REGIONAL MORTALITY DIFFERENTIALS IN IIASA NATIONS

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FOREWORD

The evolution of human populations over time and space has been a central concern of many scholars in the Human Settlements and Services Area at IIASA during the past several years. From 1975 through 1978 some of this interest was manifested in the work of the Migration and Settlement Task, which was formally concluded in November 1978. Since then, attention has turned to disseminating the Task's results, to concluding its comparative study, and to exploring possible future activities that might apply the mathematical methodology to other research topics.

This paper is part of the Task's dissemination effort. It is a draft of a chapter that is to appear in a volume entitled *Migration and Settlement: A Comparative Study*. Other selected publications summarizing the work of the Migration and Settlement Task are listed at the back.

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ABSTRACT

This paper examines and summarizes the rich stock of regional mortality data collected for IIASA member nations by the Comparative Migration and Settlement Study. Regional mortality differentials are analyzed by comparing regional mortality rates and by constructing, for each country, an overall index of regional differentials. The principal conclusion reached is that there still are rather striking regional differentials in mortality among IIASA member nations.

CONTENTS

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1. INTRODUCTION

> Inequality with respect to death is the most severe form of injustice that could rage among human beings.
>
> Roland Pressat*

Once again, mortality is alive and doing well as a research topic. In the beginning of what was later to be known as demography, mortality indeed was the most popular subject. One may even state that demography was born thanks to mortality. An interesting feature of these early works on mortality is their focus on regional differentials.

For instance, in his "Natural and Political Observations... Made Upon the Bills of Mortality" (1662), Graunt, considered by many as the founder of demography, compared the situation prevailing in London with the conditions observed in a rural parish supposed to be representative of the countryside. The first life table, proposed in 1693 by the astronomer Edmund Halley, was

*Pressat (1971:43 - our translation).

based on the mortality regime observed in a city: Wroclaw. In the 18th century, one of the most influential students of population was Thomas Short, who, with his "New Observations on the City, Town and Country Bills of Mortality" (London, 1750) also was particularly interested in regional differentials in mortality. One century later, there was still much more interest in mortality than in fertility or migration. In 1839, the first annual report of the Registrar General of England and Wales, prepared by one of the leading population students of the time, William Farr, devoted only one page to marriage and births, and about sixty pages to mortality. It was not until the last quarter of the 19th century that fertility and—to a much lesser extent—migration, started to receive more than incidental and sporadic interest. Finally, after World War I, with mortality being increasingly "under control" at least in the most industrialized countries, fertility became the dominant topic in demographic analysis.

However, in the last decade or so, mortality is again becoming popular among population students. This is of course a consequence of the rapid aging of the population due to the considerable drop in fertility. In the same way as interest in mortality declined once mortality levels were low, the decrease in fertility levels seems to have induced a relative decline in interest for fertility studies.

The corresponding revival of interest in mortality is probably also due to some important changes in the field of mortality itself. Indeed, even if it has been accepted for some time that the life span of human beings could not be extended significantly, it was taken for granted that the average duration of life could still be increased significantly. In recent years, however, it has been observed that in many of the most industrialized countries of the world, or at least in some important regions within these countries, there was a total stop, sometimes even a reversal, in the secular trend towards increasing life expectancies. For the time being, the worsening of mortality conditions is concentrated in some age groups (young adults of both sexes, males 45 and over, and—

in some countries—infants). It should be noted that this deterioration of mortality conditions seems not to be limited to the most industrialized countries. One of the possible explanations for the recent slowing down of population growth in some developing countries could be found in the fact that mortality increased because of malnutrition and starvation.

This revival of interest in mortality is probably also due to the fact that despite the overall high level of life expectancy, there are still important differences in the mortality level according to place of residence. Regional mortality differentials have always existed. However, while some differences in life expectancy may for some part be attributed to "exogenous" factors (for instance, climatic and biological), the regional differentials are most probably related to socioeconomic factors. The existence and persistence of this kind of socioeconomic-based differentials imply that some groups still have less access to all the benefits of economic, social, and medical progress, or that some are more exposed than others to mortality risks that are related to socioeconomic factors.

Such a situation shows that, if not much can be done to lengthen the life span, which seems to be biologically determined, there is still room for extending the average duration of life, by giving to all human beings the same access to the highest existing standard of life expectancy. Life expectancy may be considered as an indicator not only of a population's average level of well-being, but also of the degree of social justice achieved in this population. After all, the most tangible sign of progress in our human society has been the increase in the number of years each individual is given to live on this earth. One should thus ask the question: who is benefiting from this increase in the average life expectancy? Moreover, one should also not neglect the fact that among all demographic phenomena, mortality is (with immigration) the most liable to intervention and control through policy measures.

From the still considerable differences in mortality according to place of residence, one may conclude that policy makers have here a major field of intervention. Let us consider two facts. On the one hand, we observe that, even within highly advanced countries like France and Switzerland, expectation of life for males at birth may differ by as much as five years (between French "départements" or Swiss "cantons"). This mortality differential increases to eleven years (for males as well as females) if we consider the nearly 260 administrative regions constituting a group of 18 European countries.* On the other hand, under mortality conditions prevailing today in most of Europe, the total elimination of death caused by malignant tumours would increase life expectancy by only three years (Preston et al. 1972). With these two facts in mind, it seems clear that policy measures that would aim at giving to all regions the mortality regime "enjoyed" by the most advanced one, could prove to be highly rewarding.

Demography, much more than any other discipline among the social sciences, is highly dependent on statistical data and on the tools for analyzing them. Thanks to IIASA's international comparative study on migration and settlement, a rich stock of regional data has been constituted and new concepts and measures developed. A considerable impetus has thus been given to the demographic analysis of regional differentials. The purpose of this chapter is to try to summarize the first results obtained in the field of mortality differentials.

This summarizing will be done in two ways: first, by comparing the various regional mortality patterns (section 3), and second, by measuring for each country, the overall level of regional mortality differentials (section 4). In both cases, attention will be devoted to interregional comparison rather

*Comprising the 10 Common Market countries, the 4 Scandinavian countries, the Iberian peninsula, Austria, and Switzerland. See Van Poppel (1980).

than to international comparison. This is justified, not only by the fact that in the various country case studies, emphasis was put on the interregional redistribution of the population, but also by the important problem of comparability of mortality data between countries. Precisely because of this kind of problem it seems appropriate to start (section 2) with a critical analysis of the mortality data used in the various countries that constitute the sample of this comparative study.

2. CRITICAL ANALYSIS OF THE DATA

In order to be able to correctly interpret the outputs of our analysis of regional mortality differentials in the various countries of our "sample", we need to know as precisely as possible the quality of the inputs.

One of the main merits of IIASA's comparative study has been to use the same methodology for all National Member Organization (NMO) country case studies. This eliminates one obstacle of comparability, but there still remains the problem of data comparability. We will see that, in this respect, it would be highly perilous to infer some international pattern from the results obtained, except for a few broad generalizations. Even in a field like mortality, where there is a long tradition of data collection, there is still a lack of international standardization of definitions, collecting procedures, tabulation categories, etc. (May this observation be seen as a plea for a closer international cooperation among data collecting agencies.) Moreover, it should be remembered that the author of each country case study in the comparative analysis was solely responsible for the choice of the period of analysis, the regional disaggregation, the procedure of estimating missing data, etc. This obivously introduces a second type of comparability problem, besides the "institutional" one already mentioned.

Because of these problems of international comparability, which will be made explicit below, we will put the main aspects on the interregional mortality differentials within a country, giving only a marginal attention to mortality differentials across countries. As we will see, however, even when comparing regional mortality conditions within the same country, there are some problems. Indeed, the impact of the national characteristics (in terms of definitions, collecting procedure, etc.) is not the same for all regions. In some cases, there are also data problems that are specific to some particular regions.

In order to summarize the most important mortality data problems encountered in this comparative study, we will successively discuss the time dimension, the spatial dimension, and the population coverage of these data.

2.1 The Time Dimension

A multiregional demographic analysis requires regional data on fertility, migration, and mortality preferably for the same period. Because data on migration usually are available only for some specific periods (a census period, for instance), the analysis of mortality had to be done for the same period or for a particular year of this period. The problem here is that this period is rarely the same for the various countries. (For example, censuses were held at different times, or if they were held at the same time, the migration question did not refer to the same year of previous residence.) When data for several periods were available (as in the case of countries where migration data were obtained from a population register with yearly tabulation), the choice of the period was left to the author of each specific country case study, and usually the most recent year was chosen.

The result of this has been a wide dispersion as far as the period of analysis is concerned. In six cases, mortality data going back to 1971 or before were used: the first Canadian study (1966-1971), Austria (1967-1973), Great Britain (1970), Japan (1970, except in the case of one region, for which the data of one of the prefectures refer to 1973), Italy (1971) and the United States (for which data for three different years have been used: 1958, 1968, 1970). There are 12 country case studies for which mortality data refer to 1974 or later; for the Federal Republic of Germany, Finland, Hungary, the Netherlands, the Soviet Union, and Sweden 1974 data were used, while for Bulgaria, Czechoslovakia, France, and the German Democratic Republic, 1975 data were taken. Finally, the second Canadian study refers to the 1971-1976 mortality conditions, while the Polish analysis was based on 1977 data (a previous study was made with 1973 data, but with a different regional disaggregation). It is obvious that an international comparison of mortality conditions observed at periods so far apart (Canada 1966-1971 and Poland 1977) is highly questionable.

