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Missing Data and Imputation in the Uniform Crime Reports and the Effects on National Estimates

James P. Lynch

John Jay College, New York, New York

John P. Jarvis

Federal Bureau of Investigation, Quantico, Virginia

The Uniform Crime Reporting (UCR) program has been a major source of data on crime since 1929. These data were long considered authoritative, but lately, questions have arisen about their accuracy. Maltz has documented the magnitude of missing data in the series and demonstrated their import for research on policy issues. Maltz's work focuses on agency-level estimates for specific months, but the UCR program was never meant to provide estimates for this unit or time period. So, although Maltz's work is important, it has not addressed the consequences of missing data for the principal purpose of the UCR program—providing annual national estimates of the level and change in crimes known to the police. This article complements Maltz's work by assessing the magnitude and distribution of missing data nationally and their effect on national-level and change estimates. It also examines the effects of the FBI's imputation practices on these estimates.

Keywords: *annual crime rates; imputation; missing data; UCR*

The Federal Bureau of Investigation's (FBI) Uniform Crime Reporting (UCR) program has been a major source of data on crime and police response to crime since 1929. Policy makers, the media, and researchers use these data to describe and understand crime and police activity (Government Accountability Office [GAO], 2005). Even Congress has used these data to allocate federal funds to states and localities (GAO, 2005). At one time, these data were considered the authoritative source of nationally representative information on crime. Over time, however, questions have arisen about the accuracy of these data (Faziolah, Matza, & McCoy, 1998; Maltz, 1999; Matza, Faziolah, & McCoy, 1998). This skepticism has increased with the appearance of the National Crime Victimization Survey (NCVS).¹ Comparisons of the UCR program and the NCVS have led to some debate about which of the two indicators is the more accurate (Blumstein, Cohen, & Rosenfeld, 1992; Cook, 1985; Decker, 1977; Gove, Hughes, & Gerken, 1985; McDowall & Loftin, 1992; O'Brien,

Shichor, & Decker, 1980; Skogan, 1974). Gradually, these debates about which series is better have given way to more useful investigations of what issues each series is best suited to inform (Bennett & Lynch, 1990; Lynch & Addington, 2007; McDowall & Loftin, 1992). Research is now focused on identifying sources of error in these statistical systems and on estimating the magnitude of the effect of these errors on different uses of the data.

Currently, we know a great deal more about the error structure of the NCVS than we do about the UCR program (Biderman & Lynch, 1991). The U.S. Census Bureau and others have conducted extensive methodological studies of the survey (Addington, 2005; Biderman, Cantor, Lynch, & Martin, 1986; Cantor & Lynch, 2005; Hubble & Wilder, 1988; Kobelarcik, Alexander, Singh, & Shapiro, 1983; Lehnen & Skogan, 1981; Lepkowski, 1981; Persley, 1995). In contrast, very little methodological work has been done on the UCR program (Poggio, Kennedy, Chaiken, & Carlson, 1985; Schneider & Wiersema, 1990).

One notable exception to this rule is the work done by Michael Maltz and his colleagues on missing data in the UCR program. Maltz has taken great pains to document the magnitude of missing data in the series and to demonstrate the import of this missing data for research on important policy issues (Maltz, 1999; Maltz & Targonski, 2001, 2003). The emphasis of Maltz's work, however, has been on estimates of crime at the county level for specific months of the year. This focus is warranted because an increasing amount of the scholarly work done using the Return A data has employed county as the unit of analysis (Lott, 2002). Moreover, efforts to adjust for missing data at any level of geography will be better if data are available at the lowest level units of time and space.

Unfortunately the UCR system was never meant to provide estimates of crime known to the police at the county level and for specific months. So, although Maltz's work is important, it has not addressed the consequences of missing data for the principal purpose of the UCR program—providing annual national estimates of the level and change in level of crimes known to the police. It is highly likely that missing data will have less effect on these national estimates than the county-level estimates addressed by Maltz. This article complements Maltz's work by assessing the magnitude and distribution of missing data nationally and its effect on national level and change estimates. We will also examine the effects of the FBI's current imputation practices on these estimates.

