

# Journal of Criminal Law and Criminology

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Volume 59 | Issue 1

Article 4

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1968

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### Recommended Citation

Philip C. Sagi, Charles F. Wellford, Age Composition and Patterns of Change in Criminal Statistics, 59 J. Crim. L. Criminology & Police Sci. 29 (1968)

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## AGE COMPOSITION AND PATTERNS OF CHANGE IN CRIMINAL STATISTICS\*

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In an attempt to provide a more accurate view of the increase in recorded crime during the period 1958-1964, the authors calculated age specific, offense specific crime rates. The analysis of the rates indicate that 30-50% of the increase in absolute crime over the years 1958-1964 can be attributed to changing age structure in the U.S.A., and that any measure of crime patterns must be interpreted with caution due to the presence of a two year cycle in rates of recorded crime. The remainder of the article discusses some structural correlates of this periodicity in crime rates.

The volume of criminal offenses in a population may be expressed in terms of three factors. These are: the productivity of criminal offenses per person at each age (the age specific offense schedule), the age structure or the proportion of the total population in each age group, and the size of the population in question. It follows that a change in the volume of criminal offenses may occur if any one factor or if a combination of these factors undergoes change. Thus, an increase in the volume of crime in a population can result from an increase in the size of the population and/or shifts in its age composition, without a concomitant change in the productivity of criminal offenses per person at each age. (There are of course other possibilities; for example, changes in the age specific criminal offense schedule may not show up in statistics describing volume of crime if there are offsetting changes in age composition.) The realistic expectation is that age specific offense rates, age composition, and size of population vary from year to year. To assess the productivity of offenses per person we must analyze the contribution of each of these factors to changes in the total volume of offenses. From the academic point of view such assessments make more precise our knowledge of causes of fluctuations in the volume of offenses. From the applied view, there is the potential of using the knowledge gained in more rational planning.

\* This paper is a revised version of a project completed for the President's Commission on Law Enforcement and the Administration of Justice. While we acknowledge their support, the results and interpretation are the authors' and not those of the Commission.

At least for the immediate future the volume of serious criminal offenses will rise even if the age specific offense schedule remains fixed (an admittedly unlikely assumption). The increase in volume will in part be determined by the continued increase in the size of the age groups most prone to committing offenses. Prior birth rates are the main cause of the increase in numbers and therefore, some portion of the increase in volume of offenses.<sup>1</sup> It is possible to forecast the size and age composition of the population for as many as ten years into the future by simply aging the population distribution reported in the census. The major problem in predicting the extent of crime is the age specific offense schedule. It represents the area of greatest uncertainty and deserves the immediate focus of attention. A portion of this research was addressed to this task.

The other focus of this project was the assessment of the potential effects of changing age composition on changes in volume of estimated offenses and arrests. In the process of achieving this aim techniques known to demography were adapted and applied to age and crime specific reports of arrests as presented in the *Uniform Crime Reports* for the years 1958 through 1964.

The degree of precision in estimation can not be

<sup>1</sup> The study of the relation between offenses recorded and the age distributional effects has its analogue in the area of victimization. Changing birth rates result in changing numbers in the crime-prone ages ten to twenty years later. As bulges appear in the age distribution, and such bulges move up to crime-prone years, corresponding changes will occur in victimization rates in the smaller age categories of victim-prone ages.

evaluated. Whatever weaknesses are characteristic of data collected for the *Uniform Crime Reports* are inherent as well in our research.<sup>2</sup> In addition, the techniques employed in the analysis reported here are not as refined as is desirable. Nevertheless, three worthwhile results are seen. Firstly, the order of magnitude of effects of changing age distribution can be assessed without the requirement of precise figures for arrests or offenses. Secondly, the results appear to justify greater attention being paid to alternate techniques of data analysis even if the data cannot be immediately improved. Thirdly, techniques employed in this study suggest what appear to be improvements in the quality of data collection and reporting.