Indeed even if on the whole, the developed countries (and the countries used in this IIASA sample are all members of this group) have not experienced a very marked gain in their life expectancy at birth over the last decade, in some countries, however, this gain was rather significant. For instance, the Japanese figure increased from 71.7 to 74.8 (total population) between 1968 and 1976, and the US figure increased from 70.3 to 72.6 between 1968 and 1975. In such a situation, a comparison for instance of the US 1968 data with the Polish 1977 data, as an analysis based on the various IIASA country case studies would imply, would be difficult to justify, because the bias due to the use of a different reference year would be larger than the international disparity actually observed for a same given year. (In 1975, the difference in life expectancy at birth in Poland and in the US was about 2 years.)

From the information given above, it is apparent that in most cases, the mortality data used in the various country case studies refer to a one-year period. This is of course a serious drawback, not only for an international comparative analysis, but for any kind of mortality analysis, be it national or international. Indeed, by using observations limited to a one-year period, one faces the risk of introducing the impacts of episodic, accidental, phenomena (such as a flu epidemic, or a change in the collecting or tabulating procedure), so that it may seem difficult to accept these one-year data as reflecting the true mortality conditions of the country being analyzed. However, in a study where the main focus is limited to regional mortality differentials within a country, this problem is not so important as it may appear. It may indeed be reasonably assumed that these regional disparities are not significantly affected by these accidental phenomena, and, more generally, that they are relatively stable over time.

The way deaths are registered and tabulated may also introduce some bias. For most countries, death statistics refer to the data of occurrence of the event. However, in some cases (the United Kingdom, for instance) data on deaths are tabulated by date of registration rather than occurrence. It seems difficult to estimate the temporal bias (time-lag between date of occurrence and date of registration) and the regional bias (spatial, urban-rural for instance, variations in this time-lag) introduced by this procedure.

2.2 The Spatial Dimension

It is clear that the number of regions, as well as the size (in terms of population size as well as area) of these spatial units, may considerably affect the results of any analysis of regional disparities. All other things being equal, one may expect that the larger the number of spatial units considered for a given region, the larger will be the spatial discrepancies observed. Moreover, these regional units usually correspond to (or are the result of the grouping of) administrative units*, which in most countries are very different in terms of population size and area, so that one is led to give the same weight to mortality indicators observed in a large region as those observed in a small region with few inhabitants (where therefore

*The USSR case study represents a partial exception in this regard. Indeed, in this case, seven "urban" regions and one "rural" macro-region comprising all rural areas of all republics, were used.

the "law of large numbers" may not apply, particularly with respect to age categories).

The result of this problem of regional delineation is that, not only is it difficult to interpret the results of an analysis of regional discrepancies within a given country, but also it is highly perilous to use such results for an international comparison of these regional differentials.

It would be fastidious to present in detail the regional delineation used in each of the 17 country case studies. It seems to be sufficient to observe that this regional disaggregation is quite different from one case study to another, ranging from 4 macro-regions for the United States to 12 relatively small regions for Czechoslovakia, Finland and the Netherlands, and that each of these 4 US macro-regions is larger (in terms of population size and area) than most of the other countries considered. This clearly shows that any international comparison of regional differentials would not make much sense.

As far as the analysis at the national level is concerned, a more specific example of the impact of regional delineation may be given. According to the results of the second Canadian study, based on 1971-1976 data, male life expectancy at birth varied from 68.6 years (in Quebec) to 71.0 years (in Saskatchewan) if we use the 10 provinces as regional units. Suppose we disaggregate the Quebec data into 6 regions, 5 of them referring to the Montreal region (which contains half of Quebec's population), four of these five being larger than the smallest Canadian province (Prince-Edward Island). The range of male life expectancy at birth extends now from 58.7 to 74.1 years (Wilkins 1980), a 15.4 years difference for the 15 regional units, instead of the 2.4 years difference observed when only 10 regional units are considered. This is of course an extreme case due to the particular type of regional delineation used, but considering that all regional delimitations used are always, in some way or another "particular", it serves to illustrate how sensitive the results of an analysis of regional differentials may be.

2.3 Population Coverage

The next problem that merits careful scrutiny in this critical analysis of mortality data, refers to the following questions: Who is covered by these mortality statistics, and to what extent are those deaths registered? More specifically, do the mortality data include deaths among all nationals, or only nationals residing within the country; e.g., do they include deaths among immigrants, among nationals residing temporarily outside the country, among persons having no fixed place of residence; do they include stillbirths; what is the rate of under-registration or incomplete registration; when registration is incomplete, with regard to age for instance, how has this problem of incomplete registration been solved? Again, it would be rather fastidious to discuss these questions for each of the seventeen countries of our sample. Only a global view will be presented.

As a general rule, the data refer to death occurring to individuals who have their main residence in the country and who are either citizens of the country or immigrants to the country. This implies that deaths occurring to residents temporarily outside the country will be included. (The problem here is one of under-registration and time-lag in registration.) Thus deaths occurring among military and diplomatic personnel stationed outside the country, among students attending school in a foreign country, among tourists, etc. will be registered and will refer to their "official" place (region) of residence within their country of origin. The same is valid, *mutatis mutandis*, at the interregional level: deaths occurring in region A of a particular country among army personnel, students, tourists, etc., whose main place of residence is in region B, will be included in the death statistics of region B.

To this general rule there is at least one main exception: the case of Japan. Mortality data for this country refer to Japanese nationals who, at the moment of their death, were in Japan.

A particular problem arises with persons having no fixed place of residence. Different solutions are conceivable in this case; their death may be referred to the region of occurrence of the event, to the region of birth of the deceased, to their last known official place of residence, if any, or to a fictitious place of residence. The most appropriate system seems to be the one used in the Netherlands, where persons having no fixed place of residence are entered separately in the central register of population, so that they are all supposed to reside and die in a special, non-existent region, which serves as an accounting device.

Stillbirths are usually excluded from mortality data. In other words, deaths among infants born alive are supposed to be entered in the death statistics. There are however some exceptions to this rule. For instance, mortality data for the USSR exclude infants born alive after less than 28 weeks gestation, whose weight is less than 1000 grammes and whose length is less than 35 centimeters, if they die within 7 days of birth. French mortality data exclude deaths of infants who died before the registration of their birth. And in some countries, it may be suspected that statistics on stillbirths (and therefore mortality data) are biased, because hospitals either do not want to recognize that a "viable" baby died under their responsibility (this infant death is then transformed into a stillbirth) or do prefer to inflate the number of births (and therefore infant deaths) having occurred in their institution, because their financial funds depend in some way or another on the number of babies delivered under their responsibility.*

Problems of under-registration and incomplete registration or tabulation are not to be neglected, because their impact is usually highly localized, being concentrated in some particular regions or age groups.

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*It seems, however, that at least among Western European countries, international differences in the definitions and the collecting of data, do not have a significant impact on the measures of infant mortality (see Höhn, 1981).

It is rather difficult to estimate the rate of under-registration of death. In most cases, this rate seems to have an insignificant impact. There is, however, at least one case where a marked bias could be observed: Canada. For this country, the total number of deaths in the province of Quebec had to be corrected for 228 "not reported" deaths in 1975 and 166 in 1976; these unreported deaths were attributed to the 0-1 age group, and represent about 18 percent of the total number of reported deaths for this age group in this region, a quite remarkable bias.

Moreover, even if all deaths were registered, there remains the problem of incomplete registration, particularly with respect to age. Information available for the Quebec region in Canada, indicates that these deaths with "age unknown" represents about 0.5 percent of all reported deaths. Of course, one may always disaggregate these deaths among the different age groups according to the known distribution, but this may introduce a new bias, because most of these deaths are probably concentrated in the older age groups.

In some cases, deaths may be correctly reported, but the tabulation of these statistics may be incomplete. This concerns particularly the last, open-ended, age group. In the USSR, for instance, the last age group for which the death rate is available is the 70 and over age group. Because the age structure and mortality patterns in the older age groups of the USSR and Poland are believed to be similar, the disaggregation of the 70 and over death data into four age groups (70-74, 75-79, 80-84, 85 and over) was done by using Polish age-specific mortality rates. It should be noted in this respect that while most country case studies used a disaggregation into 18 age groups (the last age group being open-ended, 85 years and over), there are, however, two cases where only 16 age groups (the last one being 75 years and over) were used. This is the case for Finland and the German Democratic Republic. Such a situation, of course, is one more reason to be highly cautious of any international comparison.

It should also be considered that, according to standard practice, age classification is based on the number of completed years of life. (In the case of France, however, age classification for ages 5 and over is based on the difference between year of birth and year of death.) In this study, where five-year age groups are used, this implies that an infant who lived only one hour and one who lived four years plus 360 days are both entered into the 0-4 age groups, just as an individual who lived 85 years plus one day and one who lived 110 years are both entered into the 85 and over age group. This introduces some imprecision in the computation of age-specific death rates (particularly with regard to infant and old age mortality) and therefore in the significance of many mortality indicators.