After a brief description of the UCR program, we examine the extent and magnitude of missing data in the Return A, or offenses that become known to police, as reported, collated, and released by the UCR program.² We then describe how this "missingness" is distributed across types of agencies included in the UCR system. The third section describes the imputation procedures that are employed by the UCR program to correct for missing data when encountered. In the last section, we estimate how missing data and the FBI's imputation procedures affect the annual, national estimates of the level and change in reported crime. Using these analyses, we assess

the adequacy of these imputation procedures with particular attention to their implications for the choice of imputation strategies.

The Uniform Crime Reporting Program

The UCR program is an administrative series of police records. The program includes seven distinct data collections: Offenses Known to the Police (Return A including the supplement), Arrests (ASR), Law Enforcement Officers Killed or Assaulted (LEOKA), Police Employment, Arson Reports, the Supplementary Homicide Reports (SHR), and the Hate Crime Supplement. All of these data collections are based on police records in state and local police agencies that are submitted directly or through state UCR programs to the FBI. Most of these data collections involve aggregate reporting at the jurisdiction level, so that individual police agencies report counts of eligible incidents to the state and ultimately to the FBI UCR program. Historically, only the SHR and the Hate Crime Supplement data have been reported on an incident basis where a separate record is submitted for each crime event.³

Participation in the UCR program is largely voluntary, but approximately 38 states have mandatory reporting laws that require local police departments to send their data to the state program if not the UCR program (Barnett-Ryan, 2007). In these cases, participation may be required, but the quality of that participation is voluntary and there is no evidence that failure to report in states with mandatory reporting laws has ever resulted in sanctions. Furthermore, the UCR program attempts to collect reports from the population of state and local police agencies. It does not rely on a sample.⁴ Of these various components, Offenses Known data, or Return A, is by far the one most often used to describe the overall crime picture, followed distantly by the arrest data. Perhaps, for this reason, these are the only two components of the FBI UCR program that employ imputation in their reporting. For these reasons, we restrict the focus of this work to Return A, but as mentioned in Note 3, we do allude to patterns found in the arrest data when appropriate.

The Return A provides the following counts of offenses known to the police: the number of criminal offenses reported, the number of crimes unfounded, and the number “cleared” by arrest. These counts are reported for all Part I crimes, including the seven Index crimes—homicide, rape, robbery, aggravated assault, burglary, larceny, and motor vehicle theft; arson is included here as well. Counts for arson are not included in the Crime Index. However, counts for subclasses of these offenses are also reported. For example, burglary subclasses distinguish forcible entries from nonforcible entries and attempts. Robbery is differentiated by the type of weapon or force employed. Other Index crimes have subclasses reported on Return A or in the Supplement to Return A.

The procedures used to collect Return A and arrest data are similar in most major respects. State and local police agencies classify and then score events to

obtain tallies in the categories specified by the UCR program. Classification involves determining whether the incident reported and recorded by the police fits into a UCR crime class described in the *Uniform Crime Reporting Handbook* (FBI, 2004). The handbook provides definitions of criminal acts as well as illustrations of incidents and their correct classification. A second aspect of classification involves the application of the Hierarchy Rule. This rule specifies that in the cases of multiple crimes in one event or "operation," priority is given to some crimes over others. Specifically, homicide is considered the most important, followed by rape, robbery, aggravated assault, burglary, larceny, and motor vehicle theft. Adhering to the classification scheme as well as the scoring or counting rules of the UCR program prevents double counting of crime events in the annual tallies.

Once these and other rules are applied, the resulting counts are forwarded directly to the respective UCR state program or to the FBI. Reports from police agencies are submitted on a monthly basis, although some contributors will report for all months at year's end. At the present time, there are 45 states that have state programs, up from 1 state in 1967. This has also varied over the years with 38 participating state programs in 1990 and as many as 47 plus the District of Columbia in 2007. The growth of state programs has been a major change in the UCR system. Although no formal evaluations have been done, it is reasonable to assume that state programs have resulted in a significant improvement in the quality of UCR data (Barnett-Ryan & Swanson, 2008; Lynch, 2003). UCR programs compile and edit the data from local agencies. These edits usually involve addition checks that confirm subclass totals to the crime class counts or that the counts that are supposed to form separate components add up. When apparent errors or omissions are detected, efforts are made to obtain clarification and correct these problems. When the state edits and compilation are completed, the resulting tallies are sent to the FBI. The UCR program performs its own edits on these data. These edits involve addition checks, examination of the distribution of offenses, inspection of monthly variations, as well as a check for the reasonableness of a jurisdiction's report relative to previous years. Large fluctuations in the data are investigated as part of an error check.