#### ANALYSES OF DATA

The statistics and statistical procedures were adapted from demography were applied to data reported in the series of UCR publications covering the period 1958 through 1964. These publications contain estimates of clearance rates for each type of index offense as well as age specific arrest rates by size of reporting areas. Throughout the analysis, data on arrests in cities of 2500 or more were selected (to preserve some comparability) and inflated to represent the United States population as a whole. As indicated in later portion of this paper, these procedures appear not to meaningfully influence the measurement of change in crime rates or the volume of crime.

Once decisions on choice of data were made, the rote application of the various computational schemes followed. Tables reported the variation among the years 1958-1964 in the values of total volume of offenses, total offense rates and offense ratios were constructed to demonstrate facets of the rise in arrests and offenses committed for the period under study. The thrust of the analysis is twofold. First there is the evaluation of the effect of age composition and size of population on changes in the crime rate. Second, there is the evaluation of the pattern of change over time in statistics describing the rate of crime.

The first concern, the effects of age composition and size of population on apparent changes in the volume of crime or arrests, requires not direct confrontation with the question of reliability (or validity) in the reporting of offenses or arrests. The order of the effects of age composition and size of population may be assessed, though not precisely,

<sup>2</sup> For a more detailed discussion see the Appendix.

by comparing magnitudes of statistics that do and do not take into account these demographic facts.

The second concern is with the pattern of change over time in statistics describing arrests or offenses. Attention is fixed on the explanation of temporal variation in the value of a statistic rather than differences among different statistics during some time interval.

#### PATTERN OF CHANGES IN CRIME RATES AND VOLUME OF CRIME

Data presented in Table 1 display changes in offense rates in the period 1958-1964, with the constant base year being 1958. These statistics are being compared in each column of the table. The volume of offenses in all columns shows the greatest change over the years.<sup>3</sup> The change reflects possible increases in the propensity toward crime by individuals, the increase in the number of individuals producing crimes, and changes in the age composition of the population. The Total Offense Rate takes into account both changing numbers and changing age composition.<sup>4</sup> As such, the Total Offense Rate displays the smallest amount of increase, being from 30-50% lower than the other measures. The Offense Ratio adjusts for the numbers of persons in the crime prone ages only (ages 10-50). It yields intermediate values for the changes in offenses over time.

The analysis so far does not require great accuracy in the reporting of offenses provided there is a concession that offenses vary greatly with age and that some age groups are vastly more crime productive than others. Thus, even if the offenses are not accurately recorded, comparisons among estimates in columns at least show the potential effects of changing size and age composition. The analysis to this point demonstrates the importance of age composition.

Intermediate statistics that give rise to part one of Table I and to subsequent tables are presented in Table II.<sup>5</sup> These intermediate statistics allow a quick appraisal of the impact of differing procedures in the estimation of volume of offenses (as noted in the appendix). It can be seen that though

<sup>3</sup> The percentage change in volume differs from UCR estimates for reasons that are explicitly stated in the Appendix. For the discussion at hand the difference between these estimates and the UCR estimates is not meaningful.

<sup>4</sup> All statistics are described in the Appendix.

<sup>5</sup> Similar tables were constructed for crimes of violence and crimes against property. These are available by request.

TABLE I  
PERCENT CHANGE BY TYPE OF OFFENSE BY  
TYPE OF RATE FROM 1958 TO 1964

	1958-59	58-60	58-61	58-62	58-63	58-64
	Percent Changes					
<b>All Serious Crimes</b>						
Volume	1.6	19.7	24.1	34.2	44.9	66.5
Total Offense Rates	-1.3	13.9	15.8	20.0	26.6	39.2
Offense Ratio	0.2	16.4	18.8	26.5	34.4	52.2
<b>Crimes of Violence</b>						
Volume	2.5	38.4	40.7	48.1	48.3	60.9
Total Offense Rate	.8	33.2	33.9	36.8	34.2	42.2
Offense Ratio	1.1	34.6	34.7	39.6	37.2	47.0
<b>Crimes Against Property*</b>						
Volume	1.6	18.2	22.8	33.1	44.7	67.1
Total Offense Rate	-1.5	12.2	14.2	18.7	26.0	39.0
Offense Ratio	.1	14.9	17.5	25.5	34.2	52.7

\* Property crimes include larceny under \$50.00.

