How many Peruvians have died?

An estimate of the total number of victims killed or disappeared in the armed internal conflict between 1980 and 2000

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0.   Preface to the English version

The report which appears below from the Peruvian Comisión de la Verdad y Reconciliación (CVR) was released in Lima, Perú on 28 August 2003. It is joint work done by the American Association for the Advancement of Science (AAAS) with data and technical support provided by the Comisión. Patrick Ball and Jana Asher were the principals from AAAS, and David Sulmont and Daniel Manrique were the principals from the CVR.

The report, with all of its technical detail, warrants patient study. While further analyses will be possible from the basic data, the results are broadly similar to earlier work AAAS conducted in Guatemala and Kosovo. This study and its two predecessors employed multiple systems estimation with tightly controlled matching of victims across all lists.

The report observes that total estimated number of victims (69,280) differs considerably from the figures commonly advanced before the creation of the CVR. Earlier information came from the centers of social, economic, political and cultural power within the country. Drawing on the detailed discussions presented in the CVR report, we note that the geographic regions where the conflict was most intense are remote, and that the people who were affected were primarily peasants in rural areas, poor people, and those culturally farthest from the "western" world. Given these factors, it is disturbing but not, perhaps, surprising that so many of these citizens of this "ignored" Perú perished in the face of the ignorance and even indifference of the official, modern, and "western" Perú. Statistical methodology has parted the veil of indifference and ignorance, and the true state of affairs in Perú over the past two decades has begun to emerge.

1.   Introduction

How many people died or disappeared in Perú between 1980 and 2000 as a consequence of the armed internal conflict? In this article, we try to

answer this question by presenting the results of data analysis of three sources of information available to the CVR.[1] This analysis applies a similar statistical method used in other projects, including Guatemala (1960-1996) and Kosovo (March to June 1999), to estimate the number of deaths caused by political violence.[2]

Given the available information, we estimate that the total number of deaths caused by the armed internal conflict in Perú is 69,280 people. The 95% confidence interval around this estimate spans the range 61,007 to 77,552. The relative proportions of victims attributed to the principal actors of the conflict are 46% for the PCP-Shining Path, 30% for the agents of the Peruvian state, and 24% for "other perpetrators" (including the peasant "rondas", the self-defense committees, the "Tupac Amaru" Revolutionary Movement (MRTA), paramilitary groups, unidentified perpetrators, and victims of armed combat).

In this document, we first analyze the relationship between reported and unreported cases of deaths. In the second part, we present a summary of the principal findings and conclusions of the report. Next, we describe how the source information is organized and processed. In the final section, we explain the procedures and techniques used to calculate the total number of deaths. In Appendix 1, we present the results of sensitivity tests to which we subject the calculations and estimates. In Appendix 2, we compare the results of the estimate for the Department of Ayacucho with demographic projections based on the national censuses of 1981 and 1993. Finally, in Appendix 3, we present our schema for the stratification of Perú for estimation purposes.

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[1] The data sources include the following: The database of the CVR; the database of the Defensoria del Pueblo including depositions about forced disappearance presented to the Public Ministry; and the database of depositions registered by NGOs. These sources are described in detail in Section 3.

[2] See CEH 1999; Ball 2000; Ball, Betts, Scheuren, Dudukovich and Asher 2002.

1.1 The questions that guide the analysis

In the process of its research, the CVR received reports of approximately 24,000 people dead or disappeared[3] as a result of the armed internal conflict. From this total, 18,397 people were identified specifically by their complete names (forename, paternal and maternal surnames).[4]

Even with the unprecedented mass of information collected by the CVR, not all the victims are documented. In Section 3, we show that there are approximately 5,000 victims who are not reported in the testimonies collected by the CVR, but who are documented in the databases of the Defensoria del Pueblo (DP) or by human rights NGOs (ODH). There are, furthermore, other victims who have never been documented by any project: the witnesses may live in remote regions of the country, some witnesses may have been profoundly traumatized and continue to fear reprisals if they tell their stories, some victims died without leaving live witnesses of the events, etc.

One of the first questions with which to begin a scientific analysis that takes all of these factors into account is the following: how many deaths occurred in the armed internal conflict in Perú? Answering this question requires us to count all the victims who have been reported to one or more of the research projects, (CVR, DP, ODH), plus those who have never been reported to any project.

Another important question is in what proportion are potential perpetrators responsible for deaths. In the total number of cases reported in the testimonies collected by the CVR, slightly less than half of the deaths are attributed to the PCP-Shining Path; approximately a third are the responsibility of the agents of the state; the remaining

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[3] From this point forward we refer to deaths and disappearances as deaths. Nonetheless the authors are aware that these are distinct categories from legal and social perspectives.

[4] Seventy-eight percent of the deaths reported to the CVR have a complete name; 19% have only the forename and a paternal surname; 3% of the reported victims have only a paternal surname, a forename, a pseudonym or some other characteristic with which the victim could be individually identified, short of a complete name. The

proportion corresponds to victims of other perpetrators or to unidentified perpetrators. However, in other data collection projects, the PCP-Shining Path and other non-governmental perpetrators are named in a much smaller proportion of the documented cases (between 5 and 16%) than calculated by the CVR. Given the great difference between the sources of information, how can we know what the real proportions are?

Multiple, separately-collected documentation systems (like the three already mentioned) can be used to estimate the total number of deaths, including both the documented and undocumented deaths. The statistical method used is called "multiple systems estimation" (MSE). This method uses information about the overlapping report of the same event across multiple data gathering projects (say A, B, and C). "Overlap" is the pattern in which some people are documented by name in only one data gathering project, others are documented by name in A and B but not C, others in A and C but not B, others in A, B, and C, etc. Using the overlap pattern (and some basic assumptions, described below), we make statistical inferences about how many people are not documented by any list.

This report describes an estimation procedure that starts with MSE and draws on other statistical techniques to answer the questions above.

1.2 Antecedents

Multiple-systems estimation was originally developed to estimate the size of animal populations (Petersen 1896), and it has been applied to many estimation questions in which probability sampling is insufficient or infeasible. The most prominent use of MSE has been to correct population censuses where the direct enumeration of people is known to exclude some individuals from the final counts (Sekar and Deming, 1949; Hogan, 1993; and Anderson and Fienberg, 2001).

alternative identifiers included age, family relationship, or their position in their community.

Most relevantly to this study, MSE has been used twice before — in Guatemala and in Kosovo[5] — to clarify the total number of deaths due to political violence.

In Guatemala, the estimates were made using data collected in 1994 to 1998 by three independent research projects: by the "Recuperation of Historical Memory Project" (REMHI) of the Catholic Church, by a coalition of non-governmental human rights organizations (the CIIDH), and finally, by the U.N.-organized Commission for Historical Clarification (CEH) which is analogous to the Peruvian CVR.

The total estimate formed the core of the CEH's finding that more than 200,000 people were killed during the armed internal conflict. When the total estimates in Guatemala were disaggregated by the ethnicity of the victims, we established that a) in some regions, 40% or more of the indigenous people alive (and documented in the census in 1981) had been killed between 1981–1983; and b) that the proportion of people killed was five to eight times greater for indigenous people than for non-indigenous people. The combination of these observations formed one of the bases for the Commission's finding that acts of genocide were committed by the Army against the Mayan people (see CEH 1999 and Ball 2000).

In Kosovo, multiple systems estimation was used to estimate first the total number of Kosovar Albanians killed during the conflict between the North Atlantic Treaty Organization (NATO) and Yugoslavia in March–June, 1999 (Ball, Betts, Scheuren, Dudukovich, and Asher 2002). The total number of people killed was then disaggregated over time and space. The results, combined with an analysis of patterns of migration also over time and space, were compared with various explanations for violence in Kosovo during this period. Hypotheses that violence was caused by NATO or by the guerrillas of the Kosovo Liberation Army were rejected as inconsistent with the data. The analysis was presented as

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[5]The projects in both Kosovo and Guatemala were conducted by subsets of the authors of the present study.

expert testimony in the trial of Slobodan Milosevic at the International Criminal Tribunal for Former Yugoslavia in the Hague.[6]

2.   Summary and principal conclusions

In the Peruvian case we use the CVR and the other two sources of information to estimate the total number of deaths caused by the armed internal conflict, broken down by the principal perpetrator groups and by broad geographic regions. In the following sections we present the results at lower levels of disaggregation.

The total number of deaths broken down by perpetrating organization is shown in Table 1. The total sum is 69,280. This estimate should be interpreted to be in a range from 61,007 to 77,552 victims which constitutes a 95% confidence interval around the estimate.[7] The table shows that the PCP-Shining Path (SLU) is responsible for 46% of the victims, the agents of the state (EST) for 30%, and the rest of the perpetrators (OTR) for 24%.

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[6] See http://shr.aaas.org/kosovo for more information.

[7] This range may be understood in the following way: there is a true number of deaths which we are estimating for each perpetrator. Our estimate of the number of deaths for each perpetrator is just that – an estimate. Since the confidence interval upper and lower bounds are determined by adding and subtracting from this estimate, they are also estimates. The confidence interval represents a probability that these estimates (the upper and lower bound) "sandwich" the true number of deaths. In this case, we have constructed the confidence interval so that there is a probability of 95% that the lower bound of the confidence interval lies beneath the true number of deaths and the upper bound of the confidence interval lies above the true number of deaths.

Table 1

Perú 1980–2000: Estimates and confidence interval limits of the total number of deaths caused by the armed internal conflict, by responsible party (confidence level: 95%)

Estimates	Responsible party			Total(*)
	PCP-Shining Path	State agents	Others	
Lower limit	24,823	17,023	11,858	**61,007**
Estimate	31,331	20,458	15,967	**69,280**
Upper limit	37,840	23,893	20,076	**77,552**

(*) Results in the "Total" column were directly calculated by the MSE, and are not the sum of the individual estimates.

Table 2 shows the estimates of the differences between the number of victims for whom responsibility is attributed to each perpetrator group. For example, the total number of deaths attributed to the PCP-Shining Path minus those attributed to the agents of the state is found in the range 5,118 to 16,626 (SLU-EST). The results in Table 2 indicate that the total number of estimated victims for one perpetrator group is significantly different from the estimates for the other two groups. In this context, we speak of *significance* in order to assert that the quantitative difference between groups is very unlikely to have occurred by chance. Using formal statistical language, by significance, we mean that we can reject the hypothesis that the number of deaths caused by one group is the same as the number caused by either one of the other two groups. The central conclusion of this table is that considering the country as a whole, between 1980 and 2000, the PCP-Shining Path is responsible for a significantly greater number of deaths than agents of the state involved in the counterinsurgent struggle or the other actors in the armed internal conflict.