Finally, the important distinction between *de facto* and *de jure* population should be taken into account, because it may explain some considerable biases in the computation of regional death rates. Indeed, when these rates are obtained by dividing the number of deaths among a *de facto* population through the number of inhabitants in the *de jure* population, one may obtain a significant under-estimation of the mortality level in regions of heavy outmigration and emigration.

3. REGIONAL ANALYSIS OF SOME MORTALITY INDICATORS

As a first step in our analysis of regional mortality differentials in the 17 IIASA member countries, we need to describe the mortality regime observed in the regional system of each of these countries. It would obviously be vain to analyze in detail the age-specific death rates in each region of each country. We have thus to choose some way of summarizing the mortality regime, i.e., to select some global mortality indicators. Moreover, these indicators should be chosen in such a way as to allow for a meaningful interregional analysis.

Five mortality indicators will be used in this analysis. A first way to measure the mortality level of a region is to add up all age-specific death rates and to multiply by the age interval (five, in our case). This is called the gross death rate (GDR). Such a measure gives the same weight to each age-specific death rate. But, from the individual's point of view as well as from a macro-demographic prospect, dying at age 1 or at age 80 has quite a different impact. This is why, besides the gross death rate, we will also consider a more traditional indicator: the total number of years expected to be lived by a newborn baby (if he remains in his region of birth during his entire lifetime). This is called the expectation of life at birth (e_0). An interregional comparison of the gross death rate and the expectation of life at birth does, however, not provide any idea of the regional differentials in the age-specific death rates. In order to obtain some indications in this respect, we will consider the mortality conditions for three age groups: 0-4 (because infant mortality is an important indicator of medical and social progress), 15-29 (because the recent increase in the death rate at these low mortality ages is probably due to some specific socioeconomic factors) and 65 and over (because most of a region's deaths—and most of its GDR—is due to this age group).

Often used indicators, like the crude death rate and the mean age at death, have not been considered. These measures are too dependent on the age composition of the population. We could of course have presented the mean age of the mortality schedule. But empirical results show that, by eliminating in this way the effects of the age structure, not much regional disparity is left. In other words, the sometimes considerable regional differences in the observed mean age of death are due almost totally to the differences in the age compositions of the populations.

Probabilities of surviving in the region at some given ages (for instance, at exact ages 20 and 65) show a remarkable regional uniformity. We therefore will not analyze them either.

Of course, when migration is taken into account, i.e., when these probabilities are obtained not from a single-region (closed to out-migration) life table but from a multiregional life table, then considerable regional differences appear. As these differences reflect almost totally differences in migration behavior and not in mortality, we did not analyze them in this paper on mortality.

It is clearly not possible to produce here the various figures obtained for each of the five indicators in each of the 151 regions of our IIASA sample. As the main purpose of this paper is to analyze regional differentials, it will be sufficient to present a few figures that will allow us to estimate the importance of these differentials, without having to describe in detail the mortality conditions observed in each region. Moreover, because most of the country case studies have considered only the total population (i.e., males plus females), we will have, at least as a first step, to restrict our synthesis to the same global view.

For each of the five mortality indicators, and for each of the 17 countries of our sample, we will present the lowest and the highest observed regional figure, and, in order to appreciate the importance of the range so obtained, we will also produce the national average value. The "highest absolute deviation" is a very rough measure of regional disparity. This is why we also show the "mean absolute deviation" (MAD), i.e., the sum of the differences between the regional value and the national figure, divided by the number of regions; this mean absolute deviation is then further related to the national average value of the indicator.

Table 1 presents these various figures for the (single-region) *expectation of life at birth*. From this table, it may be observed that still in the 1970s, and even in the most advanced countries of the world, there are considerable regional disparities in the number of years one may expect to live. In some countries, small ones (Hungary, Sweden) as well as large ones

Table 1. Regional differentials in the expectations of life at birth (e_0): both sexes.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
Austria (1967-1973) (9)	70.5	69.6	71.7	0.6	0.8
Bulgaria (1975) (7)	70.9	69.9	71.8	0.5	0.7
Canada (1966-1971) (10)	72.5	71.5	73.8	0.6	0.8
(1971-1976) (10)	73.2	72.2	74.3	0.5	0.7
Czechoslovakia (1975) (12)	70.3	68.7	71.5	0.5	0.7
Federal Republic of Germany (1974) (11)	71.9	70.4	72.8	0.5	0.7
Finland (1974) (12)	71.7	69.9	72.8	1.1	1.5
France (1975) (8)	73.5	70.2	74.7	1.1	1.5
German Democratic Republic (1975) (10)	71.7	70.8	72.9	0.4	0.5
Hungary (1974) (6)	69.0	68.4	69.8	0.3	0.5
Italy (1971) (4)					
Japan (1970) (8)	72.1	71.2	72.5	0.4	0.6
Netherlands (1974) (11)	74.7	73.6	75.7	0.5	0.6
Poland (1973) (9)	70.9	70.1	72.5	0.5	0.8
(1977) (13)	70.6	69.4	71.8	0.6	0.9
Soviet Union (1974) (8)	69.3	68.2	73.5	1.7	2.5
Sweden (1974) (8)	75.2	74.4	75.9	0.4	0.6
United Kingdom (1970) (10)	71.9	70.3	73.5	0.9	1.3
United States (1958) (4)	69.4	68.5	70.4	0.6	0.9
(1970) (4)	70.8	69.9	71.8	0.7	0.9

(Japan, Canada, USA), the highest absolute deviation is relatively small (1.3 to 2.1 years). But in others (the United Kingdom, France, and the Soviet Union), this range is twice as large. Of course, the particular regional disaggregation adopted for each country significantly affects the various figures presented here, and thus precludes any serious international comparison. But the fact remains that, with the regional system as given, one observes in some cases marked regional disparities in the expectation of life. Moreover, we will show later that for those countries where another, more refined, regional disaggregation was available, this conclusion is much stronger than the one reached here.

With the regional delineation considered here, we observe that the range of life expectancy at birth extends from 68.2 years in the least privileged region to 75.9 in the most privileged one, a 7.7 difference, and that the lowest regional life expectancy varies from 68.2 to 74.4 (a 6.2 years difference) while the highest regional life expectancy varies from 69.8 to 75.9 (a 6.1 years difference). We also note that in only two countries (France and the Netherlands) does the highest regional value exceed the lowest Swedish regional value. By looking only at the extreme values, we tend of course to magnify the importance of these regional differentials. Once one considers the mean absolute deviation (MAD) instead of the highest absolute deviation, the regional variation is much less marked. Most countries show a MAD in the 0.3-0.7 years range; in only three countries (Finland, France, and the Soviet Union) is this mean deviation of life expectancy at birth more than one year, and only in one of these three cases does this mean deviation represent more than 2 percent of the national life expectancy.

On the whole, regional disparities in life expectancy at birth seem thus to be relatively small. This conclusion should, however, be nuanced. Indeed, there are at least two important reasons for obtaining such a result. First, by taking the total population (i.e., males plus females) we may dilute some marked regional differences, which are observed only for subgroups of the population. Second, the regional disaggregation used in the various NMO country case studies reviewed here, is particularly rough; by considering only a very small number of regions (for instance, in the case of Italy and the United States, there are only 4 regions...), one is necessarily led to minimize the probability for regional disparities to appear. Let us first deal with the male-female disaggregation.

In only seven of IIASA's country case studies, has this disaggregation by sex been made. Table 2 presents for each of these countries, the extreme values and mean absolute deviations of life expectancy at birth, for the male and female populations separately. These figures clearly show that, for each country considered in this sample, regional disparities are higher for males than for females. The mean absolute deviation of male life expectancy, considered in itself or related to the national value, is always higher than the corresponding figures for the female population.* These regional differences, however, remain relatively small. For these seven countries, the mean deviation of male life expectancy varies from one-half year to one year, which represents only between 0.7 percent and 1.4 percent of the national life expectancy.

With the data available, the impact of regional disaggregation on the importance of regional disparity in life expectancy may be tested in only a few cases. Table 3 presents the extreme values of life expectancy at birth, for the five countries for which these figures were available at two different levels of regional disaggregation. It may easily be observed that for France, Sweden, and the United Kingdom, a more refined regional disaggregation (from 8-10 regions to 21-24 regions) leads to a marked increased in the difference between these extreme values, at least for the male population. The fact that regional disparities in female life expectancy do not seem to be

*The same conclusion may be inferred from the results obtained by Van Poppel (1980) in his study on regional disparities in 18 European countries.

Table 2. Regional differentials in the expectations of life at birth: males and females.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
a. males					
Canada (1966-1971) (10)	69.3	68.4	70.8	0.7	1.0
(1971-1976) (10)	69.7	68.6	71.0	0.6	0.9
Federal Republic of Germany (1974) (11)	68.5	66.5	69.4	0.7	1.0
Finland (1974) (12)	67.2	64.9	68.4	1.0	1.4
France (1975) (8)	69.6	66.1	71.0	0.8	1.2
Japan (1970) (8)	69.5	68.2	70.0	0.6	0.8
Sweden (1974) (8)	72.5	71.7	73.2	0.5	0.7
United Kingdom (1970) (10)	68.7	67.1	70.5	1.0	1.4
b. females					
Canada (1966-1971) (10)	76.1	75.0	77.5	0.7	0.9
(1971-1976) (10)	77.1	76.1	78.3	0.6	0.8
Federal Republic of Germany (1974) (11)	74.9	73.4	75.7	0.4	0.5
Finland (1974) (12)	76.2	74.0	78.3	0.9	1.2
France (1975) (8)	77.5	74.7	78.4	0.8	1.1
Japan (1970) (8)	74.8	74.1	75.4	0.3	0.4
Sweden (1974) (8)	78.2	77.4	78.8	0.4	0.5
United Kingdom (1970) (10)	75.0	73.3	76.5	0.9	1.2

Table 3. Regional disparities in the expectations of life at birth, for different levels of regional disaggregation.