When the counts of offenses and arrested persons are aggregated and imputed, if necessary, rates are calculated using these counts and corresponding population counts. The resulting rates are made available in public use files and in the annual publication of the FBI UCR program, *Crime in the United States*.

Missing Data

Data are considered missing when agencies with an ORI number do not report crimes or persons arrested within the scope of the UCR program. This is the equivalent of household nonresponse in household surveys. Agencies participating in the UCR program can also report some of the required information (e.g., total crime

counts) but not other items (e.g., subclass reporting of the number of robberies with a gun). The focus here is on agency nonresponse and not item nonresponse.⁵

Return A

In concept, the UCR program is based on a census of police organizations. In reality, however, the system does not include data from every police department in the nation, and for some subsets of the data (e.g., arrests), the departures from complete reporting are substantial. *Crime in the United States* (FBI, 1993) noted that data on crimes known to the police were reported by 85% of all known police agencies that cover about 96% of the population. On its face, this suggests that the UCR program is very close to a complete census of police organizations. In other words, there appears to be little nonresponse. It is important to note that these figures include any organization that sent any data to the UCR program for the reference year. Some portion of these reporting agencies submitted as little as 3 months of data. If we examine the proportion of agencies reporting a complete 12 months of data to the UCR program, then the level of missing data is much greater. For example, in 1992, more than 28% of all agencies did not completely report Return A data to the FBI. This translates into a population coverage figure of 90.3%. The amount of missing data in Return A has increased somewhat throughout the decade. By 2003, 65.5% of agencies reported for a full 12 months. These agencies accounted for approximately 87.9% of the population (see Table 1).

Most of the missing data result from agencies not reporting at all in a given year rather than agencies failing to report for a particular month. Twenty-two percent of police agencies covering 6.1% of the population did not report any Return A data in 1992. In 2003, the corresponding figures were 30.5% of agencies covering 9.6% of the population. Another 5.6% of the agencies covering 3.5% of the population did not report 1 or more months of data in 1992, and in 2003, the corresponding figures were 4.0% of the agencies covering 2.5% of the population. It is useful to describe the proportion of missing data in two categories: less than 3 months of data reported (more than 9 months missing) or more than 3 months but less than 12 months of reported data. This is because the imputation procedures described below are different depending on the number of months included. Twenty-three percent of the agencies in the UCR program report 2 months of Return A data or less. These agencies covered approximately 6.4% of the population in 1992. An additional 6% of the agencies that accounted for 3.4% of the population report more than 3 months but less than 12 months of crime data.

Missing data are also not randomly distributed across the population of state and local police agencies. The previous analysis suggests that there are more missing data in smaller rather than larger jurisdictions. This is confirmed in Table 2, which shows that in cities with more than 250,000 population, approximately 95% of all departments completely report 12 months of Return A data. In stark contrast, cities a tenth of this size (less than 25,000 population) are just 57.2% complete reporters.⁶

Table 1
Distribution of Missing Data by Agency and Percentage of the
Population Covered: Return A, 1992 and 2003

# of Months Missing	1992			2003		
	# of Agencies	% of Agency	% of Population	# of Agencies	% of Agency	% of Population
12	4,045	22.50	6.10	6227	30.54	9.60
11	44	0.20	0.10	37	.18	0.10
10	57	0.30	0.10	37	.18	0.09
9	58	0.30	0.10	39	.19	0.23
8	42	0.20	0.20	49	.24	0.10
7	57	0.30	0.20	38	.19	0.13
6	124	0.70	0.30	52	.26	0.12
5	67	0.40	0.20	68	.33	0.12
4	74	0.40	0.50	54	.26	0.17
3	84	0.50	0.40	87	.43	0.31
2	132	0.70	0.40	134	.66	0.56
1	273	1.50	1.00	213	1.04	0.56
0	12,955	71.90	90.40	13,353	64.49	87.89
Total	18,012	100.0	100.0	20,388	100.0	100.00