Table 2

Perú 1980–2000: Estimates and confidence interval limits for the difference between deaths attributed to responsible parties (confidence level: 95%)

	Differences between responsible parties		
Estimates	SLU-EST	EST-OTR	SLU-OTR
Lower limit	5,118	872	12,175
Estimate	10,872	4,824	17,376
Upper limit	16,626	8,776	22,577

Graph 1 gives the total number of victims estimated for each of seven regions[8] and their respective 95% confidence intervals.

Graph 1

Perú 1980–2000: Estimates of total fatal victims of armed conflict by region (confidence level: 95%)

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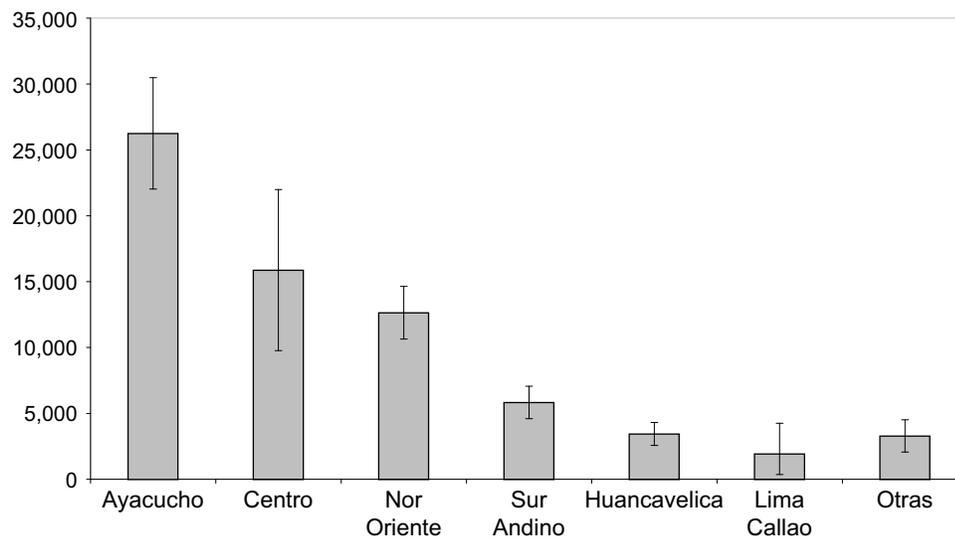
[8] The Central region is composed of the Departments of Junin and Pasco; the Northeast region is composed of the Departments of Huanuco, Yucayali, and almost all of the provinces of San Martin; the South Andean region is composed of the Departments of Cusco, Aporimac and Puno. Except the Department of Huancavelica and the Provinces of Lima and Callao, the rest of the regions are in the category "Other."

This graph confirms that Ayacucho was the Department most affected by the armed internal conflict, followed by the Central region and the Northeast. As can be seen in the graph, the size of the confidence intervals for the Central and Northeast region suggest that it is not possible statistically to assert that either of these regions had more victims than the other.

It is worth clarifying that the geographic divisions shown in Graph 1 are not exactly the same as used in the chapters describing regional histories in the CVR report. The differences result from how we used geographic stratification to detect and isolate differences in the overlap patterns among the sources of information. Our stratification did not necessarily follow major political divisions, but corresponds instead to a statistical grouping of similar departments (for more details, see Section 4.3).

In order to corroborate the estimate of the total number of deaths, in Appendix 2 we compare the estimate made for Ayacucho (26,259 victims) with an analysis of the demographic patterns of that Department between 1981 and 1993. We show that the number of people "lost" in the demographic analysis is greater than the number of deaths calculated by MSE. In the context of this demographic analysis, we conclude that the estimates produced by MSE can be considered as a reasonable lower limit of the total number of deaths in the Department of Ayacucho.

In Graphs 2 and 3 we compare the estimated number of deaths by perpetrators across different regions, along with the 95% confidence intervals for each estimate. In Graph 2 the distribution of victims by perpetrator over regions follows the general pattern show in Graph 1.

Here we emphasize the importance of the estimates calculated in the category "other perpetrators" in the regions of Ayacucho and Central and Northeast, especially compared with the other regions. It is in these zones that the "rondas" and self-defense committees had their greatest impact (for example, in the Apurimac and Ene River valley between Ayacucho and Junin; and in the province of Satipo in Junin), as well as

the MRTA (in the Department of Junin in the zone of Alto Huallaga and in the Department of San Martin). On the other hand, it is clear that in the zones where the conflict was most intense it is very difficult to identify precisely which perpetrators are responsible for a death or a disappearance. This difficulty is likely to be the cause a large number of victims in the category of "other" perpetrators.

Graph 2

Perú 1980–2000: Estimates of the total number of victims of
internal armed conflict, by region and responsible party
(confidence level: 95%)
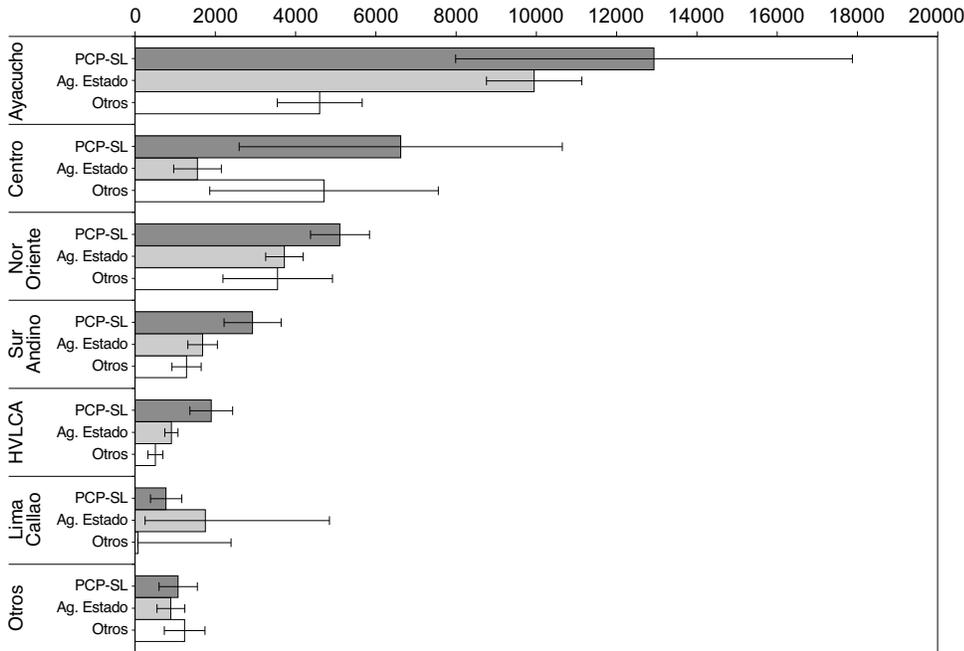
Graph 3 shows with greater precision the differences between the estimates calculated for different groups in each region. Each bar represents the difference between the estimates for a pair of groups, i.e.

SLU versus EST, EST versus OTR, and SLU versus OTR. Inside each bar is a line that represents the 95% confidence interval of the difference.[9]

Graph 3

Perú 1980–2000: Estimated differences between the number of victims per pertrator, by region (confidence level: 95%)
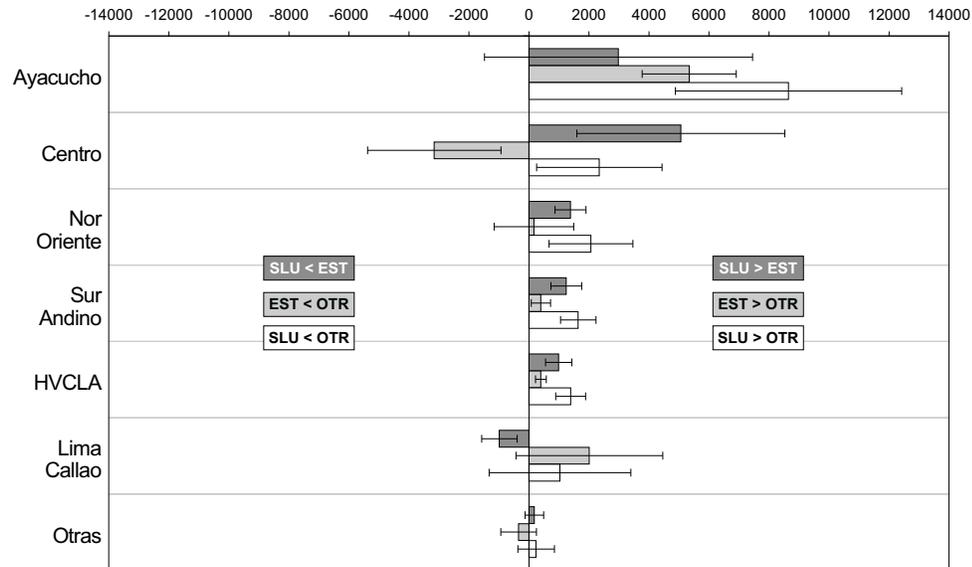
Reading Graph 3, we conclude that in Ayacucho between 1980 and 2000 it is not possible to assert that the number of victims attributed to the PCP-Shining Path is significantly greater than the number attributed to the state. In other words, given the available information, we cannot reject the hypothesis that in this area the two groups caused a similar number of deaths. Nonetheless, in the same Department the other differences are statistically significant (EST>OTR and SLU >OTR).

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[9] Graph 3 should be read in the following way, if the bar falls to the right side of the center axis of the graph, this means that the estimate is positive (SLU > EST). If, on the other hand, the bar falls to the left side of the center axis of the graph, the difference is negative (SLU< EST). If the line that represents the confidence interval remains on one side of the graph and does not cross the axis at zero, we conclude that the difference is statistically significant. However, if the line crosses the axis at zero, it is not possible to reject the hypothesis that the difference between the groups is equal to zero.

With the exception of Ayacucho, Lima-Callao, and the category "other regions", the estimates calculated for the number of victims attributed to the PCP-Shining Path are significantly greater than the estimates attributed to the other two groups. Only in Lima-Callao is the result calculated for agents of the state significantly greater than the estimate for the PCP-Shining Path.