Country and disaggregation	Lowest	Highest	Difference
France - MALES			
(1975) (8)	66.1	71.0	3.9
(1974-1976) (21)[a]	65.7	70.7	5.0
France - FEMALES			
(1975) (8)	74.7	78.4	3.7
(1974-1976) (21)[a]	74.1	77.7	3.6
Sweden - MALES			
(1974) (8)	71.7	73.2	1.5
(1974-1977) (24)[a]	71.0	73.6	2.6
Sweden - FEMALES			
(1974) (8)	77.4	78.8	1.4
(1974-1977) (24)[a]	77.3	79.2	1.9
United Kingdom - MALES			
(1970) (10)	67.1	70.5	3.4
(1974-1977) (24)[a]	65.0	71.3	6.3
United Kingdom - FEMALES			
(1970) (10)	73.3	76.5	3.2
(1974-1977) (24)[a]	73.4	76.9	3.5
Netherlands - TOTAL			
(1974) (5)	74.0	75.7	1.7
(1974) (11)	73.6	75.7	2.1
Poland - TOTAL			
(1973) (9)	70.1	72.5	2.4
(1977) (13)	69.4	71.8	2.4

[a]Data taken from Van Poppel (1980).

significantly affected by the change in regional delimitations, may be related to the observations made above, that regional disparities are much lower for the female population.

As a first conclusion, we may thus state that on the whole, regional disparities in life expectancy at birth are (1) relatively low, (2) larger for males than for females, and (3) increasing markedly, at least for males, when a more refined regional disaggregation than the one used in most country case studies is adopted. We now have to examine whether this conclusion remains valid when other mortality indicators are used. Instead of considering life expectancy at birth, where the mortality regime experienced at each age is weighted by age itself, one may look at the gross death rate, which sums the various age-specific death rates and thus better reflects the overall level of the mortality curve. (It is actually the integral of the function describing the mortality curve.)

The extreme regional values of these *gross death rates* for the total (male plus female) population are presented in Table 4. For two countries (Finland and the German Democratic Republic), age-specific death rates are available for only 16 age groups, instead of the 18 age groups as in the 15 other country case studies; being not comparable to the figures obtained for the latter countries, the absolute values of the regional gross death rates of these two countries have not been presented in this table.

As Table 4 shows, the range of the regional gross death rates is much wider than the range of the regional life expectancies. In 10 out of the 15 countries considered, the highest gross rate is more than 10 percent above the lowest rate, in 4 cases, it is even more than 25 percent higher, and in one case, the highest rate is more than 50 percent larger than the lowest rate. Whereas in the case of life expectancy at birth the mean absolute deviation of the regional values seldom represented more than 1 percent of the national value, in the case of the gross death rate, this mean absolute deviation

Table 4. Regional differentials in the gross death rates: total population.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
Austria (1967-1973) (9)	2.9	2.8	3.1	0.1	3
Bulgaria (1975) (7)	3.0	2.5	3.9	0.3	11
Canada (1966-1971) (10)	2.3	2.1	2.6	0.1	6
(1971-1976) (10)	2.2	2.1	2.4	0.1	5
Czechoslovakia (1975) (12)	3.1	2.8	3.4	0.1	5
Federal Republic of Germany (1974) (11)	2.7	2.6	3.0	0.1	3
Finland (1974) (12)[a]	-	-	-	-	5
France (1975) (8)	2.2	2.0	2.6	0.2	7
German Democratic Republic (1975) (10)[a]	-	-	-	-	3
Hungary (1974) (6)	3.0	3.0	3.2	0.1	2
Italy (1971) (4)	2.5	2.4	2.6	0.1	3
Japan (1970) (8)	2.8	2.7	2.9	0.0	1
Netherlands (1974) (11)	2.3	2.1	2.5	0.1	4
Poland (1973) (9)	2.6	2.2	2.8	0.1	5
(1977) (13)	2.6	2.4	2.7	0.1	4
Soviet Union (1974) (8)	2.3	2.0	2.3	0.1	4
Sweden (1974) (8)	2.4	2.3	2.5	0.1	4
United Kingdom (1970) (10)	2.7	2.4	3.0	0.2	6
United States (1958) (4)	2.7	2.6	2.9	0.1	4
(1970) (4)	2.4	2.2	2.4	0.1	3

[a]Age-specific death rates were available for 16 rather than 18 age groups and are therefore not included in this comparison.

represents 5 percent or more of the national rate in 7 countries out of the 15, reaching even 11 percent in one country. We may thus conclude that, on the whole, the level of the regional mortality curves, as measured by the gross death rate, varies much more than the level of the regional life expectancies at birth.

Until now we have considered the mortality level as a whole, i.e., by taking all age-specific death rates simultaneously (these rates being either "weighted", as in the life expectancy, or "unweighted" as in the gross death rate). As a next step, we turn to the regional disparities with respect to the age-specific death rates themselves. It is obviously rather difficult, in this short review, to analyze these disparities for each of the 18 age groups. Therefore we have selected the three representative age groups of 0-4, 15-29, and 65 years and over.

Table 5 produces, for each of 17 countries of our sample, the extreme values of the regional *infant mortality* rates as well as the mean absolute deviation of these rates around the national average. It is clear from these figures that regional disparities are much larger for infant mortality than for total mortality (measured through life expectancy at birth and the gross death rate). In almost half of the IIASA countries (7 out of 17), the highest regional infant mortality rate is more than 50 percent above the lowest regional rate, and in all of the 17 countries considered, this percentage is above 20 percent. Moreover, the mean absolute deviation represents in each country at least 5 percent of the national average, and in 8 countries it represents more than 10 percent.

Abstracting from problems of international comparability (which, as we have shown, are not negligible), one may also observe that the range between the lowest and the highest infant death rates is particularly large. The highest observed rate is as much as 6 to 8 times larger than the lowest rate.

Table 5. Regional differentials in the infant (0-4) mortality rates (per thousand): both sexes.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
Austria (1967-1973) (9)	5.4	4.7	6.2	0.3	5
Bulgaria (1975) (7)	5.8	5.3	6.5	0.4	6
Canada (1966-1971) (10)	4.5	4.0	5.8	0.4	9
(1971-1976) (10)	3.7	3.3	4.5	0.3	9
Czechoslovakia (1975) (12)	5.3	4.2	7.3	0.8	15
Federal Republic of Germany (1974) (11)	4.4	3.8	5.1	0.3	7
Finland (1974) (12)	2.8	2.0	3.5	0.3	10
France (1975) (8)	3.7	3.4	5.0	0.4	10
German Democratic Republic (1975) (10)	3.6	2.8	4.2	0.3	9
Hungary (1974) (6)	9.3	7.4	11.4	1.0	11
Italy (1971) (4)	6.6	5.0	8.3	1.4	20
Japan (1970) (8)	3.8	3.4	4.2	0.2	6
Netherlands (1974) (11)	2.5	2.1	3.0	0.2	7
Poland (1973) (9)	6.4	5.7	7.0	0.3	5
(1977) (13)	6.0	4.8	7.0	0.4	7
Soviet Union (1974) (8)	9.0	4.6	14.1	2.4	26
Sweden (1974) (8)	2.1	1.8	2.8	0.3	12
United Kingdom (1970) (10)	4.2	3.7	4.8	0.3	8
United States (1958) (4)	6.8	6.1	8.1	0.7	10
(1970) (4)	5.0	4.6	5.8	0.4	9

If one considers only the minimum or the maximum rates, the range is of course much smaller, but still considerable. The highest minimum rate is four times larger than the lowest minimum rate, and the highest maximum rate is five times larger than the lowest maximum rate. The data also show that the maximum rate observed in Sweden (2.8 per thousand in the South Middle region) is lower than the minimum rate observed in most countries. Only two countries (Finland and the Netherlands) have minimum rates that are below Sweden's maximum rate.

All this indicates that there are still, even in the 1970s and within the group of the most advanced countries, very large disparities in infant mortality. With differences of such a magnitude, one may reasonably conclude that there is room for considerable progress in the probability of survival of infants. As the very few historical data produced in Table 5 show, a reduction of infant mortality is possible over a relatively short period (see the data for Canada, Poland, and the United States). Unfortunately, from the rare evidence available, it does not seem that this decrease in infant mortality easily leads to a reduction in regional disparity.

The second age group considered in this analysis of regional differentials is the group of *young adults*, aged 15 to 29. In order to summarize the mortality level for this age group, we computed the gross death rate over these ages. We did this by summing the death rate observed for each of the three five-year age groups contained in the 15-29 category and multiplied by five (the number of years in each of the three age intervals). Table 6 presents the extreme regional values obtained in each of the 17 countries of our sample as well as the mean absolute deviation.