IV, comparing the behavior of change in Offense Ratios for total offenses, as well as the preceding table suggest the existence of some sort of periodicity in the reporting of offenses.<sup>8</sup> Statistics displayed on either side of the main diagonal of each table tend, with the exception of 1962-1963 comparisons, to show the odd to even year comparisons with larger positive changes than preceding even to

TABLE III  
PERCENT CHANGE OF VOLUME OF OFFENSES  
1958 through 1964\*

(Study method above diagonal, UCR  
method below diagonal.)

	1958	1959	1960	1961	1962	1963	1964
1958		1.6	19.7	24.1	34.2	44.9	66.5
1959	2.5		17.8	22.1	32.1	42.6	63.9
1960	19.8	16.9		3.6	12.1	21.1	39.1
1961	24.0	21.0	3.5		8.2	16.8	34.2
1962	31.8	28.7	10.1	6.4		8.0	24.1
1963	45.5	41.9	21.4	17.3	10.3		14.9
1964	67.6	63.6	39.9	35.2	27.1	15.3	

\* Data of study includes theft under \$50.00.

TABLE II  
OFFENSES—TOTAL  
*Descriptive Statistics*

	1958	1959	1960	1961	1962	1963	1964
<b>Study</b>							
Volume	3,149,468	3,201,064	3,770,500	3,907,810	4,227,092	4,564,922	5,245,432
Offense Ratio	.03	.03	.04	.04	.04	.04	.05
Total Offense Rate	1.25	1.23	1.42	1.45	1.50	1.58	1.74
<b>UCR</b>							
Volume	1,553,922	1,592,160	1,861,300	1,926,090	2,048,370	2,259,160	2,604,450
Offense Ratio	.008969	.008960	.010379	.010528	.011023	.011983	.013612

magnitudes of volume of offenses greatly differ, percentage changes (with few exceptions) over time do not. The per cent increase for all offenses derived from the two methods as compared in Table III.<sup>6</sup> For reasons that are not entirely apparent, 1959-1960 comparisons are most inconsistent.<sup>7</sup> Similar patterns obtain in tables displaying per cent changes in Offense Ratios. The greatest inconsistency again appears in the 1959-1960 period. Table

<sup>6</sup> Similar tables are available for crimes of violence and crimes against property.

<sup>7</sup> The inconsistency is probably due to the over-estimation of Robbery in the United States as a whole when infating data for cities 2500 and over.

odd year changes. That is to say, the per cent changes 1958-1959 is small compared to 1959-1960 and so on alternating up to 1962-1963 when exceptions are consistently seen. Subsequent tables (which are offense specific) employing Total Offense Rates demonstrate the periodicity for some crimes even for the 1962-1963 years (Table V).<sup>9</sup> As can be seen, the pattern is particularly apparent in the crimes of violence. Thus, when age composition is

<sup>8</sup> The same pattern is observable in the violent and property crimes considered separately. (Tables available by request.)

<sup>9</sup> Again, space limitations do not permit us to display the offense specific data.

TABLE IV  
PERCENT CHANGE OF OFFENSE RATIO  
FOR TOTAL OFFENSES  
1958 through 1964  
(Study method above diagonal, UCR  
method below diagonal.)

	1958	1959	1960	1961	1962	1963	1964
1958		.2	16.4	18.8	26.5	34.4	52.2
1959	-.10		16.2	18.6	26.3	34.1	51.9
1960	15.7	15.8		2.0	8.7	15.5	30.8
1961	17.4	17.5	1.4		6.5	13.2	28.1
1962	22.9	23.0	6.2	4.7		6.2	20.3
1963	33.6	33.7	15.5	13.8	8.7		13.2
1964	51.8	51.9	31.2	29.3	23.5	13.6	

to examine arrest rates for white and Negro combined, arrest rates for Negroes, patterns of change in clearance rates, changes in percentages of uniformed and civilian employees, and changes in percentages of population covered by the UCR.<sup>11</sup>

In brief, for the period 1958 to 1964 inclusive, our explorations show no convincing pattern of periodicity in arrest rates of whites and Negroes combined. (See Table VI.) However, Table VII shows a periodicity for arrests in the case of Negroes that complements the previously described offense patterns. Thus, when the total offense rate is increasing rapidly, the rate of negro arrests is also disproportionately increasing.