The extent of missing data in Return A data varies by type of police organization as well. Eighty-five percent of college and university police agencies report for the full 12 months, followed by city and rural police departments and state police agencies at about 70%. Suburban counties have the lowest rate of complete reporting at 64.7%. Missing data are also distributed by region. The UCR program divides the nation into nine divisions, as illustrated in Table 4. Here, the highest rate of complete reporters is in the Pacific (85.2%) and the lowest are the South Atlantic and New England regions. This regional distribution may vary widely from year to year.

Last, the volume of missing data also appears to vary according to the social organization of the UCR program in the jurisdiction. As we noted earlier, the number of state UCR programs has varied over the years, with 44 states having such programs in 1992. Six states did not have administrative support for a UCR program during this timeframe. Agencies in these states submitted their crime information directly to the FBI UCR program. Approximately 74% of agencies in states with UCR programs submit complete reports, and 57% of agencies in nonprogram states submit complete reports. This suggests a substantial contribution by UCR programs operating at the state level in securing accurate and complete crime data. However, it also implies that those jurisdictions reporting directly to the national UCR program may be fundamentally different from those reporting to state programs.

In summary, there is a significant amount of missing data in Return A, and the amount of missing data is increasing. Agencies serving approximately 10% of the

Table 2
Percentage of Agencies by Amount of Missing Data and Type
of Jurisdiction and Agency: Return A, 1992

	Months Reported			Total
	0-2	3-11	12	
Size of area				
250,000	3.0	1.5	95.5	66
100,000	2.9	1.5	95.6	136
50,000	3.0	2.5	94.5	364
25,000	5.1	1.9	93.0	728
10,000	7.7	4.0	88.3	1,747
2,500	15.1	5.3	79.6	4,325
< 2,500	36.7	6.1	57.2	4,990
Non-MSA	23.5	5.5	71.0	3,674
MSA	30.5	4.0	65.5	1,979
Region				
New England	34.80	3.00	62.20	1,084
Middle Atlantic	25.40	4.20	70.40	3,062
East North Central	21.20	7.90	70.90	2,904
West North Central	16.20	7.40	76.40	1,790
South Atlantic	28.40	6.30	65.30	3,638
East South Central	27.00	5.60	67.40	1,455
West South Central	14.60	0.90	84.60	1,690
Mountain	21.90	4.60	73.50	995
Pacific	13.70	1.10	85.20	1,391
Type of jurisdiction				
Cities	22.20	5.20	72.70	11,803
Suburban counties	31.10	4.20	64.70	1,667
Rural counties	23.50	6.10	70.40	3,176
University police	10.80	3.40	85.70	553
State police	25.20	2.10	72.70	810

Note: MSA = metropolitan statistical area.

population in 1992 did not submit complete reports of Offenses Known, and this grew only slightly, to slightly more than 12%, by 2003 (see Table 1). This is well within the range of nonresponse for household surveys done by the better private survey firms and slightly below the response rates of major household surveys conducted by the Demographic Surveys Division of the Census Bureau (Rennison & Rand, 2007). Nonetheless, when the average annual change in crime rates based on Return A data is about 3%, even 10% missing data can account for a substantial portion of that change. If the agencies that do not report are substantially different in important respects from those that do report, then missing data are more likely to affect the level and change estimates in important ways.

The foregoing distributions of missing data confirm that police agencies that do not completely report are different from those that do. In the years of UCR data examined here, these police agencies are disproportionately from smaller rural and suburban counties, are more often from New England and the South Atlantic regions of the United States, and are more likely to be without UCR programs.⁷ Given the amount of missing data and the fact that nonreporting agencies appear to be different from those that do report, it would be unwise to base national estimates on complete reporters only. It is fortunate that the UCR program does not ignore the problem of missing data and employs an imputation procedure to estimate the missing data.