From the results produced in this table, it is clear that, just as in the case of infant mortality, regional differentials in the mortality regime of young adults (15-29) are much larger than regional mortality differentials for the total (all ages)

Table 6. Regional differentials in the gross death rates (in percent) for the 15-29 population: both sexes.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
Austria (1967-1973) (9)	1.8	1.4	2.3	0.2	12
Bulgaria (1975) (7)	1.3	1.1	1.6	0.2	12
Canada (1966-1971) (10)	1.6	1.3	1.9	0.2	12
(1971-1976) (10)	1.9	1.3	2.2	0.2	10
Czechoslovakia (1975) (12)	1.4	1.1	1.6	0.1	9
Federal Republic of Germany (1974) (11)	1.5	1.3	1.7	0.1	8
Finland (1974) (12)	1.5	0.8	2.3	0.3	18
France (1975) (8)	1.5	1.3	1.7	0.1	5
German Democratic Republic (1975) (10)	1.4	1.2	1.6	0.1	7
Hungary (1974) (6)	1.4	1.2	1.7	0.1	9
Italy (1971) (6)	1.3	1.1	1.6	0.1	10
Japan (1970) (8)	1.4	1.3	1.9	0.2	11
Netherlands (1974) (11)	1.0	0.8	1.5	0.1	14
Poland (1973) (9)	1.5	1.1	1.7	0.2	10
(1977) (13)	1.9	1.1	2.0	0.3	15
Soviet Union (1974) (8)	2.7	1.5	3.8	0.7	27
Sweden (1974) (8)	1.0	0.8	1.3	0.1	12
United Kingdom (1970) (10)	1.0	1.0	1.1	0.0	3
United States (1958) (4)	1.8	1.4	2.1	0.3	14
(1970) (4)	2.0	1.7	2.2	0.2	8

population. In almost half of the IIASA countries (7 out of 17), the highest regional mortality rate for young adults is more than 50 percent above the lowest regional rate, and in all but one, this percentage is more than 30 percent. Moreover, the mean absolute deviation represents at least 5 percent of the national average in all countries but one, and in ten countries it represents more than 10 percent.

As expected, the range is even wider when we compare regions of different countries. One may notice that the highest observed gross rate (3.8 percent) is almost five times larger than the lowest (0.8 percent). The data of Table 6 also show that the maximum rate observed in the United Kingdom (1.1 percent) is lower than (or equal to) the minimum rate observed in most countries. Only three countries (Finland, the Netherlands, and Sweden) have minimum rates that are below the maximum rate of the United Kingdom. If one considers only the minimum rates observed in each country, the range is relatively narrow; the minimum rate varies from 0.8 percent (in Sweden) to 1.7 percent (in the United States), a twofold figure, which should be compared with the fourfold variation observed between the minimum infant mortality rates. As far as the maximum rates are concerned, however, the range is considerably wider. The highest maximum rate (3.8 percent) is three times larger than the lowest maximum rate (1.3 percent), but this variation is still much smaller than the one observed for infant mortality.

For three countries we have the possibility of analyzing the evolution of the regional mortality regime for young adults. The data for Canada and the United States show that the mortality rate for the 15-29 age group is increasing not only at the national level, but also in each of their regions. In Poland, however, only the regions containing the main urban areas have experienced such an increase. All three countries show not only an increase in their lowest regional rate, but also an increase in their highest regional rate. Note that this deterioration of mortality conditions among young adults seems to be accompanied by a reduction in the regional mortality differentials for this age group. Insofar as young-adult mortality is related to traffic accidents (mainly for males) and childbearing, one may assume that this reduction in regional mortality differentials is, at least partially, due to a regionally more uniform rate of car ownership and medical progress.

The last age group we are considering is the *old age group* (65 years and over). Here too we could use the gross death rate as a summary measure of the mortality level at these ages. It does, however, not come as a surprise that the GDR for the 65 and over age group represents the main part (about 90 percent) of the total (over all age groups) gross death rate, and therefore, that regional differentials in the GDRs for these ages are highly similar to those observed for the GDR over all age groups. A comparison between Table 7, which gives regional differentials in the gross death rates for the 65 and over population, and Table 4 shows this quite clearly.

In order therefore to get a more precise idea of the regional differences in the mortality regime of the older age groups, we should consider the death rates of each five-year age group separately. The oldest five-year age group for which data are available in each of the 17 NMO countries is the 70-74 age group. Indeed, in the case of Finland and the German Democratic Republic, the last, open-ended age group is the group of those aged 75 and over. Of course, we could have analyzed the regional death rates for this group, but regional differences in the age distribution within this very large age interval would make any comparison highly disputable. We have therefore chosen to limit our analysis of regional differentials in old age mortality to the 70-74 age group. Table 8 presents for each country of our sample, the minimum and maximum regional values of the death rate for this age group as well as the mean absolute deviation from the national average.

Table 7. Regional differentials in the gross death rates for the 65 and over population: both sexes.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
Austria (1967-1973) (9)	2.7	2.5	2.8	0.1	4
Bulgaria (1975) (7)	2.7	2.2	3.6	0.3	12
Canada (1966-1971) (10)	2.1	1.9	2.3	0.1	6
(1971-1976) (10)	2.0	1.8	2.1	0.1	5
Czechoslovakia (1975) (12)	2.8	2.5	3.0	0.1	5
Federal Republic of Germany (1974) (11)	2.5	2.4	2.6	0.1	2
Finland (1974) (12)[a]	-	-	-	-	5
France (1975) (8)	2.0	1.8	2.3	0.1	7
German Democratic Republic (1975) (10)[a]	-	-	-	-	3
Hungary (1974) (6)	2.7	2.7	2.9	0.0	1
Italy (1971) (4)	2.3	2.2	2.3	0.1	2
Japan (1970) (8)	2.5	2.4	2.6	0.1	2
Netherlands (1974) (11)	2.1	1.9	2.3	0.1	4
Poland (1973) (9)	2.3	2.0	2.5	0.1	5
(1977) (13)	2.3	2.1	2.5	0.1	5
Soviet Union (1974) (8)	2.0	1.7	2.0	0.1	6
Sweden (1974) (8)	2.2	2.1	2.3	0.1	3
United Kingdom (1970) (10)	2.4	2.2	2.7	0.2	7
United States (1958) (4)	2.3	2.2	2.5	0.1	4
(1970) (4)	2.0	1.9	2.1	0.1	4

[a]Age-specific death rates were available for 16 rather than 18 age groups and are therefore not included in this comparison.

Table 8. Regional differentials in the death rates (in percent) for the 70-74 age group: both sexes.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
Austria (1967-1973) (9)	5.1	4.6	5.4	0.2	4
Bulgaria (1975) (7)	5.2	4.2	7.2	0.7	13
Canada (1966-1971) (10)	4.0	3.3	4.4	0.3	8
(1971-1976) (10)	3.9	3.3	4.3	0.3	7
Czechoslovakia (1975) (12)	5.4	4.6	6.3	0.4	8
Federal Republic of Germany (1974) (11)	4.8	4.4	5.1	0.2	3
Finland (1974) (12)	4.8	4.5	5.6	0.3	7
France (1975) (8)	3.7	3.3	4.7	0.3	8
German Democratic Republic (1975) (10)	5.2	4.7	5.8	0.3	5
Hungary (1974) (6)	5.2	4.9	5.4	0.1	3
Italy (1971) (4)	4.3	4.0	5.0	0.4	8
Japan (1970) (8)	4.8	4.4	5.3	0.2	4
Netherlands (1974) (11)	3.8	3.3	4.5	0.2	4
Poland (1973) (9)	4.6	3.9	5.1	0.3	6
(1977) (13)	4.7	4.1	5.1	0.3	6
Soviet Union (1974) (8)	3.8	3.3	3.9	0.2	5
Sweden (1971) (8)	3.6	3.4	3.9	0.2	5
United Kingdom (1970) (10)	4.9	4.4	5.4	0.3	7
United States (1958) (4)	4.9	4.6	5.4	0.3	5
(1970) (4)	4.4	4.0	4.7	0.2	4

From the figures produced in this table, it is apparent that, on the whole, the range between the extreme regional values is much smaller for old age (70-74) mortality than for infant (0-4) and young adult (15-29) mortality. In 13 out of the 17 countries, the ratio between the maximum and minimum regional values is smaller for the 70-74 age group than for any of the two other age groups considered, and only in one case is this ratio higher in both comparisons. In only one case (Bulgaria) is the highest regional old age mortality rate more than 50 percent above the lowest regional rate observed in the country. Moreover, in only one country does the mean absolute deviation represent more than 10 percent of the national average, while, as far as infant and young adult mortality is concerned this is the case in 8 and 12 countries, respectively. Moreover, when we compare countries, one observes that the highest regional rate (7.2) is only two times larger than the smallest rate (3.3), whereas in the case of infant and young adult mortality, the ratio between the smallest and the largest rate is from 1 to 8 and from 1 to 5, respectively.