A further point about the Central Region: the totals calculated for the PCP-Shining Path and the "other perpetrators" are much greater than the estimated number attributed to agents of the state. However, we are unable to assert that the difference between the PCP-Shining Path and the other agents is statistically significant, although we note that the result is consistent with the historical characteristics of the conflict in the Central Region. Research conducted by the CVR has emphasized the importance of the actions of the "rondas" and the self-defense committees (especially of the Ashaninka people) and of their armed confrontations with members of the PCP-Shining Path. These conflicts were particularly acute in the Central rain forests.

In general, the tendencies and patterns in the estimates shown in Graph 3 are consistent with the findings presented in various chapters of the CVR report. The magnitude of the total estimated number of victims — 69,280 — differs considerably from the figures commonly advanced before the creation of the CVR, which were between 23,000 and 35,000.[10] Please note that there is no correction for undocumented events in these earlier figures. The magnitude of the differences may seem strange in the context of common sense and national public opinion, especially for those people whose contact with debates and information has come from the centers of social, economic, political, and cultural power

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[10] The sources of these projections are: the National Police and Ministry of Defense — 22,854 victims (Bernales, et al., 1989; INEI 1999); Chronology of DESCO 1980-2000 — 25,753 victims (DECSCO 1989; and the monthly bulletins of DESCO 1989 and 2000); Census for Peace of the PAR — 34,489 victims; (PAR 2001). However, none of these sources created a list of victims identified by name. Their projections were calculated on a database of reported violent actions (appearing in news media, registered by military or police forces, or recorded by community leaders) and an approximate number of victims caused by the action.

within the country. Looking beyond scientific arguments about the rigor of the methods used in this statistical analysis, and drawing on the detailed discussions presented in the CVR report, it was the remote geographic regions where the conflict was most intense, and we note that those most affected (rural areas, peasants, poor people) were culturally farthest from the "western" world). Given these factors, it is disturbing but not, perhaps, surprising that so many of these citizens of this "ignored Perú" perished in the face of the ignorance and even indifference of the official, modern, and "western" Perú.

3 Description of data and matching process

The preparation of information on which the analysis and calculations are based required that information about identified victims be matched across six different databases. The result of this data matching is a single unified record in which each person appears only once, with references to all the databases in which he or she is found.

3.1 Sources of data used in this project

In the following table, we briefly describe the principal characteristics of the databases that were analyzed to generate the unified dataset.

Database Name	Description
Truth and Reconciliation Commission (CVR)	Contains information about victims of crimes and human rights violations. The information comes from coding 16,886 testimonies collected by the CVR in the fulfillment of its functions. These records cover the period between 1980 and 2000 in the entire territory of Perú.
National Coalition of Human Rights (CNDDHH)	The cases documented by the organizations in the CNDDHH include data on events occurring between 1983 and 2000 in the entire territory of Perú.
Agricultural Development Center (CEDAP)	Contains a list of victims from the Chungui District in the province of De La Mar in the Department of Ayacucho. The list was created with information from testimonies taken in this area by CEDAP with the assistance of the municipality of Chungui, for the period 1980 to 2000.
Human Rights Commission	This database includes records of victims of forced disappearance and events occurring between 1982

Database Name	Description
(COMISEDH)	and 1996 in the entire territory of Perú, but principally in the Departments of Ayacucho, Apurimac, and Huancavelica.
Defender of the People (DP)	Contains cases related to the forced disappearance and extra-judicial execution of people. These testimonies were presented to the Public Ministry between the years 1983 and 1996. Additionally, there are records included in this dataset derived from NGO sources; these records are distinguished from records taken by the DP.
International Committee of the Red Cross (CICR)	This list of missing persons includes people thought to have been victims of violent disappearance or murder. The list was written with information brought by families of the victims to the CICR. It does not include information about the alleged perpetrator of the disappearance.

Note: for the triple-systems estimation described in Section 4, the last four databases were treated as a single system.

3.2 Matching procedure

The procedure to merge the databases and match the results is described below.

3.2.1 Selection and preliminary preparation of records of deaths

From each of the original databases, we selected only the records with complete names (forename, paternal surname, and maternal surname)[11] in order to create a standard format to be able to compare selected information from all the databases. The standard format includes, in addition to the forename and surname, the following fields: the place where the death or disappearance occurred (department, province, district, population center), the year of the death (when provided), the organization alleged to have committed the event, the date of birth of the victim, and the current status of the victim (dead or disappeared).

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[11] We did not include records which were missing one or more of these elements because without complete data, it is impossible to uniquely match records with very similar names since incorrect matching could bias the final result. We chose to exclude incomplete records.

Similarly, we created conversion tables to standardize the coded fields (geographic codes, status).

To avoid problems resulting from typographical errors in names and surnames, especially names in Quechua and other indigenous languages, we created a table to standardize names and surnames for sorting and comparison.[12]

Finally, with all the data in standard formats, we designed a computer-assisted matching program that allows users to see the complete data on each record in each source in order to compare them, and to resolve contradictory or unclear information.

3.2.2 Matching data in series

In order to determine which records in each database corresponded to records in other databases, we ordered all the records in a single list. The users were able to sort the list using several criteria[13] in order to identify similar records. The decision about whether two or more records refer to the same person was made by members of the coding team of the information systems area of the CVR.

The work matching the databases in series, as described above, was undertaken by two independent teams working on the same data at the same time. This means that every decision about whether two or more records represent the same person was made independently by more than one analyst. By having multiple decisions about each possible match, we can measure possible bias that might result from one analyst using criteria that are different from another analyst. The final raw rate of agreement of the decisions between the two teams is 94%, which implies a relatively high level of reliability by the standards of social science.

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[12] In this way, records of victims with surnames like Llanque or Yanque; Curo, Kuro or Curi (which could all be the same person) appeared together in an alphabetical list.
[13] Criteria include name, surnames, or place of event. Each possible combination of sort orders is explored in order to maximize the detection of similar records.

3.3 Aggregating the results

Using the matchers' results, we created a single unified database which indicates, for each death, which of the databases contain that death. That is, each death is qualified by three binary variables:

- CVR: This person is recorded in the database of the CVR;

- DP: This person is identified in the records of the Defensoria del Pueblo by information collected from the Public Ministry;

- ODH: This person is identified in one or more of the following databases: CNDDHH, CEDAP, COMISEDH, CICR, or in one of the cases in the database of the Defensoria del Pueblo which was given to them by a non-governmental organization.

The final results are shown in Table 3.

Table 3

Perú 1980–2000: Reported number of deaths, by responsible party, by the presence or absence of each of the sources of data

			ODH Database				Total reported victims
			Yes		No		
		DP database	Yes	No	Yes	No	
EST	CVR database	Yes	1,184	627	554	3,888	11,564
		No	1,140	2,532	1,639	??	
SLU	CVR database	Yes	23	105	59	8,768	9,243
		No	2	251	35	??	
OTR	CVR database	Yes	7	34	10	3,138	3,885
		No	76	571	49	??	
Total							24,692

The total number of unique deaths reported to one or more of the three systems, after matching, was 24,692.

There are 1,184 deaths attributed to agents of the state which are reported in all three systems (CVR, DP and ODH), and a total of 11,565 deaths attributed to agents of the state which are reported in one or more system. This total represents 40% of all the deaths documented in these sources.

It is interesting to note that of the total documented deaths attributed to agents of the state, 33% appear only in the CVR database. In contrast, 95% and 80% of the documented deaths attributed to the PCP-Shining Path, or other perpetrators respectively, appear exclusively in the CVR database. As is clear in Table 3, the CVR recorded a broader profile of perpetrators than the other two projects. We believe that the basis of this difference can be explained by a difference in mandate and institutional objectives among the projects. The CVR was mandated to investigate all crimes and human rights violations committed between 1980 and 2000 irrespective of the alleged perpetrator. The human rights organizations and the Public Ministry were not able to conduct large scale research on the events during the most intense periods of the conflict. Furthermore, these groups received reports of violations principally from victims or family members of victims. Nearly all of these cases involved agents of the state which were involved in the counterinsurgency campaigns. These organizations focused particularly on acts of the state — not on the insurgent groups — because the state had signed international agreements that obliged them to respect human rights and to sanction those who committed violations.[14]

4   Estimation procedures

In this section, we explain in detail the procedure we use to calculate the total number of deaths resulting from the armed internal conflict. First,

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[14] For a more detailed discussion, see the Chapter covering the human rights movement and the armed internal conflict in Tomo III in the CVR report.

we present briefly the basis of multiple systems estimation (MSE), including the assumptions and limitations of the method. In particular, we examine how in the project these limitations and assumptions require us to stratify Perú into small geographic regions.

Second, we describe how the models are defined and how we calculated estimates from data aggregated over various perpetrator categories. Deaths attributed to agents of the state tend to be better documented than deaths attributed to other perpetrators. We therefore use information about deaths attributed to the state as a basis for creating estimates of deaths committed by other perpetrators.

Next, we consider the procedures we use to select the most appropriate models among the various possible estimates for each stratum.

Fourth, we present a method for stratifying the political and geographic regions in order to define the optimal models within each stratum.

Fifth, we describe a variance estimation technique called jackknifing. We explain how this technique is used to calculate the confidence intervals of the estimates of the total number of victims attributed to the PCP-Shining Path and to the other perpetrators.

Finally, in Appendix 1 we consider various techniques to test the estimates, including a comparison of different combinations of estimates for each perpetrator group and an analysis of the distribution of different types of models that result from the model selection procedure.

4.1 Multiple systems estimation — theory, limits and assumptions[15]

As is mentioned above, MSE is a method that uses several separately-collected incomplete lists of the population. The lists are matched

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[15] Section 4.1 borrows liberally from Ball and Asher, 2002.

identifying the elements common across lists in order to estimate the number of elements that are missing from all of the lists.

The most basic form of this technique is capture-tag-recapture, which uses only two lists. A simple example is shown in Diagram 1.