The lack of pattern for all arrests and the pattern

TABLE V  
PERCENT CHANGES IN OFFENSES OF VIOLENCE (*above diagonal*) AND  
OFFENSES AGAINST PROPERTY (*below diagonal*)  
(Using Total Offense Rates—1958 through 1964)

	1958	1959	1960	1961	1962	1963	1964
1958		.847	33.216	33.909	36.807	34.21	42.19
1959	-1.47		32.097	32.78	35.658	33.08	40.999
1960	12.236	13.91		.52	2.696	.747	6.739
1961	14.236	15.94	1.78		2.16	.225	6.186
1962	18.7	20.4	5.7	3.9		-1.897	3.936
1963	25.989	27.87	12.25	10.228	6.2		5.947
1964	38.98	41.059	23.829	21.66	17.1	10.31	

controlled for comparative purposes, the cycle in reported offenses becomes increasingly obvious. Of course, these tables offer no explanation of the cycle.

#### THE QUESTION OF PERIODICITY

The unanticipated observation of a periodicity in changes in offense rates (the rise in rates from odd to even years being greater than from even to odd years) indicates the need for caution in interpreting changes in offense rates whether the rates are those reported in the UCR or those presented in this paper adjusted for changes in age composition.<sup>10</sup>

One explanation of the observed periodicity is that crime follows a two year cycle, but this explanation ranks low in credibility.

Our efforts to find more reasonable causes led us

<sup>10</sup> Since the original form of this report was prepared for the President's Commission on Crime, 1965 and 1966 rates have been released. These too follow the indicated pattern.

TABLE VI  
PERCENT CHANGE IN TOTAL ARREST  
RATE FOR INDEX OFFENSES

	1958	1959	1960	1961	1962	1963	1964
1958		1.5	14.3	21.2	17.3	22.7	28.1
1959			12.6	19.3	15.5	20.8	26.1
1960				6.0	2.6	7.3	12.1
1961					-3.2	1.2	5.7
1962						4.6	9.2
1963							4.4
1964							

for estimated offenses is in part related to clearance rates. (Roughly, a clearance is an offense known to police cleared by an arrest for the offense.) There

<sup>11</sup> It may occur to the reader that the two year cycle suggests an election year phenomenon. Data bearing on this observation are being collected for analysis at a further date by the writers. Also, the cycle may reflect in part the variation due to the fluctuations in the reporting population (Table VII). However, in either case there are similar effects on the UCR statistics.

TABLE VII  
NEGRO % OF TOTAL ARRESTS IN CITIES OVER  
2500 (INDEX OFFENSES) BY YEAR

	% Popu- lation Re- porting	Yearly % Increase in Popu- lation Report- ing	Negro Arrests as % of Total	Yearly Increase % Negro	Negro % Increase over 1958
1958	29.92		34.67		
1959	31.59	5.6	35.06	1.1	1.1
1960	40.66	28.7	36.18	3.2	4.36
1961	41.12	1.1	34.68	-4.1	0.03
1962	46.13	12.2	35.83	3.3	3.36
1963	45.26	-1.8	35.36	-1.3	1.98
1964	47.25	4.4	35.51	.4	2.43

be generated by periodically improved reporting and recording of offenses without attendant improvements in apprehension.

