub-samples relating to perceived differing eras in the evolution of criminal activity.

3. Data and the Samples

Before an empirical analysis of variation in regional crime rates can be undertaken, a decision is required concerning the level of geographical disaggregation of the data to be employed. In the current study, the analysis is undertaken at the level of States. Justification for this level of regional disaggregation is provided by (i) their clear importance in the judicial process (see [31]), (ii) their use in a variety of empirical studies (see, *inter alia*, see, for example, [2,5,6,29,32–42]) and (iii) support as

the appropriate level of regional disaggregation in the analysis of [43]. For each of the 50 States, seven classifications of criminal activity are examined, these being murder, rape, robbery, assault, burglary, larceny and motor vehicle theft. In all cases, the data are measured in per capita terms per 100,000 inhabitants over the period 1965 to 2009.

The sample considered is one that has been noted anecdotally in the literature as containing marked differences in the evolution of criminal activity. More precisely, it has been argued to exhibit three distinct epochs with rapid increases in criminal activity from the 1960s followed by a period of stability from around 1980 and a subsequent downturn from the early to mid 1990s (see [9–13,44]). In response to this informal discussion, the current analysis draws upon [45] and [46], employing a simple dating technique to identify breaks or turning points in the series considered. This rule can be expressed as follows:

Peaks: An observed value for a crime series in period t , denoted c_t , is classified as a peak if (i) $c_t \geq c_{t-1} > c_{t-2} > c_{t-3}$ and (ii) $c_t \geq c_{t+1} > c_{t+2} > c_{t+3}$.

Troughs: An observed value for a crime series in period t , denoted c_t , is classified as a trough if (i) $c_t \leq c_{t-1} < c_{t-2} < c_{t-3}$ and (ii) $c_t \leq c_{t+1} < c_{t+2} < c_{t+3}$.

Therefore, the above rules deem a peak to occur when crime is higher than values observed two and three years prior to (and ahead of) it, and greater than or equal to values witnessed a year either side of it. Troughs are clearly defined in a similar, but opposing, manner. Application of this method to national data for the U.S. as a whole resulted in the identification of a clustering in the dating of peaks in the alternative classifications of crime, as presented in Table 1. Given the very close correspondence of these with the anecdotally noted changes in the evolution of crime discussed in the literature, these are taken as breakpoints or appropriate dates at which to split the overall sample available. Table 1 shows that all series aside from burglary exhibit three clear regimes or epochs in their evolution, with a first break around 1980 and a second in the early 1990s. These sub-samples are referred to as Samples I, II and III respectively. Possible explanations for these breaks and the differing behaviour of burglary are provided in Section 5.

Table 1. Identifying Regimes in the Evolution of Crime.

Crime Series	Sample I	Sample II	Sample III
Murder	1965–1980	1981–1991	1992–2009
Rape	1965–1980	1981–1992	1993–2009
Robbery	1965–1981	1982–1991	1992–2009
Assault	1965–1980	1981–1992	1993–2009
Burglary	1965–1980	1981–2009	N/A
Larceny	1965–1980	1981–1991	1992–2009
Motor Theft	1965–1979	1981–1991	1992–2009

4. A Probabilistic Approach to the Analysis of Convergence

Potential convergence in crime rates was considered in [8] in two ways. First, they explored the issue of whether there is a ‘catching-up effect’ in the form of States with lower (higher) initial levels of crime experiencing higher (lower) growth rates. This involved the use of Barro-Baumol regressions

with growth rates for States regressed upon initial levels of criminal activity, with a negative and significant coefficient on the latter term taken as evidence of convergence. Second, it was examined whether the cross-sectional variation in crime narrowed through time by plotting the coefficient of variation of the alternative crime classifications for each of the sample years. The results of this analysis for the full sample considered provided broad support for the presence of convergence. Repetition of the analysis over five equally sized sub-samples produced mixed results.

In the current study, the analysis of [8] is extended in two major regards. First, as has been noted above, a clear strategy for defining sub-samples is adopted leading to the identification of distinct epochs in the evolution of crime matching those noted anecdotally in the literature. Second, an alternative method of analysis is employed which allows the potential linkages between growth rates and initial levels of criminal activity, and hence convergence, to be viewed more closely. A particularly attractive feature of the method is that it partitions growth rates and initial levels into high and low components allowing the capture of any potential underlying asymmetries. Alternatively expressed, it may be that it is not growth rates or initial levels in aggregate that are important, but perhaps just their high or low components. The method employed allows these possibilities to be explored.