Diagram 1

Capture-tag-recapture example with two lists
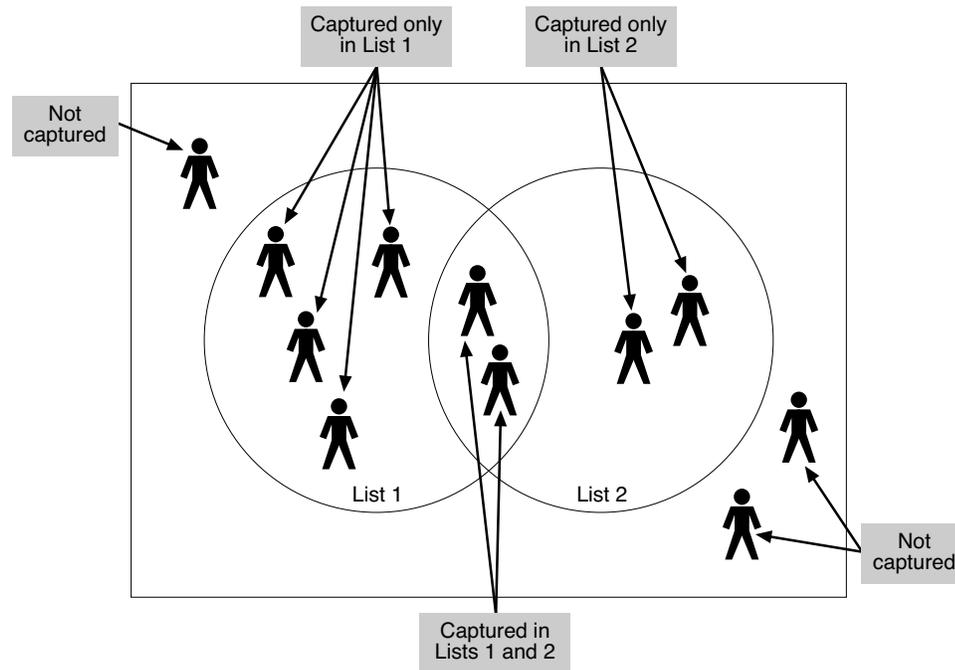
The basic technique used to estimate the total size of the population is to note that the ratio of the number of people captured in both lists (List 1 and List 2) to the number of people captured in List 1 is proportional to the ratio of the number of people captured in List 2 to the number of people in the total population. In this example, the ratio is:

$$\frac{2}{6} = \frac{4}{N}$$

where N, the total number of people in the population, is unknown. The estimated value of N can be found by rearranging the terms,

$$\hat{N} = 4 \times \frac{6}{2} = 12$$

A more technical explanation of how a count of the unknown members of the population can be estimated is as follows. Consider the case of two projects P_1 (a list of A individuals) and P_2 (a list of B individuals). There are M individuals on both lists, in a universe of N individuals. If all of the people in the universe N have an equal probability of appearing in List 1 then the probability of a specific individual being reported by P_1 is

$$Pr(captured\ in\ list\ 1) = \frac{A}{N}$$

Similarly, if all of the people in universe N have an equal probability of appearing in List 2 then the probability of a specific individual being reported by P_2 is

$$Pr(captured\ in\ list\ 2) = \frac{B}{N}$$

If these two probabilities are independent, then the probability of a specific individual being captured in both lists is

$$Pr(captured\ in\ list\ 1\ and\ list\ 2) = \frac{M}{N}$$

By definition, the probability of an event composed of two independent events is the product of the independent probabilities. Therefore,

$Pr(captured\ in\ lists\ 1\ and\ 2) = Pr(captured\ in\ list\ 1)$ x $Pr(captured\ in\ list\ 2)$

Rearranging the terms,

$Pr(captured\ in\ list\ 1) = Pr(captured\ in\ lists\ 1\ and\ 2) \div Pr(captured\ in\ list\ 2)$

Which reduces to

$$Pr(\textit{captured in list 1}) = \frac{M}{N} \div \frac{B}{N} = \frac{M}{B}$$

Combining this with the first equation,

$$Pr(\textit{captured in list 1}) = \frac{A}{N}$$

we find,

$$\frac{A}{N} = \frac{M}{B}$$

and obtain the result that

$$N = \frac{AB}{M}.$$

There are many assumptions implicit in this ratio "solution." For example, we assume that none of the lists have individuals reported twice and that matching between the lists is accurate. In this project these two assumptions were controlled during the data processing. For example, we tested the reliability of the intra- and inter-list name matching as described in Section 3.

Other assumptions inherent in the capture-tag-recapture model are more difficult to manage. First, the method assumes that individuals are not entering or leaving the universe during the process of creating the lists, and second that the lists were selected randomly from the population. In human rights documentation projects, the first assumption is usually irrelevant because the documentation occurs retrospectively. The second assumption cannot be satisfied, and it must be replaced by the assumption that the estimation is robust to the selection process.

Another assumption is that the lists are independent, that is that the probability that an individual is in list two is independent of the probability that the individual is captured in list one. The final

assumption is homogeneity: that the individuals that compose the universe all have the same probability of being captured.

If either of these assumptions is violated, the capture-tag-recapture method will not yield an adequate estimate of the total population size. However, if there are more than two lists (as is the case here), the problems of dependency or heterogeneity can often be managed through the specification and selection of appropriate models (see Section 4.2).

Using the population from the simple example shown above, we can add a third list to the Venn diagram, as seen below in Diagram 2.

Diagram 2

Multiple systems estimation example
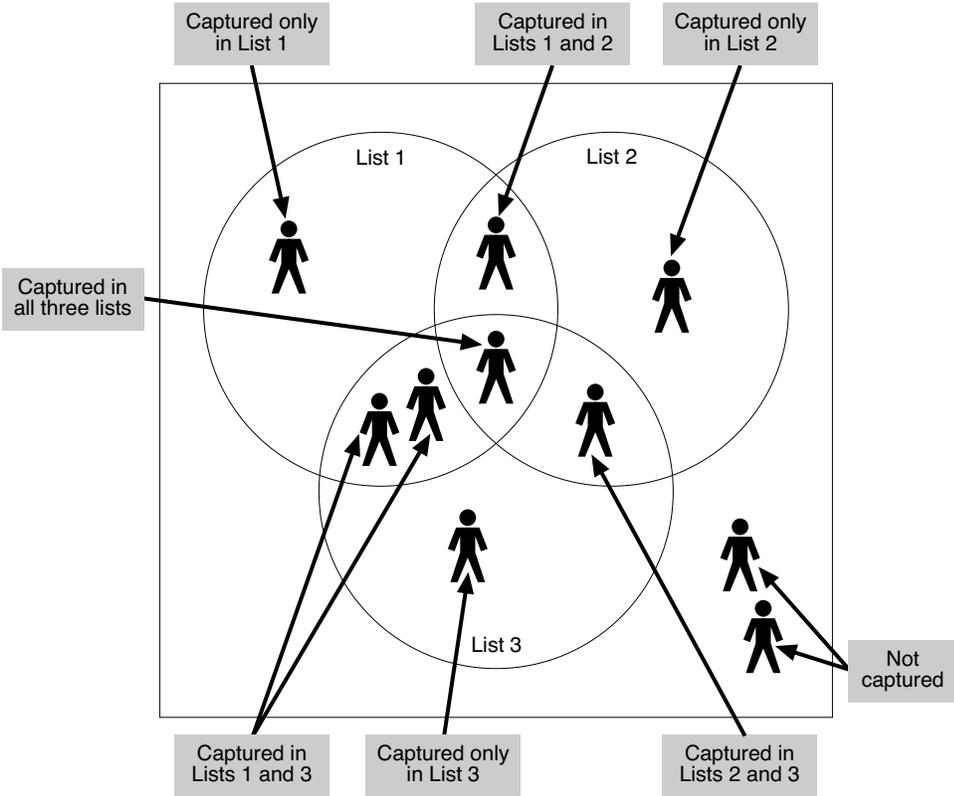
In this case, we can create models of interdependence among the three lists by using constrained, hierarchical log-linear models, as seen below.[16]

$$\log(m_{ijk}) = u + u_{1(i)} + u_{2(j)} + u_{3(k)} + u_{12(ij)} + u_{13(ik)} + u_{23(jk)}$$

The boxes in the diagram are labeled: Intercept; Parameter for List 2; Interaction between Lists 1 and 2; Interaction between Lists 2 and 3; Count: for ex. $m_{111}=1$; Parameter for List 1; Parameter for List 3; Interaction between Lists 1 and 3.

If we assume that there is no dependence among the lists, we use only the first four terms on the right hand side of the equation. If we believe that there is only dependence between the first and second lists, we add the first interaction term. We add additional terms to represent additional dependencies, as needed.[17]

There are other models that account for different forms of heterogeneity. Other violations of the assumptions can be managed through modelin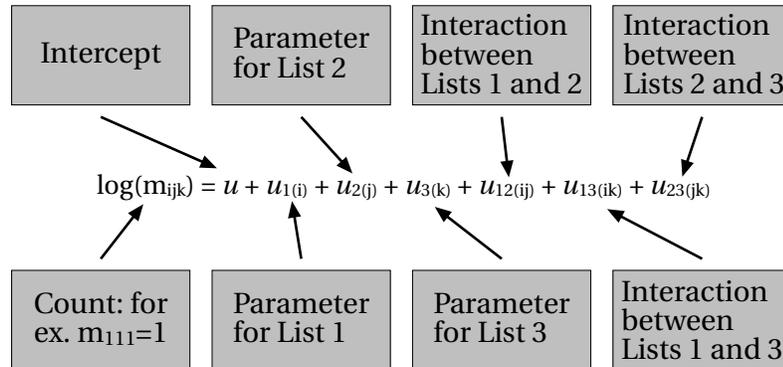g, while in other situations violations of the assumptions are minimal and can be ignored. Nonetheless, the violations of the assumptions in MSE may be too great for the models to fit well, especially if there are only three lists. For example, the heterogeneity patterns may be so complex that none of the models fits the data adequately. The measure of the "goodness of fit" of the models is the p-value of the X^2 statistic. If this probability is very small, the model does not fit the data and does not adequately estimate the undocumented deaths.[18]

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[16] In this notation, the subscript i (as well as j or k) takes the value zero if the individual is not in list i (or j or k). On the contrary, if the individual is included in list i, then i is equal to one.

[17] By fitting the model that includes an interaction between lists 1 and 3, the total estimate of the population in Diagram 2 is 12 people.

[18] If the probability of the value of the X^2 statistic is very high, the model overfits the data and cannot be used to generalize about unknown data; consequently, an

If the model is inadequate, one option is to stratify the population, using some variable that isolates the heterogeneity among the probabilities that a given individual will be captured in a given list (see Sekar and Deming 1949). In the case of reported deaths, it is likely that the probability that a death is reported varies by geographic region. We can therefore adopt a strategy of making estimates of total victims separately for different regions. However, if we create too many strata, the observed frequencies in the resulting tables will be sparse,[19] and the MSE will be unable to produce reliable estimates.