There is some evidence that the periodicities just mentioned are related to changes in per cent increases in personnel employed by police. Table IX shows that the yearly per cent increase in uniformed personnel shows periodicity, with the larger increases in the even to odd years, while civilian personnel per cent yearly increases follow the pattern observed in the offense ratio and total offense rate except for the 1961-62 period.<sup>12</sup> The appearance of periodicity in the instances just presented, as well as in percentages of population

TABLE VIII  
CLEARANCE RATES BY TYPE OF OFFENSE BY YEAR

Year	Murder	Man- slaughter by Negligence	Forcible Rape	Robbery	Aggravated Assault	Burglary	Larceny Theft	Auto Theft
1958	94	90	73	43	79	30	20	27
1959	93	89	74	43	79	31	21	26
1960	92	83	73	39	76	30	20	26
1961	93	87	73	42	79	30	21	28
1962	93	81	66	38	76	28	20	25
1963	91	84	69	39	76	27	20	26
1964	90	86	67	37	74	25	19	26

TABLE IX  
PER CENT INCREASE POLICE PERSONNEL  
(Uniformed Police Employees Above Diagonal,  
Civilian Below Diagonal)

Base Year	Years						
	1958	1959	1960	1961	1962	1963	1964
1958		4.2	7.8	13.5	12.5	16.2	15.1
1959	6.9		3.5	8.9	8.0	11.5	10.4
1960	27.3	19.1		5.3	4.4	7.8	6.7
1961	29.6	21.3	1.8		- .8	2.4	1.4
1962	31.4	23.0	3.2	1.4		3.4	2.2
1963	35.7	27.0	6.6	4.8	3.3		-1.0
1964	41.9	32.8	11.5	9.6	8.0	4.6	

covered by the UCR (Table VII) suggests certain cautions in the interpretation of crude or refined offense rates which we can now outline.

<sup>12</sup> Operating on assumptions similar to those used in estimating total offenses for the entire population, we can arrive at an estimated number of police employees in the United States for the years 1958-1964. This figure includes uniformed and civilian employees. Using the percentages of civilian employees reported in the UCR, the number of civilian and uniformed can be estimated as well.

We are particularly interested in the variations in civilian employee per cent increases because of their degree of correspondence between our estimates of crime increase in both direction and magnitude (except for 1961-1962). Presumed here is that civilian employees have their greatest impact on reducing the gap between crimes reported and crimes recorded, since they are heavily utilized in the areas of report preparation and recording. In addition, it seems reasonable to assume that as more civilians are employed, more uniformed employees will be released to the areas of detection and investigation. Thus, the correspondence between employee data and crime estimates further supports the contention that rapid and, particularly, cyclical increases in reported crime are primarily a function of variations in police system operations and increased efficiency of recording and reporting.

is a tendency to have lower clearance rates on even years than odd years. Furthermore, since 1958, clearance rates appear to be on the decline (see Table VIII). Hence, the inverse relationship between changes in clearance rates and offense rates without similar changes in overall arrest rates can

## SPECULATIONS

Data examined for this study suggest that reports on offenses are not reliable indices of the level of crime or changing rates of crime in the United States. The main evidence for this point of view is the periodic pattern of change in the volume of crime as well as in measures of crime adjusted for age compositional changes. The crux of the problem in the reliability or accuracy of statistics on crime appears to be the suspected gaps between committed offenses and reported offenses and between reported offenses and recorded offenses. The sizes of these gaps are unknown.<sup>13</sup> If such gaps exist and they are relatively large, then certain ramifications follow as reasonable possibilities. Firstly, with improvements in the system of recording offenses, the volume of offenses reported in UCR will increase whether or not there has been a true increase in committed offenses. That is to say, improvements in recording offenses primarily narrows the gap between reported and recorded offenses. Secondly, without attendant increases in the ability to clear crimes through arrests, improvements in the recording of offenses result in an apparent drop in clearance rates.<sup>14</sup> Thirdly, for reasons that are not fully explained, there are periodic spurts in the recording of offenses. Such spurts are also made possible by the gaps or reservoirs of previously unreported and/or unrecorded offenses.<sup>15</sup> These three possibilities may account in a general way for the patterns of growth and fluctuations in data previously discussed.

These uncertainties make it virtually impossible to estimate the change in the crime productivity of each age group. The undesirable consequence of a constantly improving reporting system is that for the while at least, offense rates will appear to rise if only from improved recording. However, as the

<sup>13</sup> Recent research has indicated that the gaps do exist and are, in the case of index offenses, of considerable magnitude. See, Enis, *Criminal Victimization in the United States: A Report of a National Survey*, U.S. Government Printing Office, 1967.