Imputation Procedures

The imputation procedures used in the UCR program for national estimates vary by the data series. The procedure used for the Offenses Known data are different from those employed in the Arrests data. The procedures for change estimates are also different from those for level estimates. The procedures will vary by the amount of data that are missing such that agencies with more missing data are estimated differently from those with less missing data. These different imputation routines are described below.⁸

Imputation of Level Estimates for Return A Data

An agency's offense totals are imputed when one or more of the following situations occurs: (a) Appropriate data are not received by the UCR program; (b) monthly data are examined by program specialists and identified as being "extremely high or extremely low in comparison to other reports submitted by the agency to other similar agencies"; or (c) examination of previous years data and distributions of the submitted data are deemed suspect by UCR program specialists. When any of these situations occur, the submitting agency or state program is contacted in an effort to resolve the apparent discrepancies. If the locality and the FBI cannot come to a satisfactory resolution, by mutual agreement of the locality and the FBI, the suspect data are discarded and the agency's missing values are estimated. There are two methods by which estimates for these missing months are generated, depending on the extent of missing values for the 12-month reporting period.

Method 1: Partial Reporters

A manual estimation is performed if an agency submits 3 or more months of acceptable data. A mean is calculated for the months of acceptable data and this mean is attributed to the missing months. This mean substitution procedure generates figures that can be aggregated into an annual estimate to represent the entire reporting period.

Method 2: Nonreporters

A second imputation method is used for agencies submitting less than 3 months of acceptable data. If an agency submits only 1 or 2 months of acceptable data, all data are discarded and this agency is regarded the same as an agency that submitted no data. In such instances, the following computerized method is employed to impute appropriate crime figures for that agency:

1. Each reporting agency is grouped in strata defined by its metropolitan status—metropolitan statistical area (MSA), other cities, rural counties—and its population size.
2. Those agencies that are 12 months complete are identified and only these agencies are used as a basis for imputation.
3. The estimated crime volume for each stratum to which the agency belongs is computed.
4. The annual crime rate for the stratum is then applied to the target agency's population to obtain the imputed number of offenses.
5. If no comparable agencies are available, the previous year's data for the agency under consideration are used as an estimate. In addition, the missing data from agencies with no associated population figures such as state police agencies or park police are not imputed.

The automated procedures used in Method 2 are only applied to agencies with populations less than 50,000. Cities with populations between 50,000 and 100,000 are manually estimated using the same principles. Agencies with more than 100,000 in population are not supposed to be estimated. Figures for these agencies are obtained by directly contacting the agency. Nonetheless, Table 2 indicates that there are some agencies of more than 100,000 for which there are missing data in the publicly available data files.⁹ Because we have been able to reproduce the published estimates using these data files, it seems reasonable to say that these data are missing from the published estimates and therefore must be subjected to some form of imputation.

Once these imputation methods have been applied (Method 1 for partial reporters and Method 2 for nonreporters), the resulting estimates are then merged with the actual figures for complete reporting agencies to obtain the annual totals for the nation, regions, divisions, states, and MSAs.

Of the two imputation methods described here, Method 2 accounts for the vast majority of the imputation done in the UCR program. In terms of agencies, about 79% of the imputation done for Return A employs Method 2. Based on population coverage, approximately 72% of the imputation is done using Method 2. The problems posed by missing data in the UCR program for Return A, therefore, result primarily from total nonparticipation and not incomplete participation.¹⁰ Finally, rate estimates are obtained by dividing all counts (imputed and nonimputed) by the appropriate estimate of the population.

Imputing Denominators of Rates

When assessing the effects of imputation in the UCR program, it is important to realize that potential for error is present in the denominator of the rate as well as the numerator. The population counts that serve as the denominator in the crime and arrest rates are also estimated during the intercensal period. The state growth rate in population from the Census Bureau is applied to counties within that state and the county estimates of population change are applied to jurisdictions within the counties (see FBI, 1993). These estimates of the denominators are then employed in all rate calculations. To the extent that this methodology produces inaccurate estimates of population counts, all rates in the UCR program will be affected. It is unlikely that the quality of these estimates will significantly affect national-level rates. However, there could be substantial effects on rates for subnational areas.¹¹