In the case of the data about Perú from 1980 to 2000, two levels of stratification are sought: first, over geography in order to control the affect of the heterogeneity of capture of reported deaths; and second, by perpetrator in order to determine the relative proportions of responsibility to be attributed to the PCP-Shining Path, agents of the state, and other perpetrators. However, the information available for deaths attributed to the PCP-Shining Path and other perpetrators is extremely sparse (as seen in Table 3 above). Our solutions to the problems of heterogeneity and sparseness are described in Sections 4.2 and 4.3, respectively.

4.2 Model selection

The ideal method to estimate the total number of victims for each perpetrator would be to stratify the data simultaneously by geography and perpetrator and then choose the model with the best fit for each perpetrator in each geographic stratum. This method is not possible because of the sparseness of the data for reported deaths attributed to the PCP-Shining Path and other perpetrators, as mentioned above. In

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overfitting model does not produce an adequate estimate. Overfitting occurs when the model fits the data too closely and therefore models only these data and none other. As the number of parameters used to fit the model approaches the number of cells in the table, all of the available information has been used for the model fitting, and none remains for the estimation. The goal is to find a model that fits reasonably well, but not so well that the same model would fail to fit different data describing the same phenomenon.

order to reduce the sparseness and to take advantage of the dense information about deaths attributed to the state, the following combinations of perpetrators were created.

- Agents of the state {EST}

- Agents of the state and PCP-Shining Path {EST + SLU}

- Agents of the state and other perpetrators {EST + OTR}

- All documented deaths {EST + SLU + OTR}

{EST} represents the deaths attributed to agents of the state; {EST + SLU} represents victims attributed to agents of the state and the PCP-Shining Path, etc. The fourth combination of lists is only used to verify the validity of our models (see Appendix 1), but the first three are used to calculate the estimates in each geographic stratum in the following way:

EST = {EST}

SLU = {EST + SLU} − {EST}

OTR = {EST + OTR} − {EST}

There are seven possible models for each geographic stratum and for each of the four combinations of perpetrator groups. One model assumes that three lists are independent, three models assume interaction only between two of the sources of information, and three models assume two such interactions. Schematically, if we define CVR = a, DP = b, and OTR = c:

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[19] An MSE table is sparse if some of the cells in the table have an observed frequency of zero. Although log linear models may be able to respond to one or two zero cells, a reliable estimate cannot be made in a table with three more more zero cells.

Model	Notation	Type
Model 1	a + b + c	Sources independent
Model 2	a + b + c + ab	
Model 3	a + b + c + ac	Two sources dependent
Model 4	a + b + c + bc	
Model 5	a + b + c + ab + bc	
Model 6	a + b + c + ab + ac	Two pairs of sources dependent
Model 7	a + b + c + ac + bc	

Given seven possible estimates for each stratum, we first discard those models for which the goodness of fit (given by the X^2 statistic) is inadequate. We keep only those models for which the probability of the X^2 statistic is between 0.01 and 0.50. If any models remain, we chose the model that minimizes the X^2 statistic divided by its degrees of freedom. This calculation balances the objectives of choosing a model with a reasonable fit as well as choosing a model that has the simplest possible interpretation.[20]

4.3 Design of the geographic stratum

Throughout the research process, every effort was made to assign the most precise and detailed geographic codes possible to the deaths documented in this study. We used the standard codification of geo-references from the National Institute of Statistics and Information,[21] which allowed us to code to the level of population center.[22]

On one hand, dividing and distributing the data into too many pieces (for example, one stratum for each district where victims are represented) results in sparse tables that are difficult to model. On the other hand, working with highly aggregated strata (for example, one

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[20] For more information about this method of model selection, see Ball, Betts, Scheuren, Dudukovich and Asher (2002).
[21] See: http://www.inei.gob.pe/siscodes/UbigeoMarco.htm
[22] The levels of political demarcation that represent the geo-reference of the INEI are: department, province, district, and population center.

department per stratum) results in models that fit poorly due to a multitude of heterogeneities and interdependencies.

Our objective in stratifying the data geographically was to maintain meaningful territories without allowing the data to become too sparse; this required a process of stratifying in different stages. During this process, priority was given to strata that would maintain geographic continuity and that could be modeled adequately. We started by distributing the departments in three large groups:

- The Amazon region (Loreto, Ucayali, and Madre de Dios)

- The departments that are located along the coast (Tumbes, Piura, Lambayeque, La Libartad, Ankash, Callao, Lima, Ica, Arequipa, Moquegua, Tacna)

- The departments that make up the mountainous region (Cajamarca, Amazonas, San Martin, Huanuco, Pasco, Junin, Huancavelica, Ayacucho, Apurimac, Cusco, Puno)

If the resulting table for that grouping of departments could be modeled well, and if disaggregating further would result in tables that are too sparse, we did not stratify further. Where further stratification was necessary, we tried to separate the departments that were previously grouped together. If the departments continued to have a large number of reported victims, we would subdivide the departments into groupings of provinces. In some cases (like that of San Martin), the provinces were subdivided into more groups and later were aggregated with other neighboring departments (See strata 12, 13, 14 and 58 of Map 1 and the table in Appendix 3).

Some provinces continued to have an large number of victims and substantial heterogeneity, in which case they were subdivided into groups of districts. Many of the districts were "self-representing" (especially in Ayacucho), by which we mean that they were directly converted into strata.

Finally, some reported deaths were missing information about the precise geographic site of death. Those cases were excluded from the estimation process. While we were stratifying, those victims who were documented with the geographic code necessary for placement in a specific strata remained within the group of cases used for the estimation. But when a particular case that did not have the corresponding code necessary to be considered in a designated strata was detected, it was excluded from the process. For example, in almost all of the data, the department where the incident occurred was known. When the process of stratification led us to disaggregate a department into smaller strata (provinces or districts), those cases that could not be geographically coded to this level were discarded.

The final stratification can be seen in Map 1 and in the full table in Appendix 3. Note that the majority of the departments located along the coast form a stratum that is divided in two, with the strata of Ancash and Lima in the middle.

We ran models and divided departments, provinces, and districts into strata at the same time, but only the fit of the models was used to determine whether a strata should be retained or further disaggregated; estimates created via the models were not examined at this stage. The strata where the data became too sparse were aggregated into larger regions to other stratum. We further subdivided those strata which had sufficient information. In two cases, we allowed strata to remain for which the models for the {EST + SLU + OTR} table yielded models with p-values slightly less then .01 or slightly larger than .50. We did so for two reasons: first, no other adequate models were available, and second, the estimates for this table were used only for model verification and not for the creation of estimates, so relaxing the selection procedure did not affect the substantive conclusions. After we completed the stratification, we examined the estimates produced by the modeling procedure. If the estimates in a particular stratum for {EST}, {EST + OTR}, {EST + SLU} and {EST + SLU + OTR} resulted in negative results for SLU or OTR, and if more than one estimate for that stratum had a p-value between .01 and

.5, we used the model with the next lowest adjusted X^2 statistic. In one case — strata 9 — there was no other model with an acceptable p-value, therefore the negative estimate was retained.[23]

[23]In the case of the negative estimate for Stratum 9, and in one other case where the estimate for OTR fell below the number of documented deaths, the estimate was reset to be equal to the documented total. There are 4 perpetrator-strata in which the second-best model was chosen, as described in the text.

Map 1
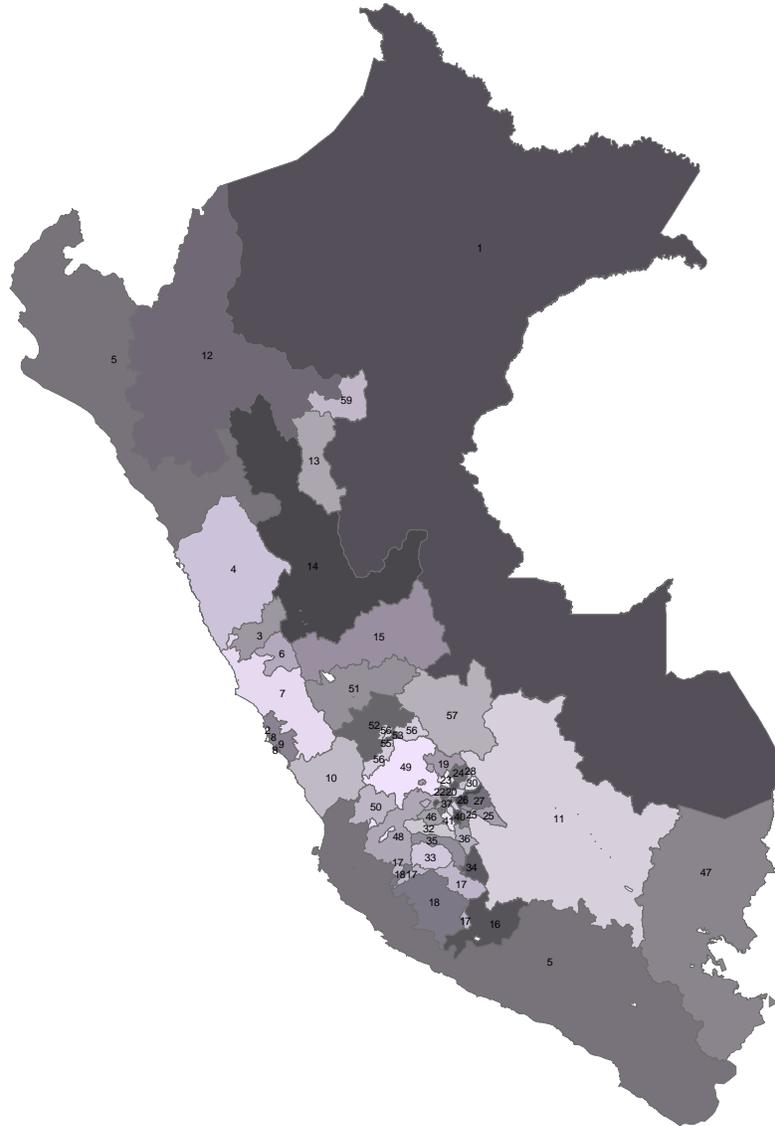
Note that Map 1 shows a large number of strata in the Department of Ayacucho. The number of documented killings in this region is relatively large (nearly half of all documented deaths occurred in Ayacucho), and so there the information is dense relative to the geographic divisions.

In Map 2, we present the estimates of the number of deaths for each of the strata. As can be seen, as in the analysis of documented deaths, the highest number of estimated victims is concentrated in the central regions of the Peruvian Andes.