<sup>14</sup> The number of police employees per 1000 population or 1000 persons in the crime prone ages in selected cities has remained virtually constant between 1958 and 1964 according to UCR. One would suppose, therefore, that the ability to clear offenses by arrests has also been largely constant during this period.

<sup>15</sup> The victimization research in Washington, D. C. suggests that recording practices of police "are a much greater source of spurious change" than the non-reporting by victims. See Bideman, et al. *Report on a Pilot Study in the District of Columbia on Victimization and Attitudes Toward Law Enforcement*, U.S. Government Printing Office, 1967, p. 111.

gap closes, those conditions that would assure meaningful comparisons are also approached.

Finally, we find that variations in the estimates of the increase in crime and the police employee data exhibit patterns whose similarity cannot be considered fortuitous or artifacts of our methodology alone. The analysis of police employee data indicates that some proportion of the increase in crime described in traditional measures of crime increase can be attributed to changes in the occupational composition of police systems. This suggests further investigation of other system characteristics and their influence on the extent of known and reported crime.

## CONCLUSIONS

Despite serious reservations, first with respect to bias in recorded data on offenses, and second with respect to operations performed on these data, such as inflating reported data on arrests to yield offenses and further inflating to yield offenses for the U.S. as a whole, certain conclusions appear warranted. These are:

1. That, as measured by the Total Offense Rate, changes in per person proneness toward committing offenses appears less (perhaps 30-50 per cent less) than are changes in the per person offense rate recorded in the UCR. That is to say, in the year 1958-1964 two facts contribute to the difference between the two rates. First, some portion is explained by the changes in the size of the population from one year to the next. Second, the remaining portion is accounted for by the procedure that adjusts for different numbers or proportions in each age category.

2. An understanding of what factors affect changes in offense rates is enhanced by the calculation of rates such as the Total Offense Rate.

3. There exists a periodicity to the recording of offenses known to police. An important correlate of this periodicity appears to be the patterns of increase in police employees, civilian and uniformed. The mechanism linking civilian employee changes to recording is not known. Nor is it known why there are periodic increases in the estimated number of civilian employees.

4. The analysis leads to a pessimistic view of the validity of using UCR data for estimating the rate of growth of either volume of offenses or crime proneness of individuals. Without techniques for the correction of year-to-year changes in bias in

the recording of offenses, neither a true rate of growth of volume of offenses nor a true rate of growth for the Total Offense Rate can be extracted from available data.

5. Finally, given laudable improvements in the police system of reporting and recording offenses, a

continued apparent increase in estimated offenses will result. The consequence of such growing efficiency is the continuing drop in clearance rates. Therefore, a drop in clearance rates is not a sure measure of increasing police load or loss of efficiency in apprehension.

## APPENDIX

### CALCULATION OF TOTAL OFFENSE RATE BASED ON UCR DATA

Because of limitations of data as well as knowledge, several assumptions have been made to facilitate the calculation of age specific and offense specific offense rates. At first glance the assumptions appear outrageous but reasons can be advanced to modify that impression.

These assumptions are:

1. Clearance rates do not vary with the age of offenders within each type of offense. That is to say, if the clearance rate for murder is 90%, it is 90% regardless of the age of the offender (no doubt the assumption is false).

2. The time interval between an offense and an arrest for that offense is minimal. Therefore, age at arrest closely approximates age at offense.

3. The age composition in reporting areas (those covered in the UCR) is representative of the nation as a whole.

4. Arrests per person at each age for each offense in reporting areas is equal to the age specific offense specific rates for the nation as a whole.

Those considerations that make these assumptions somewhat acceptable are, respectively:

1. While clearance rates probably do vary with age of the offender, offenses tend to cluster within certain ages and thus, the clearance rate for the offense is determined in large part by the clearance rate found at the modal age.

2. It seems reasonable to assume that the majority of offenses are cleared by arrests within a brief period of time if they are cleared at all.