The data in Table 8 also show that the maximum rate observed in the Soviet Union and Sweden (3.9 percent) is smaller than the lowest rates observed in most of the other countries (the exceptions are Canada, France, and the Netherlands). When we consider only the observed minimum or maximum rates in each country, the range is relatively narrow; the minimum rate varies from 3.3 to 4.9 and the maximum rate from 3.9 to 7.2. Again this variation is much smaller than the one observed for infant and young adult mortality.

For seven countries of our sample, we are able to disaggregate these old (70-74) mortality rates by sex. This is done in Table 9. It does not come as a surprise that old age mortality is much larger for males than for females. Actually, males have a mortality rate that is almost twice the rate observed for females. (In the case of France, the national rate for males is exactly double that of females.) On the whole, the importance of regional disparities (as measured by the mean

Table 9. Regional differentials in the death rates (in percent) for the 70-74 age group: males and females.

Country (Period of observation, number of regions)	National (N)	Lowest	Highest	MAD	MAD/N (in %)
a. males					
Canada (1966-1971) (10)	5.2	4.2	5.6	0.5	9
(1971-1976) (10)	5.2	4.3	5.7	0.4	8
Federal Republic of Germany (1971) (11)	6.5	5.9	7.6	0.3	5
Finland (1974) (12)	6.9	5.5	7.8	0.5	7
France (1975) (8)	5.2	4.6	6.9	0.5	10
Japan (1970) (8)	6.0	5.7	6.7	0.2	3
Sweden (1974) (8)	4.8	4.5	5.4	0.3	6
United Kingdom (1970) (10)	6.9	6.0	7.7	0.5	7
b. females					
Canada (1966-1971) (10)	3.0	2.5	3.3	0.2	8
(1971-1976) (10)	2.8	2.3	3.2	0.3	9
Federal Republic of Germany (1971) (11)	3.6	3.4	3.8	0.1	3
Finland (1974) (12)	3.5	3.2	4.2	0.3	8
France (1975) (8)	2.6	2.3	3.3	0.2	9
Japan (1970) (8)	3.7	3.4	4.1	0.2	4
Sweden (1974) (8)	2.7	2.6	2.9	0.1	3
United Kingdom (1970) (10)	3.6	3.3	4.1	0.3	8

absolute deviation divided by the national figure) seems to be of the same magnitude for males as for females. There is, however, one main exception: Sweden. In Sweden these disparities seem to be twice as large for males as for females. There are two countries (Canada in 1971-1976 and France) where, for both males and females, the mean absolute deviation (when divided by the national figure) is larger than for the total population. This would indicate that in these countries, these disparities, while being of the same magnitude for each of the two sexes, have a different regional pattern. More data, over a larger number of countries and over a larger number of regions within these countries, are needed in order to further explore this question.

The global picture that emerges from the regional mortality data available for each of the 17 countries of our sample, is that even in these highly developed countries, there are still regional disparities in life expectancy, particularly for males, but that these disparities seem to be due mainly to the considerable differences in infant and young adult mortality and much less to disparities in old age mortality.

4. A GLOBAL MEASURE OF REGIONAL MORTALITY DIFFERENTIALS

There are two main ways to analyze regional differences in the mortality regime. The first one is based on the various age-specific death rates (or probabilities). These may be summarized through the traditional mortality indicators (crude and gross death rates, life expectancy, mean age, etc.), as was done in the previous section, or they may be parametrized by fitting a mathematical function. The second approach is based, not on the death rates as such, but on the regional differences in these rates. These regional differences are used directly as inputs in the analysis of regional discrepancies.

The parametrizing approach has been considerably developed in the last decade. In particular, we refer here to the Brass logit relational system (Brass 1971), which is based on an empirical standard set of surviving probabilities and has been extended by Brass (1977) himself and by Zaba (1979) from a two- into a four-parameter system. The Brass-Zaba model usually performs very well, except for the youngest and oldest ages. In order to obtain a better fit at those ages, Stoto (1979) and Gomez de Leon (1980) recently proposed a transformation that allows one to "twist" the standard at those ages (instead of using fixed functions of deviations from the standard).

As a first step, we adopted Brass's original two-parameter logit system to the mortality data of Canada, disaggregated into 10 provinces, 2 sexes, and 18 age groups. The results were quite remarkable; the fit was perfect (r^2 = 0.99 or 1.00) in all of the 20 cases considered. The reason for this lies in the fact that, by using five-year age groups, one introduces a "smoothing" of the age profile. This smoothing is considerable particularly in the case of the youngest and the oldest ages (the 0-1 deviation is diluted into the 0-4 figure, and the deviations at the oldest ages are collapsed into one figure for the last, open-ended, 85 and over, age group). Another reason for the remarkable performance of the Brass model in our case relates to the choice of the standard. The various regional logits were regressed against national values. (The lack of comparability of our mortality data between the various countries prevented the use of any "international" standard.) This implies that these regional values are—at least partially—regressed against themselves.

These various considerations also help to interpret another characteristic of the results we obtained by using the Brass model; namely, the estimated value of the two parameters did not significantly differ between regions. From this we should conclude that there are no regional mortality differentials in Canada, a conclusion that is highly disputable in view of the data and mortality indicators presented in the previous section.

Actually, the correct conclusion seems to be that the Brass model is not suited for analyzing regional mortality differentials. As we have seen in the previous section, it is mainly in the youngest age groups in which these interregional differences appear. By smoothing the various regional mortality curves, one makes them more or less similar, and by regressing on the base of 18 observations (the 18 age groups), one gives the same weight to the observations for which there are no regional differentials and to those where these differentials are to be found. As a result, the two or three observations (age groups) for which significant regional differences may exist are lost among a large number of "undifferentiated" observations. Instead of giving to the regional differences the opportunity to be expressed, the model leads to a dissolution of these differences. As a tool for estimating missing data and for projection, the Brass model (and its extensions) undoubtedly is very useful. But for an analysis of interregional differences, it seems that—at least with the kind of data available—this model is not appropriate.

Still along the line of parametrizing, instead of creating smooth curves approximating the survival probabilities (expressed in form of logits) as in the Brass approach, one may directly use the curve representing the age-specific death rates and try to find a mathematical function for this curve. One such function has been proposed by Heligman and Pollard (1979). (For an interesting application of the model, see Brooks et al. 1980). Their model contains eight parameters: three express infant and childhood mortality, three others reflect a hump-like "accident" component for young adults, and the last two relate to a senescent mortality component reflecting the mortality effects of aging.

Despite the many attractive features of this model, we decided not to apply it to the mortality data of the different regions of IIASA's NMO countries. To be meaningful, such an application requires single-year death rates, whereas the regional data available refer to five-year age groups. An age profile limited to five-year age groups does not allow the parameters referring to infant mortality (0-1, 1-4), accident mortality among young adults (18-25), and old age mortality (75 and over), to express much of the phenomena they are supposed to reflect. Moreover, for 9 out of the 17 countries, the regional mortality data available are not disaggregated by sex; this leads to a dilution of the "accident" component, which is meaningful mainly for male mortality. Finally, for two countries, the last, open-ended, age group is 75 and over (instead of the 85 and over class used in the other countries), so that, in these cases, the parameters of the old age component lose much of their meaning. All this would make any comparison of the estimated parameters rather questionable.

The various considerations developed above lead us to the conclusion that, with the regional mortality data available, parametrizing is not an appropriate approach for the study of regional differentials. We thus turn to a second approach, which consists in analyzing directly the regional differences in age-specific death rates. In an analysis of regional mortality differentials, we are indeed not so much interested in describing the level and age profile of death rates (which is actually the main output of the parametrizing approach just discussed), as in measuring to what extent mortality conditions vary across regions. The latter problem may be decomposed into two questions: 1) how to measure the degree of above-average —or below-average—mortality in a region when compared with a given standard (which in our case will be a national standard), a question of the overall level of a region's mortality differential; and 2) how to describe the age profile of these mortality differentials, i.e., what age groups account for the divergence.

In order to measure the overall level of a region's mortality differential, we propose applying a method widely used in regional economic analysis: the so-called "shift-share" method. The purpose of this method is to decompose a region's growth (in our case, a negative growth due to mortality) into two main components: growth due to the structure of the region and growth due to the dynamics (the "competitiveness") of the region.

The first of these two components expresses the number of deaths that would have occurred in the region if one applies to the given age structure of the region the national (standard) age-specific death rates. It represents the number of deaths expected in the region if there were no regional mortality differentials. The second component reflects the number of deaths that did or did not occur in the region because of the fact that the region's age-specific rates are above or below the national average.

If K_{ix} = the number of inhabitants of age x in region i

δ_{ix} = the death rate at age x in region i

δ_x = the national death rate at age x

D_i = the total (all ages) number of deaths in region i

then

$$D_i = \sum_x K_{ix}\delta_x + \sum_x K_{ix}(\delta_{ix} - \delta_x) \qquad (1)$$

Note that the structural component could be further decomposed into two parts; one part reflecting the number of deaths that would have occurred in the region if this region had had the same age structure as the nation, and the second part expressing the number of deaths due to the difference in age structure. Thus $\hat{D}_i$, the expected number of deaths in the region, may be written as

$$\hat{D}_i = \sum_x K_{ix}\delta_x = \sum_x \left(\frac{K_x}{K} K_i\right)\delta_x + \sum_x \left(K_{ix} - \frac{K_x}{K}\cdot K_i\right)\delta_x \qquad (2)$$

where the last term on the right represents the number of deaths due to the difference in age structure as such (independent of any differences in death rates). However, because the main focus of this paper is on regional differentials in the mortality schedule rather than on differentials in the age structure, we will not make use of this extension of the model.