Map 2

Leyenda

Nº de víctimas

51	500
501	1000
1001	2000
2001	4000
4001	9109
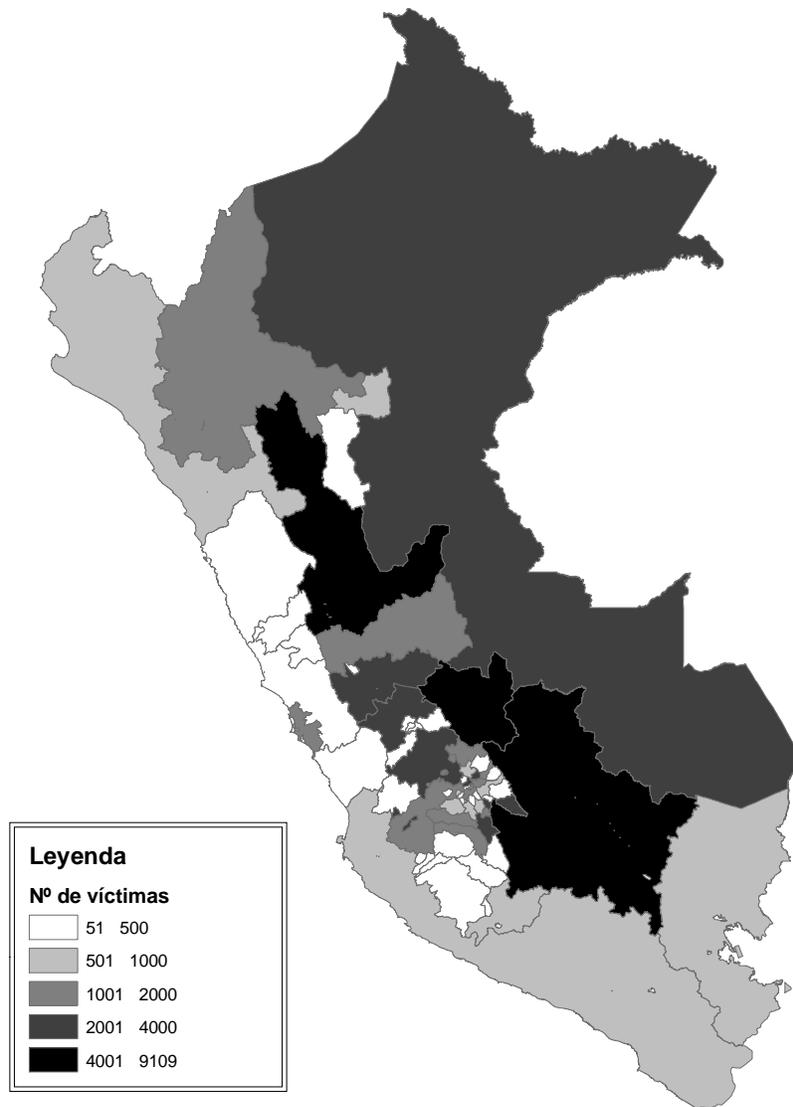
4.6 Calculating the confidence interval

To calculate the total number of deaths by perpetrator — EST, SLU and OTR — it is not sufficient to determine which perpetrator group is responsible for a greater number of victims than the others. It is also necessary to calculate the standard error and the corresponding confidence interval for each estimated total.[24]

Bishop, Fienberg and Holland (1975) provide estimators for the variance of the estimates resulting from the log linear models described above. Using these formulas, we can calculate the standard errors and the confidence intervals for the estimates of EST. However, the calculations for SLU and OTR are more complicated because they are derived from the differences between two estimated totals.

It is possible to calculate the standard errors for {EST}, {EST + OTR} and {EST+SLU} separately; however, the estimates of the standard errors for each category cannot be used to estimate the errors of their differences because these errors depend on the covariances between them, which are unknown.[25] In the same way, the standard errors of SLU-EST, EST-OTR, and SLU-OTR must take into account the covariances between the estimates for different perpetrators. We must therefore use an alternate variance estimation technique to calculate the standard errors directly for SLU, OTR, SLU-EST, EST-OTR and SLU-OTR. We have used a technique called jackknifing.

We created vectors of estimates called $\hat{\Theta}_k$ by successively omitting each observation k and recalculating the estimate. The vector was tranformed into "pseudovalues" by the following calculation:

$$\hat{\Theta}_\alpha = n\hat{\Theta} - (n-1)\hat{\Theta}_{(k)}$$

---

[24] We use the standard 95% confidence interval estimate: the estimate ±2 * (the standard error).
[25] For any two estimates, X and Y, the variance of X-Y is equal to the variance of X plus the variance of Y minus two times the covariance of X and Y. The standard error of X-Y is the square root of this result.

for all values of k. The mean of the pseudovalues was calculated in the following way:

$$\hat{\bar{\Theta}} = \frac{1}{n}\sum_{\alpha=1}^{n}\hat{\Theta}_{\alpha}$$

The mean $\hat{\bar{\Theta}}$ is used to calculate the standard error of theta in the following way:

$$\sigma_{\hat{\Theta}} = \sqrt{\frac{\sum_{\alpha=1}^{n}(\hat{\Theta}_{\alpha} - \hat{\bar{\Theta}})^2}{n(n-1)}}$$

Where theta is estimate of the number of deaths estimated by the difference method (explained in section 4.2). For more information about jackknifing, see Ball (2000).

When strata are aggregated from a lower level (for example districts, g) to a higher level (for example, provinces, h), the calculation of the standard error is calculated as shown below.

$$\sigma_{g\cdot} = \sqrt{\sum_{h}\sigma_{gh}^2}$$

The confidence intervals for the seven regions shown in Graphs 1, 2 and 3, were calculated in this way, as were the estimates that correspond to the country as a whole. Summing the variances over strata to estimate the variance for an aggregate category ignores the effect of the covariances among the strata. However, it is logical to assume that these covariances are zero or, at most, minimal. Completely different data are being fit to separate models for the different strata. Some of these data, however, may come from the same underlying reports, and therefore potentially could be correlated. Such correlations, if they even exist, would be minimal.

The conclusions we have made over the country as a whole for the period between 1980 and 2000 about the number of deaths attributed to

the PCP-Shining Path is that it is significantly greater than the number attributed to the state or other perpetrators.

Appendix 1 – Model verification

Rigorous data analysis requires steps to verify the models. In this Section, we present four procedures used to verify the models being used in this study: a comparison of combined estimates, a comparison of coefficients of variation, an analysis of patterns of model selection, and an analysis of the ratios between documented and undocumented cases.

a. Comparison of combined estimates

Model verification begins in the model selection procedure. In this study, models were chosen in order to minimize the X^2 statistic divided by the degrees of freedom. This has as its main objective the balance of two criteria: interpretive simplicity and goodness of fit.

There are two ways to estimate the EST, SLU and OTR totals. These are described in Table 4, below.

Table 4

List of estimated totals

Categories of Agents and Perpetrators	Estimate 1	Estimate 2
EST	{EST}	{EST+OTR+SLU} – {EST+OTR} – {EST+SLU} + 2*{EST}
SLU	{ESL+SLU} – {EST}	{EST+OTR+SLU} – {EST+OTR}
OTR	{EST+OTR} – {EST}	{EST+OTR+SLU} – {EST+SLU}

In this report, we used estimator 1 as the direct estimate of deaths and estimator 2 as a check on estimator 1. In this sense, we can compare the two estimates for each category of perpetrators in order to examine how close one is to the other. The first three diagrams in Graph 4 show the pairs of logs of the estimates that correspond to each of the three

perpetrator categories. As can be seen, estimator 1 and estimator 2 produce very similar results.

Additionally, the fourth diagram in Graph 4 shows the distribution of relative differences between pairs of estimates. These are calculated by the following formula:

absolute relative difference = (estimate 1 - estimate 2) ÷ estimate 1

These differences should be close to zero. Nearly all of the differences seen in the diagram are less than one. There is one exception where an atypicalestimate for EST using estimator2 is approximately four times greater than the corresponding estimate for estimator 1.

Graph 4

Distribution of Log Estimates for EST

Distribution of Log Estimates for OTR

Distribution of Log Estimates for SLU

Relative Differences between Estimates
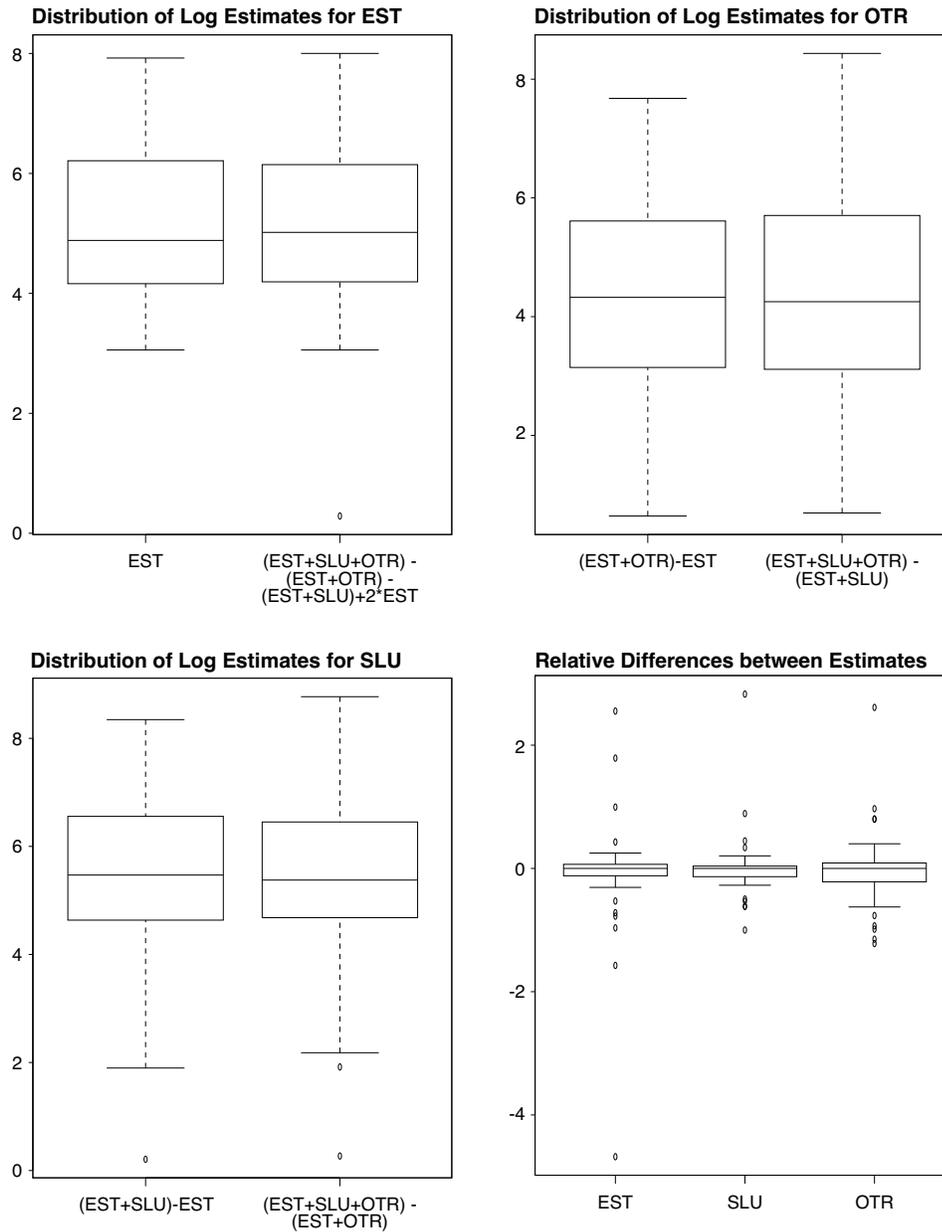
b. Comparison of the estimated coefficients of variation