Drawing upon [47], the method utilised can be explained as follows. First, growth rates and initial levels of crime are both split into two regimes on the basis of whether they are above or below the average value for the 50 States considered. Denoting the growth rate and initial level of crime for a particular region as G and I respectively, and using the subscripts L and H to represent low and high regimes, the following four terms arise: G^L , G^H , I^L and I^H . With these terms given, it is then considered whether the probability of low and high growth rates are influenced by low and high initial levels. To achieve this, the *unconditional* probability of high (low) growth is considered in relation to its probability *conditional* upon either high or low initial values. More formally, the unconditional probability $\pi = \text{prob}(G^i)$ is compared to the conditional probability $\pi^c = \text{prob}(G^i|I^j)$ for $i, j = L, H$, where:

$$\text{prob}(G^i|I^j) = \frac{\text{prob}(G^i \cap I^j)}{\text{prob}(I^j)} \quad (1)$$

To examine formally whether there exists a significant difference between these probabilities, the following test statistic is constructed:

$$Z = \frac{\pi^c - \pi}{\sigma} \quad (2)$$

where

$$\sigma = \sqrt{\frac{\pi(1 - \pi)}{T}} \quad (3)$$

and T denotes the sample size involved. Rejection, or non-rejection, of the 'no convergence' null hypothesis $H_0: \pi = \pi^c$ is determined via comparison of the resulting test statistic with the appropriate critical value from the standard Normal (Gaussian) distribution. Clearly, the sign of the Z -statistic is of crucial importance when considering potential convergence, with the sign required dependent upon which of the four possible pairings of $\{G^i, I^j\}$ is considered. Using the current present notation,

convergence requires a positive Z -statistic when $i = j$ for the pairing $\{G^i, I^j\}$, while negative sign is required when $i \neq j$.

5. Results

The calculated Z -statistics and their corresponding two-sided p -values obtained from analysis of the full sample of observations (1965–2009) are presented in Table 2.² The immediately apparent feature of these results is that overwhelming evidence of convergence is present with all classifications returning test statistics which are of the required sign for convergence and statistically significant (the p -values lie between 0.03 and 0.00). Considering these results in more detail, there is a general tendency for greater evidence of convergence as a result of high initial levels leading to an increased (decreased) probability of low (high) growth, rather than low levels reducing (increasing) the probability of low (high) growth. An exception to this is provided by the ‘rape’ classification where the opposite outcome is observed. It should be noted that this classification provides the most significant overall evidence of convergence. The conclusion here is that as crime has increased through the 1960s and 1970s ahead of a slowdown in the 1980s and decrease in the 1990s, the differing crime rates observed across regions have narrowed. What can be examined now via consideration of sub-samples is whether this observed behaviour of highly significant convergence is apparent during these markedly different periods in the evolution of crime.

Table 2. Convergence in crime.

Crime Series	G^L, I^L	G^L, I^H
Murder	−1.79 (0.04)	2.47 (0.01)
Rape	−5.01 (0.00)	4.63 (0.00)
Robbery	−2.94 (0.00)	5.22 (0.00)
Assault	−1.75 (0.04)	2.62 (0.00)
Burglary	−3.10 (0.00)	3.64 (0.00)
Larceny	−4.48 (0.00)	4.85 (0.00)
Motor Theft	−2.61 (0.01)	4.25 (0.00)

Note: p -values are given in parentheses.

Turning to the results for sub-sample analysis presented in Table 3, it is clear that the overwhelming evidence of convergence for all classifications over the full sample masks some interesting variations

² By construction, the value of the Z -statistic for $\{G^L, I^L\}$ will be of opposite sign but equal absolute value to that for $\{G^H, I^L\}$. The same property holds for $\{G^L, I^H\}$ and $\{G^H, I^H\}$. This is straightforward to prove, with a proof available from the authors upon request. For this reason, results are presented for $\{G^L, I^L\}$ and $\{G^L, I^H\}$ only as other values can be inferred.

present at different points in time. Considering the first sample corresponding to the ‘crime boom’ of [10], the signs of the derived test statistics and their *p*-values indicate that convergence is apparent for nearly all classifications of crime. The exceptions to this are ‘rape’ for which marginal significance is apparent and ‘robbery’ where insignificant results are observed. From direct examination of the data this is not surprising as a number of regions start this period with high crime levels of crime and experience high growth throughout the sub-sample (examples of this are California, Illinois, Maryland, Michigan, Nevada, New York), while a number of other regions start and stay ‘low’ with low growth rates exhibited (for example Maine, New Hampshire, North Dakota, South Dakota and Vermont). However, at the same time these findings are not quite sufficient to result in a detection of divergence.

Table 3. Sub-sample analysis of convergence in crime.