Differences Between Data Files and *Crime in the United States*

The first step in estimating the effects of imputation should be reproducing the official estimates published by the FBI. This is difficult to do for two reasons. First, UCR staff make changes in the estimates after manual and automated edits and imputations are completed. At any time until the final *Crime in the United States* volume is sent for printing, the UCR staff can make changes in the estimates. These changes may not always be documented in detail. Second, traditionally, there has not been an absolute cutoff date beyond which new data will not be added to the UCR data files maintained by the FBI. As a consequence, the estimates generated from the data may differ from published estimates.⁸

Assessing the Effects of Current UCR Imputation

The magnitude of the effect of missing data on annual estimates of the level of offenses known is not great in absolute terms. The estimate of the national-level volume of Index crimes in 1992 without imputation is 13,858,202. When imputed data are included, the reported volume of crime in 1992 is 14,660,364, a difference of 5.7% (see Table 3).

Estimates of the change in the level of crime from the UCR program are much more important than annual-level estimates. These are the numbers on which the agencies base their claims that crime is up or down. The effect of imputation on estimates of change in the level of offenses known is substantial for the years 1992 and 1993, for example. Using the data reported without imputation, a 4.7% decrease in the volume of offenses known was reported. When imputation was used, the estimate of change dropped to 1.91%, less than one half the decrease observed in the unimputed data. The imputed data published by the UCR program indicate a decrease of 2.0%.¹² Therefore, it is clear that imputation can make a considerable difference for

Table 3
Estimates of Level and Change in Level of Offenses Known:
Imputed and Unimputed Data

Imputation Method	1992	1993	% of Change
Imputed	14,660,364	14,380,698	1.907
Unimputed	13,858,202	13,202,499	4.730
Publication	14,438,191	14,140,952	2.058

annual estimates of change in the level of offenses known to the police. It is also clear, and comforting, that any informal changes in the UCR data made by UCR staff after the formal editing and imputation do not significantly affect the estimates.

Given the distribution of missing data, it is not surprising that imputation serves to counteract the effects of the overrepresentation of larger urban jurisdictions in the UCR program. During the period examined here, large urban jurisdictions were experiencing larger reductions in crime than other places. This results in larger reductions when the unimputed data are used than when the imputed data are used. In the late 1980s, when large cities were experiencing significant increases in crime, imputation undoubtedly served to substantially lessen the increases that would have been reported in unadjusted UCR crime data figures. The direction of the effect of imputation on change estimates will differ, but the current imputation procedures always serve to lessen the effects of the overrepresentation of large urban places.¹³ This would suggest that, even though the imputation methods currently used by the UCR program are simple and have a number of disadvantages, it is better to impute using these methods than to ignore the missing data altogether.

A more precise and desirable way of assessing the quality of imputation methods currently used by the UCR program would involve finding some external source of validation against which imputed values can be compared. This was the approach employed in the census undercount adjustments, for example. The original census counts were validated by employing much more expensive and exhaustive enumeration procedures in a small subset of areas than was used in the original enumeration (Robinson & Adlakha, 2002). This "better" number was used to establish the "true" count. In the context of the UCR program, this would mean a nonresponse study in which site visits, for example, would be conducted with a sample of nonreporting agencies to obtain their counts of offenses reported to police. These counts would be compared with the imputed counts to assess the accuracy of the imputation procedures. This type of external validation would be useful, but it would also be quite expensive. To date, no such external validation has been undertaken for the purpose of validating imputation procedures used in the UCR program.

Various forms of simulation could also be used to assess the quality of current imputation methods used in the UCR program. In the simulation, the true crime rate would be known for a particular jurisdiction and then deleted according to certain

assumptions, and various imputation methods would estimate values for those that are missing. If the imputation methods currently in use by the FBI produced estimates very similar to the true crime rates in the simulation, then this would confirm the quality of these procedures. If the nature of missingness in the simulation is similar in all important respects to that in the UCR program, then this would be useful. If it is not, then the simulation results will not be very useful. The weakness of this method, of course, is that it assumes that results from complete reporters can be used to say something about nonreporters.