The "regional mortality differential" component presents some interesting features. First, this component is the sum of the age-specific regional mortality differentials, weighted by the importance of the corresponding age group. This offers an important advantage. Indeed, when the absolute number of deaths is small (either because the region is small or because the age group has a high rate of survival), it often happens that the figure for the death rate is not very meaningful (particularly when mortality data refer to a one-year period). Moreover, in such a case, expressing the differentials in relative terms may be misleading: if the death rate is 1/10,000 in one region, the slightest (fortuitous) difference with respect to the death rate observed at the national level will easily represent a large percentage. But this large relative difference is not meaningful; first, because from the individual's point of view, it is the absolute level, and therefore the absolute difference, which matters, rather than the relative difference; and second, because large relative differences are often based on small numbers, reflecting possibly random phenomena. The conclusion of this is that it is important to express differentials in absolute terms and to have them weighted by the number of individuals exposed to this higher or lower mortality risk. By doing so, one introduces a kind of built-in correction, where large absolute differences, when they are due to small numbers, have only a minor impact on the computed level of overall mortality, either because the age-specific death rate (and thus the number of deaths) is low anyway, or because the population figure is small.

In this connection, it should be stressed that this weighting process also eliminates the biases due to the particular regional disaggregation that has been chosen. With most indicators of regional disparity, it is well known that, all other things being equal, the finer this disaggregation, the larger the national measure of regional disparity. This is because, explicitly (as when the mean absolute deviation is used) or implicitly (when comparing for instance the results of regional parametrization), one gives the same weight to each regional observation. With the measure used here, however, because each of the m regional observations is actually the weighted sum of a finite number n of sub-regional observations, the global (i.e., national) measure of regional disparity, being itself regionally weighted, will be the same with m regional observations or with mn regional observations. This eliminates of course one of the main, if not the most important, obstacle to international comparisons, so that in this respect we will be allowed to derive more meaningful conclusions than previously.

The second feature of the regional component is related to the one just discussed. This component combines age structure and mortality differentials. There is however a possible drawback in this kind of combination, because the results obtained by applying such a formula do not reflect only the level of above or below-average mortality, but also the difference in age structure between the region and the national standard. In order to take this into account, we will further decompose the regional component (R) into two parts, so that

$$R_i = \sum_x K_{ix}(\delta_{ix} - \delta_x) \qquad (3)$$

$$= \sum_x \left(\frac{K_x}{K} \cdot K_i\right)(\delta_{ix} - \delta_x) + \sum_x \left(K_{ix} - \frac{K_x}{K} \cdot K_i\right)(\delta_{ix} - \delta_x) \qquad (4)$$

where the first term on the right expresses the number of deaths due to regional mortality differentials as such, while the second term reflects the effect of the interaction between differences in age structure and differences in mortality conditions. Note that the first term of formula (4), which thus represents a standardized measure of regional mortality differentials, necessarily has the same sign as the non-standardized measure of formula (3). Differences in age structure may reduce or increase the level of above-average or below-average mortality of a region, but not change above- (below-) average mortality into below- (above-) average mortality.

The various formulas presented above lead only to absolute numbers. In order to obtain from them a measure of above-average or below-average mortality, one has to relate the total (i.e., over all ages) number of unexpected (excess) deaths or unexpected survivals (missing deaths) of a region to the number of expected deaths. In other words, the number of deaths that have occurred in the region because of the differences in the death rates [obtained from formula (3) or (4)], is divided by the number of deaths expected when no such differences had existed [obtained from formula (2)]. We thus define our observed (i.e., non-standardized) *index of mortality differential (IMD) for a given region* i, as

$$IMD_i = \frac{\sum_x K_{ix}(\delta_{ix} - \delta_x)}{\sum_x K_{ix}\delta_x} \qquad (5)$$

and our standardized index (i.e., standardized for differences in age structure) as

$$IMD_i^* = \frac{\sum_x \left(\frac{K_x}{K} \cdot K_i\right)(\delta_{ix} - \delta_x)}{\sum_x K_{ix}\delta_x} \qquad (6)$$

If positive (negative), the index shows that the region has an overall above- (below-) average mortality. The level of the index represents the percent of excess (or missing) deaths due to the fact that the region's level (and age profile) of the death rates is different from the standard (in our case, the national values).

Until now, we have only obtained a measure of the level of above- or below-average mortality of a particular region. We also want to derive from this regional measure, applied to each unit of a regional system, a national measure that will express the degree of regional disparity within the whole system. A third feature of the "regional mortality differential" component discussed in the previous pages will help us in developing this national measure.

This third feature is expressed by a mathematical property of the regional component. Let us indeed consider this regional-differential component for a given age group x in a given region i. We have, as in formula (3),

$$R_{ix} = K_{ix}(\delta_{ix} - \delta_x)$$

$$= K_{ix}\delta_{ix} - K_{ix}\delta_x$$

When summed over all regions of a particular system (country), one obtains

$$\sum_i R_{ix} = \sum_i (K_{ix}\delta_{ix}) - \sum_i K_{ix}\delta_x = 0 \qquad (7)$$

In other words, for a given age group, the total (national) number of "expected" deaths is necessarily equal to the total (national) number of observed deaths, so that the sum over all regions of the regional-differential component necessarily equals to zero. This "zero-sum game" property leads to two national measures of regional disparity particularly useful in our analysis.

If, for a given age group x, the sum of the regional differential components necessarily equals zero, it implies that the number of excess deaths in the regions of above-average mortality is equal to the number of missing deaths in the regions of below-average mortality. If we add this total number of excess deaths and this total number of missing deaths [i.e., if we take the sum over all regions of the absolute value of each $K_{ix}(\delta_{ix} - \delta_x)$], we obtain the total number of deaths that should be "transferred" between regions in order to obtain uniform regional mortality conditions over the whole system. By relating this grand total number of missing and excess " component to the total number of deaths observed at age x in the ...ping this we then obtain an *index of regional mortality disparity fo... group x* in country j:

$$IMD_{jx} = \frac{\sum_{i} |K_{ix}(\delta_{ix} - \delta_{x})|}{D_{jx}}$$

$$= \frac{2 \sum_{i} \left[K_{ix}(\delta_{ix} - \delta_{x})\right]}{D_{jx}} \quad \text{for } (\delta_{ix} - \delta_{x}) > 0 \quad (8)$$

It is now easy to derive from this an overall (all ages) national measure of regional mortality disparity. Indeed, because for each age group x in country j, the total number of excess deaths equals the total number of missing deaths, when we sum over all age groups of country j, we necessarily obtain the same equality, and therefore

$$\sum_{x} \sum_{i} R_{ix} = \sum_{x} \left[\sum_{i} K_{ix}(\delta_{ix} - \delta_{x}) \right] = 0$$

Correlatively, if we consider the total population (all age groups) and sum over all regions i the various regional components R_i, we will also necessarily obtain zero, that is: the total (over all ages) number of excess deaths in all regions of above-average mortality equals the total (over all ages) number of missing deaths in all regions of below-average mortality. We may thus also write:

$$\sum_{i} \sum_{x} R_{ix} = \sum_{i} \left[\sum_{x} K_{ix}(\delta_{ix} - \delta_{x}) \right] = 0$$

If we add this total number of excess deaths and this total number of missing deaths [i.e., if we take the sum over all regions of the absolute value of each $\sum_{x} K_{ix}(\delta_{ix} - \delta_{x})$], we obtain the total number of deaths that, irrespective of age, should be "transferred" between regions in order to obtain uniform regional mortality conditions over the whole system. By relating this grand total of missing and excess deaths to the total number of deaths observed in the total (all ages) population of the country, we finally obtain a *global national index of regional mortality disparity* in country j:

$$IMD_j = \frac{\sum_i \left| \sum_x K_{ix}(\delta_{ix} - \delta_x) \right|}{D_j} \quad (9)$$

$$= \frac{2 \sum_i \left[\sum_x K_{ix}(\delta_{ix} - \delta_x) \right]}{D_j} \quad \text{for } (\delta_{ix} - \delta_x) > 0 \quad (9')$$

It should be stressed that for each particular age group as well as at the global (over all ages) level, the total "observed" number of excess (missing) deaths and the total "standardized" (for differences in the age structure) number of excess (missing) deaths is not necessarily the same. Therefore, if we want to obtain a measure of regional mortality disparity that is not biased for regional differences in the age structure, we will have to substitute the first term on the right of formula (4) for formula (3) in the numerator of formula (9) above, so that the *standardized global index* will be

$$IMD_j^* = \frac{\sum_i \left| \sum_x \left(\frac{K_x}{K} \cdot K_i \right) (\delta_{ix} - \delta_x) \right|}{D_j} \quad (10)$$

the equality between (9) and (9') being not valid in this case.

Formulas (5), (6), (8), (9), and (10) will provide us with the needed tools for analyzing regional mortality differentials in each country of our IIASA sample. Because of space constraints, it is not appropriate to discuss the particular mortality level of each region in each country, as measured through formulas (5) and (6). The results obtained from these formulas will thus be presented only for information (in the Appendix), except for some particularly interesting cases, which will be mentioned incidentally in our global analysis. We are thus left with two main questions: What is the degree of regional disparity in the mortality conditions of each country, and to what extent does this regional disparity vary with the age groups?