One method of verification of the models is to calculate the coefficient of variation of the estimates in order to compare the size of the standard errors in a standard scale. The formula for the estimated coefficient of variation is:

estimated coefficient of variation = standard error ÷ estimate

In Graph 5 we present the distribution of estimated coefficients of variation for each of the four groups of models. Generally the coefficients of variation are small, and the majority are less than 0.4.

Graph 5

Coefficients of variance of the estimates
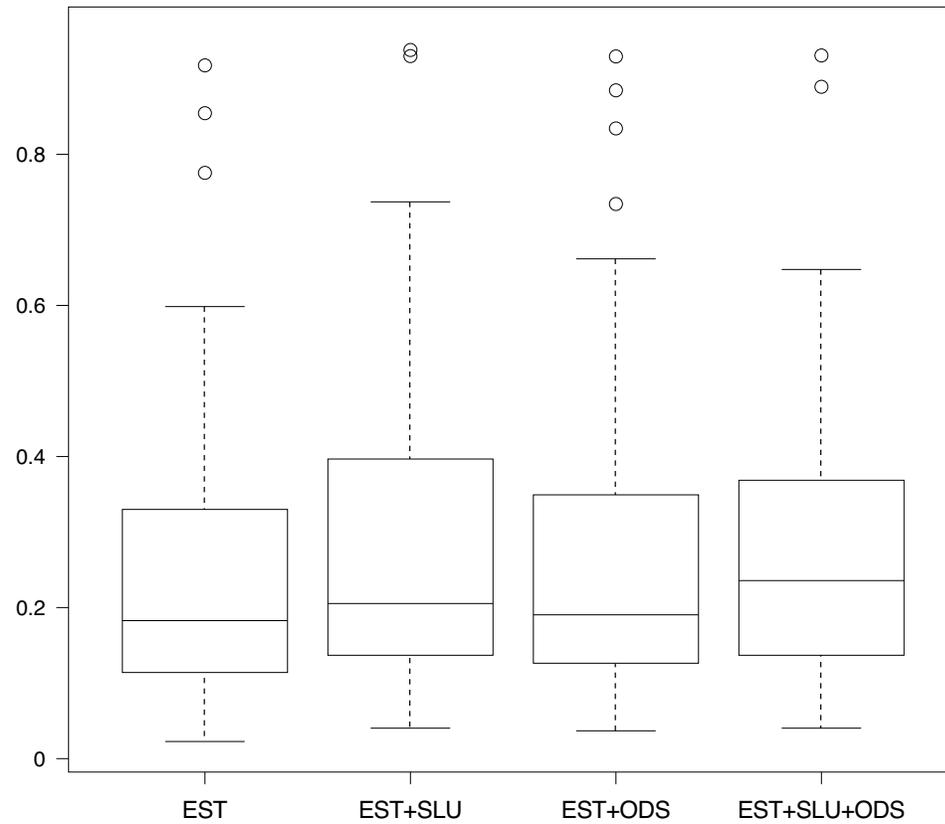
c. Analysis of model selection patterns

Another verification technique is to analyze the model selection patterns. A skeptical reader could wonder that if the same model had been used to calculate the four estimates in a given stratum, the resulting estimates would necessarily be complementary. Also, if the four estimates come from the same model, it could mean that the

interdependencies among the three sources of information are the same, which is unlikely.

In this analysis, we first determine in how many strata the four estimates are calculated using the same model (denoted as homogeneous models), and in how many strata at least two different models were used (denoted as heterogeneous models). The results shown below in Table 5 suggest that while there exists a tendency for the four estimates to be calculated using the same model, there is a significant number of strata in which the calculations are done using at least two distinct models.

Table 5

Number of strata for type of estimation

Type of estimation	Number of Strata
Models with Homogeneity	34
Models with Heterogeneity	23

Table 6 considers this question in more detail. It shows the number of times that each model was selected for each of the combinations of perpetrators. The Table provides additional information about type of relations that exist among the three sources of information.

Table 6

Number of times each model is used

Model		Estimates			
		{EST}	{EST+ SLU}	{EST+ OTR}	{EST+ SLU+ OTR}
Independent	CVR+ODH+DP	2	1	0	0
One interaction	CVR*ODH	3	1	1	0
	CVR*DP	5	1	3	1
	ODH*DP	19	22	23	23
Two interactions	{CVR*ODH} + {ODH*DP}	10	11	11	11
	{CVR*ODH} + {CVR*DP}	0	0	0	0
	{CVR*DP} + {ODH*DP}	18	21	19	22

The distribution of models shown in Table 6 is interesting for various reasons. First, the models selected to estimate {EST} tend to be simpler than the models selected for the other estimates: for 29 strata, one of the four simplest models is chosen (the independence model or the models with one interaction) to estimate {EST}.

Second, the models selected with the greatest frequency are those in which there is at least one interaction between the lists ODH and DP. This interdependency is logical if we take into consideration that the majority of cases for the SLU and OTR perpetrators come from the CVR list. This is confirmed further by the total absence of cases in which the model {CVR*ODH} + {CVR*DP} was used; this model represents the independence of the data between ODH and DP controlling for the effect of the CVR.

In general, we can say that there is a strong relationship between the lists that come from human rights groups and the Defensoria del Pueblo.[26] Those two institutions focused their data collection on deaths attributed

to agents of the state, and paid less attention to the actions of the PCP-Shining Path and other actors of the armed internal conflict. More technically, the capture probability of someone on these two lists changes radically if the perpetrator is attributed to be the EST, SLU or OTR relative to someone on the CVR list where the probabilities are more homogeneous with respect to perpetrator.

d. Relationship between documents and undocumented cases

Finally, we consider the relationship between documented and undocumented cases that results in the estimates presented here. This relationship is measured by the following formula:

estimated number of undocumented cases ÷ number of documented cases

We do not expect that the ratio should be consistent across the strata, instead we are interested in identifying atypical cases.

Graph 6 shows the distribution of ratios of undocumented to documented deaths for each of the four groups of perpetrators. Although there are atypical cases, none has a sufficiently large value as to raise concerns. The majority of the strata have ratios less than one. The largest ratios are for estimates for SLU and OTR — perpetrators for which many of the cases could not be documented by all of the data collection projects.

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[26] The Defensoria del Pueblo list includes only those deaths that were reported to the Public Ministry. The deaths that were in the database of the DP that came only from NGO sources were deleted from this list.

Graph 6

Estimated ratio of undocumented cases to the total number of
documented cases
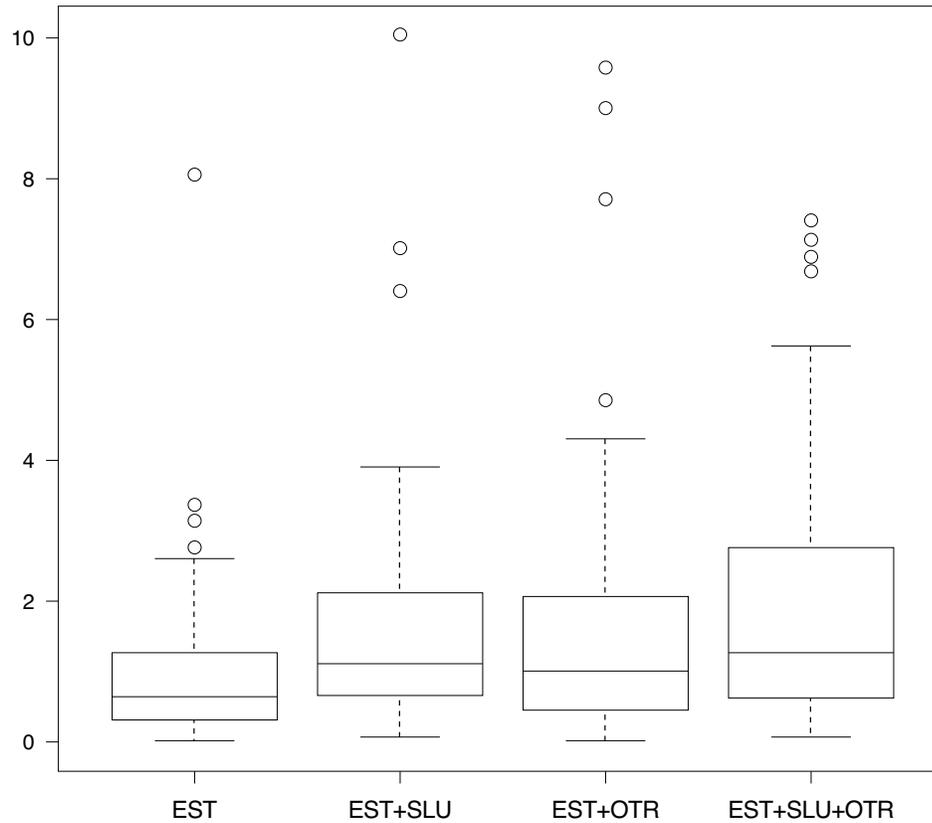
Conclusion of the model verification

We believe that the results of the verification procedures are satisfactory.
In the comparison of the two types of estimators for the perpetrator
groups we found similar results; the coefficients of variation of the
estimates follow a smooth distribution; the models chosen by the
model selection procedure respond to the interdependencies among the
different sources of information; and finally the estimates for the
missing cells do not vary too much, nor are they too uniform.