Still another approach to assessing the quality of imputation in Return A data would rest on the assumption that an imputation method that conditions on observed attributes of the agencies in estimating the mean is superior to those methods that do not (Little & Rubin, 2002) because it reduces bias due to nonresponse and increases precision. The more discriminating the variables that are used to estimate the missing crime data, the more likely that this conditioning is to produce the benefits that Little and Rubin claim. We can, therefore, assess the relative quality of the UCR program's current imputation methodology on the basis of the discriminating power of the variables used to condition the mean in the mean substitution component of the imputation method. If the stratification used by the FBI based on size of place and type of jurisdiction yields very low within-strata variance relative to between-strata variance, then the imputation method would be more acceptable than if the within-strata variance were large compared with the between-strata variance.

To implement this test, the factors that are used in the UCR imputation routines were entered into an analysis of variance predicting jurisdictional crime rates (see Table 4). This was done for the total crime rates and for crime-specific rates. For both types of rates and for all classes of crime, the results were the same. The factors used to form strata in the UCR imputation routines do not explain much of the variation in crime rates. Although the proportion of variance explained by these factors is statistically significant, it is very small. This suggests that the factors used to form strata in the current UCR imputation routines are not very discriminating and that a more discriminating stratification would produce better imputation.

Conclusion

This article confirms Maltz's (1999) findings that missing data are substantial in the UCR program and certainly worthy of attention. They are not randomly distributed and cannot, therefore, simply be ignored. Much of the work done with the unimputed UCR data has overrepresented the experience of larger urban places and underrepresented smaller and less urban places (LaFree, 1998). It is difficult to determine if this overrepresentation has substantial effects on conclusions based on these data. The imputation strategies employed by the UCR program are reasonable and appear to reduce the overrepresentation of larger places. However, these methodologies can clearly be improved upon.

Table 4
Ratios of Between and Total Variation in Offenses Known Rates
by Population Subgroups and Division for Specific Types
of Crime: Return A Data, 1992

Type of Crime	Ratio of Between to Total Variance	
	Population Group & Division	Population Group, Division, & Agency Type
Murder	5.30	6.40
Rape	9.20	12.80
Robbery	3.80	4.00
Aggravated assault	7.90	11.50
Burglary	3.40	5.50
Larceny	5.00	8.90
Motor vehicle theft	0.80	0.90
Total offenses	3.90	6.50

Initially, improvements in the mean substitution methodology currently employed by the UCR program should more completely exploit the minimal information available on agencies in the current data files. Adding additional variables to identify homogeneous strata could be easily done, as this article has demonstrated. A more thorough effort could look more broadly for information about police departments and jurisdiction that would increase the homogeneity of the strata used in mean substitution. Linking the Law Enforcement Management and Administrative Statistics (LEMAS) to the Offenses Known and Arrests data would provide a reasonable database for identifying the kind of information useful for building homogeneous strata.

Imputation strategies very different from mean substitution should also be explored. Maltz (1999) has advocated the use of longitudinal rather than cross-section imputation techniques. Here, prior data from the same agency or jurisdiction would be used to estimate missing data rather than contemporaneous data from "similar" jurisdictions. Our data suggest that the bulk of missing data are from chronic nonreporters, which would limit the feasibility of longitudinal imputation at the agency level. Nonetheless, it is important to explore the potential viability of longitudinal imputation. Similarly, it is also important to explore multiple imputation techniques so that imputed estimates in the UCR program could be presented with some sense of the variability introduced by the process of imputation (Little & Rubin, 2002; Rubin, 1987).

Ultimately, all of the foregoing remedies for missing data assume that those who report are similar to those who do not. It would be useful to explore this assumption with a limited study of nonreporting in the UCR program. This not only would tell us about our assumptions but it would also suggest to the UCR program strategies for reducing nonreporting.

Notes

1. It is useful to distinguish the use of the Uniform Crime Reporting Program as an indicator of police activity and as an indicator of crime. The appearance of the victimization surveys raised more questions about the latter use than the former (Biderman & Reiss, 1967).

2. We also present, where appropriate, information on the extent of these issues in the Arrests data, known as Age, Sex and Race (ASR) Arrests data in the Uniform Crime Reporting Program. Although these issues merit extensive examination as well, in-depth analyses of this data source are beyond the scope of this work.