3. While there is variation in age composition from area to area, age compositions in general show some invariance. They tend to show decreasing numbers or proportions with age.

4. There are differences in arrest rates and offense rates from area to area; and the techniques used here will not take these into account. However, much of the attention will be focused on change in rates over time so that errors more or less of the same kind will be introduced at each

point in time for which estimates are made. This will be true for the errors of estimation committed due to the prior assumption about age composition as well as the assumption of varying rates among reporting areas and non-reporting areas. In effect, measures of change will be less affected by these consciously naive assumptions than the yearly rates. The effects of these assumptions are the percent change on the volume of offenses from year to year, compared with estimates made in accord with UCR Techniques are displayed in Table II. From this table there is support for the modifications employed in the analysis and, inferentially, for a charitable view of the assumptions. The assumptions made here appear not to differ significantly in effects on measures of change from the assumptions made in the UCR estimates of change. The weakness inherent in data are probably of greater significance.

Given these prior assumptions, the calculation of the total offense rate for a particular year is symbolized below:

Definitions:

$N(a)$  = the number of persons in the population  $N$  at age  $(a)$  during some year.

$P(a)$  = the proportion of persons in the population  $N$  at age  $(a)$  during some year,

so 
$$N(a) = NP(a).$$

$C_j$  = is the clearance rate for offense  $j$ .

$A'_j(a)$  = arrests for offense  $j$  of persons age  $(a)$  during some year—for areas covered by UCR,

then 
$$A'_j(a)/C_j$$

is the number of offenses of type  $j$  due to persons age  $(a)$  during some year—for areas covered by UCR,

$N'$  = the population covered by UCR.

then

$$\frac{N}{N'} \frac{A'_j(a)}{C_j} = \frac{A_j(a)}{C_j}$$



is the estimate of number of offenses due to persons age (a) during some year subject to the assumptions listed earlier.

$O_j(a) = A_j(a)/C_jN(a)$  the age specific and offense specific rate of offenses.

$\sum_{j=1}^k O_j(a) = O(a)$  the age specific rate of offenses,

and  $\sum_{a=0}^{\infty} O(a) = \text{Total Offense Rate.}$

In practice, further modifications were employed. The summation on (a) age, need not proceed over the range indicated. Offenses are committed in the main by those 10 years old and over but under 65. Without too great a distortion, we can substitute

$\sum_{10}^{50} O(a)$  for the more precise expression of the total offense rate.

In addition, adjustments were made in those age categories where arrests were not reported by single years. For example, if the age category was a five year interval, all arrests for that category were divided by the size of the population in that five year interval. The rate so obtained was then attributed to each year in the age interval.

#### TOTAL ARREST RATE

The Total Arrest Rate is similar to the Total Offense Rate. It differs only by the division of the offense specific clearance rate. Therefore:

$$\text{Total Arrest Rate} = \sum_a \sum_j \frac{A_j(a)}{N(a)}$$

#### THE OFFENSE AND ARREST RATIO

Changes in the volume of arrests or the volume of offenses committed are related to the growth of

population. In particular, they are related to the growth of that portion of the population in the ages most prone toward criminal activity, say ages above ten but less than 50, if we are concerned with serious offenses. This observation suggests a statistic that takes the numbers in this age bracket into account. Ratios that may be formed include:

$$\frac{\sum_{a=10}^{50} \sum_j A_j(a)}{\sum_{10}^{50} N(a)} \quad \text{or} \quad \frac{\sum_{a=10}^{50} \sum_j O_j(a)}{\sum_{a=10}^{50} N(a)}$$

for the Arrest Ratio and Offense Ratio respectively.

#### AN INTERPRETATION OF THE TOTAL ARREST OR TOTAL OFFENSE RATE

Apart from the use of these statistics as a measure of criminalness of a population holding constant the size and age composition of populations being compared, the Total Offense Rate (or Total Arrest Rate) has another interesting meaning. It measures the number of offenses (or arrests) per person for a cohort moving through in its lifetime the various age specific offense rates observed at a given period or year. This interpretation requires that the age specific offense rates be fixed during the lifetime of the hypothetical cohort.

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