Crime Series	Sample I		Sample II		Sample III	
	G^L, I^L	G^L, I^H	G^L, I^L	G^L, I^H	G^L, I^L	G^L, I^H
Murder	-1.50 (0.07)	2.08 (0.02)	0.85 (0.20)	-0.93 (0.18)	-2.72 (0.00)	3.46 (0.00)
Rape	-1.12 (0.11)	1.13 (0.13)	-2.89 (0.00)	4.33 (0.00)	-1.87 (0.03)	2.38 (0.01)
Robbery	-0.99 (0.16)	1.76 (0.04)	0.85 (0.22)	-1.28 (0.10)	-3.37 (0.00)	5.05 (0.00)
Assault	-2.39 (0.01)	3.58 (0.00)	-0.55 (0.29)	0.51 (0.31)	-1.09 (0.14)	1.27 (0.10)
Burglary	-1.83 (0.03)	2.15 (0.02)	-1.75 (0.04)	1.61 (0.05)	N/A	
Larceny	-4.77 (0.00)	5.17 (0.00)	-1.69 (0.05)	2.34 (0.01)	-2.47 (0.01)	2.90 (0.00)
Motor Theft	-1.71 (0.04)	2.79 (0.00)	0.79 (0.22)	-1.00 (0.16)	-3.84 (0.00)	4.16 (0.00)

Note: *p*-values are given in parentheses.

At this point it is perhaps appropriate to next consider the findings for the third sub-sample as the results are straightforward to interpret. At this point a period during which crime declines substantially is considered. During this era convergence is apparent in all series albeit that those for ‘assault’ are at best marginal using a two-sided approach to hypothesis testing.³ The interpretation here is then that as crime fell, differences in the levels for alternative regions narrowed or, alternatively expressed, the regions moved closer together. Again, an asymmetry is present in the form of high initial values having greater impact than lower initial values upon the probabilities for growth rates of the necessary direction for convergence. The results for the second sub-sample prove the most interesting in terms of variation across the alternative classifications of crime. Considering violent crimes, while the results for ‘assault’ are insignificant, the results for ‘rape’ provide strong evidence of convergence. However, the most interesting results for the component series are those for ‘murder’ and ‘robbery’ where the signs of the test statistic indicate divergence. While the results for the two series are not significant at

³ As burglary exhibited just one break, results for only two sub-samples are available. However, in the second of the identified samples for this series, convergence is overwhelming.

conventional levels of significance, there is marginal evidence of significance, particularly for 'robbery'. A major factor to consider during this period is the emergence of the crack cocaine epidemic and its noted impact upon violent crime, particularly 'murder' (see [48]). From inspection of the results obtained, it can be argued that this has impacted upon the distribution of crime with regions with high (low) levels of crime pulling further above (below) other regions. With regard to property crime, the convergence is witnessed for 'burglary' and 'larceny', but not for 'motor vehicle theft'. The results for this series are similar in nature to those for 'murder' and 'robbery': the test statistics have signs depicting divergence, but fail to prove significant.

Reasons for the breaks or changes in the evolution in criminal activity have been discussed by [49]. These factors included increased arrest rates, improved policing strategies from the early 1980s, enhanced drug enforcement strategies, increased incarceration, decreased alcohol consumption and the ending of the crack cocaine epidemic of the 1980s (see, *inter alia*, [3,10,13,44,48,50]). These factors provide an explanation for the changes in the behaviour of crime and the resulting distinct epochs in its evolution. However, a further issue to consider is the presence of just two regimes for burglary which contrasts with all other series. Some understanding of this is available via the noted differing responses of violent and property crimes to the various policies and initiatives discussed above (see [19,20,23]).

6. Concluding Remarks

The current analysis has revisited the issue of convergence in U.S. crime rates, extending the existing literature in two regards. First, a new method was employed. Second, a statistical dating method was utilised to identify distinct eras in the evolution of crime, thus permitting a sub-sample analysis supported by anecdotal discussion in the literature. The general conclusion drawn from the present analysis was that differences in crime rates have narrowed over time, with convergence present. However, the use of sub-sample analysis showed marked differences in the behaviour of alternative crime through time. In particular, it was seen that while all crime classifications exhibited convergence during the crime boom of from the 1960s to the early 1980s, and the crime decline witnessed from the early to mid 1990s, the intervening period produced differing results. Interestingly, while the period could be viewed as a period of stability following the preceding period of rapid increases in crime, this masked and absence of convergence, and in some cases, divergence in crime rates. In particular, while the property crimes 'burglary' and 'larceny' exhibited convergence, as did 'rape', other violent crimes ('murder' and 'robbery') produced test statistics corresponding to divergence. Similarly, 'motor vehicle theft' provided significant test statistics corresponding to divergence.

Considering the implications of the results obtained, the findings for the full sample suggest the growing relevance of theories emphasising national factors underlying the evolution crime and the use of national, rather than local, crime-fighting policies. However, the results show this inference has to be considered with caution as it does not hold for all classifications across all sample periods. This is most relevant for violent crimes for which evidence more suggestive of divergence were witnessed. In summary, the present study shows that while discussion of crime convergence is appropriate in general, it has to be qualified according to the specific form of crime and sample period considered.

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Conflicts of Interest

The authors declare no conflict of interest.

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