Appendix 2 – Multiple systems estimation and demographic analysis

In the twenty year period corresponding to the CVR mandate (1980 to 2000), two national censuses were conducted, in 1981 and 1993. Information from these censuses allows us to to verify the plausibility of number of deaths estimated by MSE.

Information from the census yields the following values for the population of Perú in the year 1993:

- Expected population (P_E): We calculated the probable population of 1993 combining the population census of 1981 with the estimated birthrate, mortality, and migration for the period 1981–1993.

- Observed population (P_O): The observed population is simply the number of people that appeared in the census of 1993.

If some places in the country had a significantly higher death rate than the crude rates estimated at the national level, the expected population for these localities should be greater than the population observed ($P_E > P_O$). In this way, the difference between the two would be an approximate estimation of the "excessive" mortality that occurred in that time period. This section compares the observed population in the Department of Ayacucho in 1993 with its expected population. We interpret those results in light of the deaths estimated by MSE as described in earlier sections.

The expected population in 1993 (P_E) is equal to the number of living individuals in 1981 (P_{81}), plus the number of births (N), minus deaths (M), plus the net effect of migration (S) for the period 1981-1993.

$$P_E = P_{81} + N - M + S$$

To apply this formula, the following values are relevant:

- According to the 1981 census, in that year 503,392 people were living in Ayacucho.

- The 1993 census showed 182,420 people twelve years old and younger; these people were born between the years 1981 and 1993. Of this group, those children born after the 1981 but who died before 1993 did not appear in the 1993 census. Thus total number of 182,420 people should be considered the total number of children who were born and survived between 1981 and 1993.[27]

- Many of the residents of Ayacucho registered by the 1981 census died before the 1993 census. Between 1981 and 1993, the crude mortality rates in Perú declined from 9.04 per thousand for the period of 1980–85, to 7.77 per thousand for the period 1985-90, and later to 6.93 per thousand for the period 1990–95.[28] If we expose the 503,392 residents of Ayacucho alive in 1981 to these mortality rates, we come up with a resulting total of 47,136 deaths during the period of 1981–1993.

- According to the National Institute of Statistics and Information, Ayacucho experienced a net loss of 23,147 people between 1976–1981, due to migration. Later, between 1988 and 1993, the net loss due to migration from this department was 46,443 people.[29] There is no data for migration for the period of 1982–1987. If we assume a rate of annual net migration consistent with the highest projection from the earliest period (9500 people fewer in Ayacucho per year), the net reduction to the population of Ayacucho due to migration would reach 114,000 people.

Applying then the formula $P_E = P_{81} + N - M + S$, we have

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[27] This does not estimate the children never born because one or both of their parents were killed.

[28] See: http://www.inei.gob.pe/; "Mortality indicators". For the boundary years (1985, 1990), we used the mortality rates of the preceding period. For example, for 1985 we used the rated reported for the period 1980-85.

[29] See: http://www.inei.gob.pe/biblioineipub/bancopub/Est/Lib0202/caP0107.htm.

$$524,676 = 503,392 + 182,420 - 47,136 - 114,000$$

The census of 1993 documented 492,507 residents of Ayacucho, which leaves us with a missing population of 32,169 people ($P_E - P_O$).

According to the patterns of deaths reported to CVR, we estimate that 92.3% of the deaths calculated by MSE for Ayacucho occurred between the years 1981 and 1993. The estimate of deaths for this department is 26,259; the estimate for the 92.3% occurring between 1981–1993 is 24,237. The number estimated by MSE is less than the 32,169 "missing" residents of Ayacucho that result from the analysis of the census data.

One interpretation of the number of "missing" people in Ayacucho may be that it represents the excess mortality above that suggested by the crude mortality rates for the country as a whole. Theoretically, the crude mortality rates should include all cases of death. But if we accept the hypothesis that due to intense conflict in that region, the pattern of mortality in Ayacucho should be substantially different than in the rest of the country, the expected population (P_E) calculated using only the crude death rate would not include the excess mortality.

There are other aspects regarding the information from the census that should be taken into consideration. The phenomenon of migration is very difficult to quantify,[30] and consequently, the numbers reported in the official statistics may not adequately represent the real rate of migration. Despite our effort to be conservative, the official statistics may underestimate migration and therefore overestimate the "missing" Ayacuchanos.

The effect of the imprecise use of the mortality rates weighs in the other direction. The crude annual mortality tables include deaths in all of the age and sex categories of the Peruvian population, but for this analysis, we have only the rates for those people who were alive in 1981. As the years passed, the ages of those who were in the group of infants in 1981

grew to a maximum of twelve years old in 1993. The infant mortality rate is much greater than that for the other age groups. Estimates for infant mortality between the years 1981 and 1993 varies between 100 children per thousand live births to 200 per thousand, that is, more 10 to 20 times greater than the crude mortality rates. This means that if we apply the overall crude mortality rates to make projections for a population that excludes infants, we would tend to overestimate mortality. If the estimate of mortality is reduced, the expected number of Ayacuchanos in 1993 (P_E) increases — increasing the number of "missing" Ayacuchanos. To obtain more precise results, it would be necessary to know the age-specific mortality rates for Ayacucho for the inter-censal period.

The conclusion of this demographic analysis is that the estimates that we have calculated using MSE may be considered a reasonable lower limit of the total deaths that occurred in Ayacucho as a consequence of the internal armed conflict.

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[30] It is hard to quantify mobile people precisely. The majority of methods based on surveys (like the census) are "photographs" of a situation in a given moment.

Appendix 3 – List of stratum definitions

( ) = Province; [ ] = District

1	Loreto, Ucayali, Madre de Dios
2	Callao
3	Ancash (Orcos, Bolognesi)
4	Ancash (Huaraz, Huaylas, Mariscal Luzuriaga, Pallasca, Santa, Sihuas, Pomabamba, Recuay, Asuncion, Carhuaz, Aija, Antonio Raymondi, Carlos F. Fitzcarrald, Huari, Huarmey, Casma, Corongo, Yungay)
5	Arequipa, Moquegua, La Libertad, Lambayeque, Piura, Ica, Tacna, Tumbes
6	Lima (Oyon, Cajatambo)
7	Lima (Huaura, Huarochiri, Huaral, Canta, Barranca)
8	Lima (Lima [Rimac, San Martin de Porres, Villa el Salvador, San Juan de Miraflores])
9	Lima (Lima [Carabayllo, Miraflores, Magdalena Vieja, Magdalena del Mar, Jesus Maria, Comas, Independencia, El Agustino, Los Olivos, Lince, La Victoria, La Molina, Puente Piedra, Surquillo, Santiago de Surco, Bre a, Lima, Ate, Villa Maria del Triunfo, Santa Anita, San Juan de Lurigancho, San Isidro, San Borja, San Miguel, San Luis, San Bartolo])
10	Lima (Caqete, Yauyos)
11	Apurimac, Cusco
12	Amazonas, Cajamarca, San Martin (Rioja, El Dorado, Moyobamba, Lamas, Huallaga)
13	San Martin (Picota, Bella vista)
14	Huanuco, San Martin (Mariscal Caceres, Tocache)
15	Pasco
16	Ayacucho (Parinacochas, Paucar del Sara Sara)
17	Ayacucho (Lucanas [Aucara, Chavipa, Chipao, Laramate, Carmen Salcedo, Cabana])
18	Ayacucho (Lucanas [San Pedro, Puquio, San Pedro de Palco, Santa Ana de Huaycahuacho, Leoncio Prado, San Juan, Lucanas])
19	Ayacucho (Huanta [Ayahuanco, Huamanguilla, Llochegua])
20	Ayachuco (Huanta [Huanta])
21	Ayacucho (Huanta [Iguain])
22	Ayacucho (Huanta [Luricocha])
23	Ayacucho (Huanta [Santillana])
24	Ayacucho (Huanta [Sivia])
25	Ayacucho (La Mar [Chungui, Luis Carranza])
26	Ayacucho (La Mar [San Miguel])
27	Ayacucho (La Mar [Anco])
28	Ayacucho (La Mar [Ayna])
29	Ayacucho (La Mar [Chilcas])
30	Ayacucho (La Mar [Santa Rosa])
31	Ayacucho (La Mar [Tambo])
32	Ayacucho (Cangallo)
33	Ayacucho (Huanca Sancos)
34	Ayacucho (Sucre)

35	Ayacucho (Victor Fajardo)
36	Ayacucho (Vilcas Huaman)
37	Ayacucho (Huamanga [Quinua, Ayacucho, Pacaycasa, Jesus Nazareno, Orcos])
38	Ayacucho (Huamanga [Acos Vinchos])
39	Ayacucho (Huamanga [Carmen Alto])
40	Ayacucho (Huamanga [Santiago de Pischa, Acocro])
41	Ayacucho (Huamanga [Chiara])
42	Ayacucho (Huamanga [San Jose de Ticllas])
43	Ayacucho (Huamanga [San Juan Bautista])
44	Ayacucho (Huamanga [Socos])
45	Huancavelica (Huancavelica, Tayacaja, Acobamba, Churcampa)
46	Ayacucho (Huamanga [Vinchos])
47	Puno
48	Huancavelica (Huaytara, Angaraes)
49	Ayacucho (Huamanga [Tambillo])
50	Huancavelica (Castrovirreyna)
51	Junin (Junin, Tarma, Yauli, Chanchamayo)
52	Junin (Jauja, Concepcion, Chupaca)
53	Junin (Huancayo [Huancayo])
54	Junin (Huancayo [Chilca])
55	Junin (Huancayo [El Tambo])
56	Junin (Huancayo [Chupuro, Huayucachi, Hualhuas, Huacrapuquio, Cullhuas, Huasicancha, Huancan, Colca, Sapo, Santo Domingo de Acobamba, Viques, Sapallanga, Sicaya, Chicche, Chongos Alto, Carhuacallanga, Ingenio, Pucara, Quichuay, Pariahuanca, SanAgustin, San Jeronimo de Tunan, Chacapampa, Pilcomayo, Quilcas])
57	Junin (Satipo)
58	San Martin (San Martin)

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