3. The Federal Bureau of Investigation is in the process of implementing the National Incident-Based Reporting System, which will be the incident-based successor of the current Uniform Crime Reporting Program (see Addington, 2008; Barnett-Ryan & Swanson, 2008).

4. The Uniform Crime Reporting Program increasingly includes special police agencies such as university and special district police.

5. Work in progress suggests that there might also be a certain amount of undercoverage in the Uniform Crime Reporting (UCR) program that will contribute to the missing data in the system. Undercoverage refers to agencies that are eligible to participate in the UCR program but are unknown to the program. These agencies are not included in estimates of missing data due to nonresponse. It is not yet clear how many undercovered agencies there are.

6. The 1992 data are used here and in subsequent sections because the crime problem in the period 1992 to 1995 was quite different in large and small places. The effects of imputation and the overrepresentation of large places will be most visible in this period. Moreover, the overall distribution of reporting across types of places in the annual estimates does not change radically over time. Due to space considerations, we focus primarily on the 1992-1993 data with some contrasts to more recent 2003 data.

7. Reporting patterns in the Uniform Crime Reporting (UCR) program Arrests data for the same time period suggest a similar pattern among small rural, regional, and non-UCR program reporting localities, except the prevalence of missing data is considerably larger in these Arrests data with about 10% to 20% more missing data distributed nonuniformly across these strata.

8. Maltz (1999) makes a convincing case for the importance of county-level imputation for the production of county estimates. An increasing number of researchers are using these county-level data (Lott, 2002). Imputing at the county level, however, is much more complex than imputation for the purpose of nation-level estimates. It is not clear that reasonable imputation strategies can or should be implemented at the county level.

9. *Crime in the United States* is published annually by the Federal Bureau of Investigation. However, at least three sources of data can and are sometimes used by researchers, practitioners, and others to support statements relative to policy and practice in crime analysis and criminology. The annual publications are the most common source of data. A second source of data is the various tapes that are deposited with institutions or individuals who request such data on various electronic mediums. Finally, a third source of data is the raw tapes that are maintained by the Uniform Crime Reporting Program of the FBI. These tapes may vary from other tapes produced for third parties and almost always vary from the annual publication.

10. Imputation for Arrests data is somewhat more straightforward using agency totals and population data and groupings (see FBI, 2004) from complete reported to employ a mean substitution strategy for specific offenses with rounding employed for ease of reporting totals.

11. Sometimes, county, state, or special census estimates become available and they are used when appropriate. Nonetheless, intercensal estimates of the population become increasingly larger underestimates of the population as the time from the last census increases. By the end of the decade, the population estimates provided by the U.S. Census Bureau are approximately 4% lower than the estimates from the decennial census.

12. This reported percentage decrease also happens to be of similar magnitude to the change shown in the trend data tables reported in *Crime in the United States*, which use agencies reporting 6 or more

common months of data. In using this methodology for trend analysis, the Uniform Crime Reporting Program provides an additional check on the magnitude of imputational effects in the overall crime data reported.

13. The imputation procedures for Arrests data similarly redress the overrepresentation of large places in the raw Uniform Crime Reporting Program data. However, the effect of imputation on change estimates is substantially greater than the effects of imputation on level estimates in the Arrests data, perhaps due to the greater volume of missing data in this series.

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James P. Lynch is a distinguished professor at John Jay College. He has written extensively on crime statistics and, specifically, the Uniform Crime Reports and the National Crime Victimization Survey. His interests also include theories of victimization risk, cross-national comparisons of crime and justice policy, and the role of coercion in social control.

John P. Jarvis is a senior scientist for the Federal Bureau of Investigation's Behavioral Science Unit. He has worked for the bureau in a variety of roles including a statistician for the Uniform Crime Reporting Program. He currently instructs FBI personnel in crime analysis and applied criminology and conducts research on crime trends, serial crimes, and related criminological topics of interest to the intelligence and law enforcement communities. He received his doctorate from the University of Virginia and serves as an adjunct professor and guest lecturer at numerous universities, colleges, police departments, and other venues across the country.