Table 10 provides us with some answers to the first of these questions. From the data shown, some important conclusions on the level of regional mortality disparity in IIASA's NMO countries may be derived.

1. The overall level of regional mortality disparity, as measured through the index of formulas (9) and (10), varies considerably between countries. The index actually ranges from 1.3 in Hungary to 7.8 in the United Kingdom, a sixfold variability. This means that, while in Hungary only 1.3 percent of the total number of deaths should be redistributed across regions in order to obtain identical mortality conditions among regions (that is, regions of above-mortality have 0.65 percent "excess" deaths, and regions of below-mortality have 0.65 percent "missing deaths"); in the United Kingdom this percentage is six times larger.

2. Thanks to the "weighting" process implied in the formulas used, international comparisons are not biased for differences in regional disaggregation, so that we now may group the 17 countries of our sample according to their level of regional mortality disparity. (Of course, this abstracts from problems related to differences in definitions and in periods of observation.) Three main groups may be considered: six countries where regional differentials are low [Hungary (1.3), Japan (2.4), Austria (2.6), the Federal Republic of Germany (2.9), the Soviet Union (2.9) and the United States (2.9)], seven countries where these disparities are "middle-range" [the German Democratic Republic (3.3), the Netherlands (3.4), Poland (3.5 in 1973, 3.1

Table 10. Index of regional mortality disparity in IIASA's NMO countries.

Country (Period of observation, number of regions)	Observed	Standardized
Austria (1967-1973) (9)	2.6	2.8
Bulgaria (1975) (7)	6.4	6.8
Canada (1966-1971) (10)	4.4	4.6
(1971-1976) (10)	4.5	4.7
Czechoslovakia (1975) (12)	4.6	4.8
Federal Republic of Germany (1974) (11)	2.9	2.9
Finland (1974) (12)	6.3	6.3
France (1975) (8)	6.3	6.6
German Democratic Republic (1975) (10)	3.3	3.2
Hungary (1974) (6)	1.3	1.4
Italy (1971) (4)	3.7	3.8
Japan (1970) (8)	2.4	2.3
Netherlands (1974) (11)	3.4	3.5
Poland (1973) (9)	3.5	3.4
(1977) (13)	3.1	3.1
Soviet Union (1974) (8)	2.9	3.3
Sweden (1974) (8)	3.5	3.4
United Kingdom (1970) (10)	7.8	7.8
United States (1958) (4)	4.2	4.0
(1970) (4)	2.9	2.9

in 1977), Sweden (3.5), Italy (3.7), Canada (4.4) and Czechoslovakia (4.6)], and four countries where regional mortality differentials are relatively high [Finland (6.3), France (6.3), Bulgaria (6.4) and the United Kingdom (7.8)].

3. From the classification sketched above, we see that there is no clear relation between level of mortality and level of regional mortality disparity. More precisely, the often assumed direct relation (low mortality countries have lower regional mortality differentials than higher mortality countries) seems not to be observed in our sample. Let us compare the results of Table 10 with the data on national life expectancy at birth produced in Table 1. We may notice that in the group of countries where regional disparities are low, there are countries with relatively low life expectancy (Hungary and the Soviet Union) as well as countries with relatively high life expectancy (the Federal Republic of Germany and Japan). Similarly, in the group of countries where regional disparities are high, there are countries with relatively low life expectancy (Bulgaria) as well as countries with relatively high life expectancy (France). When interpreting this absence of relation between level of mortality and level of regional disparity, one should consider that all countries of our IIASA sample actually are low mortality countries. It may be assumed that once a country has a level of life expectancy of 69-75 years (the range in which all IIASA countries fall), any possible impact of the overall (national) mortality conditions on regional death rates will be minimal, so that the regional mortality regime is mainly determined by regional (economic, climatic, etc.) conditions.

4. For three countries, we have some information on the evolution of regional disparity over time. In two of these countries, there was a decrease in regional mortality disparity, and in the two cases, the rate of decrease is quite similar: the index declined by 10 percent over a 4-year period in the case of Poland, by 30 percent over a 12-year period in the case of the United States. It may be interesting to note that in

the Polish case, this reduction in regional disparity was achieved in a period in which life expectancy at birth was (slightly) declining, while in the case of the United States this reduction in regional mortality disparity was concomitant with a marked increase in the expectation of life at birth. In the third country for which temporal data are available (Canada), there was also a marked increase in life expectancy, but, contrary to its neighbor, this was not accompanied by a decline in regional mortality differentials. In interpreting these results, one should, however, remember that Canadian mortality data refer to five-year periods, and thus may be considered as better expressing a temporal evolution, whereas mortality data for all other countries of our sample (except Austria) refer to a one-year period. Comparing mortality conditions between two years (1973 and 1977 in the case of Poland, and 1958 and 1970 in the case of the United States) may be disputable, because too many "accidental" or episodic phenomena may affect the basic trend. (This is certainly the case with Poland, as will be shown below.)

5. As already stressed, one of the advantages of the measure of regional disparity adopted in this study is that it allows for a standardization where regional differences in the age structure are eliminated so as to obtain an estimate of regional mortality disparity expressing only regional differentials in mortality. The four results just discussed referred to the "observed", i.e., the non-standardized, level of regional mortality disparity. Let us now consider the standardized index, as given in the second column of Table 10. It is clear from a comparison between the observed index and the standardized index that regional differences in the age structure are not marked enough to significantly affect our measure of regional disparity. Only in two countries, the Soviet Union and Bulgaria, are there considerable differences between the two types of index. The USSR situation is probably related to the particular type of regional disaggregation used in this case (seven groups of urban areas and one rural area). When regional differences

in the age structure are taken into account, i.e., when only regional differences in the age-specific death rates are considered, the index for the USSR increases from 2.9 to 3.3, so that, according to the cut-off point used in our classification, this country should now be considered as having a middle-range level of regional mortality disparity.

The latter discussion, on the impact of regional differences in the age structure on the measure of regional mortality disparity, leads us to a short examination of the level of above- or below-average mortality for each specific region in each country, which is given in the Appendix. Of course, it is not possible in this brief review, to consider in detail each of the 151 regions of our IIASA sample. Only some general comments will be made.

It is clear, from a comparison between the observed (i.e., the non-standardized) and standardized regional indices of the Appendix, that, for most regions, the differences in the age structure (with respect to the national structure) are not important enough to have a significant impact on their level of above- or below-average mortality, as measured through our formulas. The most striking exceptions are the Sofia region of Bulgaria, for which the level of above-average mortality (with respect to the national level) increases from 8 percent (when differences in the mortality regime are combined with differences in the age structure) to 22 percent (when differences in the age structure are eliminated), and the Urban Areas of the Central Asian Republics of the USSR, for which an above-average mortality of 5 percent totally disappears when differences in age structure are accounted for. Other, less important, cases where the elimination of differences in age structure significantly changes the results are in Austria (the Vorarlberg region), in Bulgaria (the Northwest region), in Czechoslovakia (the Bratislava region), in the Federal Republic of Germany (the West Berlin region), in France (the North region), and in the Netherlands (the regions of Zeeland, Noord Brabant and Limburg). In Canada, Finland, the German Democratic Republic, Hungary, Italy, Japan, Poland, Sweden, the United Kingdom and the United States, each region has a level of above- or below-average mortality which is not significantly affected by differences in the age structure.

Let us now turn to the levels of regional above- or below-average mortality as such. Even if, as we just have seen, differences between observed and standardized indices of mortality differential are negligible for most regions, it seems more appropriate to limit our discussion to the standardized measure of above- or below-average mortality. Among the 151 regions of our sample, there are 17 regions for which the standardized indices are equal or superior to 10 percent (in absolute value), that is, for which the number of "excess" or "missing" deaths represents at least 10 percent of the number of deaths that would have been observed if the national mortality regime had been applied; 12 of these regions are regions of above-average mortality.

The two regions where above-average mortality is the highest are the North region in France (+27 percent) and the Sofia region in Bulgaria (+22 percent). Other regions of high above-average mortality are the North Bohemia region (+16 percent) in Czechoslovakia; the Scotland (+14 percent) and North West (+11 percent) regions in the United Kingdom; the Limburg region (+13 percent) in the Netherlands; the Saar region (+12 percent) in the Federal Republic of Germany; the East region (+12 percent) in France; the Northern Carelia (+12 percent), Mikkeli (+11 percent), and Oulu (+10 percent) regions in Finland; and Quebec (+10 percent) in Canada. There are no regions of high above-average mortality in Austria, the German Democratic Republic, Hungary, Italy, Japan, Poland, the Soviet Union, Sweden, and the United States, at least with the type of regional disaggregation adopted in each of these IIASA country case studies considered here.

Five regions have a marked below-average mortality: the urban areas of the Byelorussian republic (-23 percent) and the urban areas of the Caucasian republics (-13 percent) in the USSR; the East Anglia region (-11 percent) in the United Kingdom;

the Vorarlberg region (-10 percent) in Austria, and the Paris region (-10 percent) in France.

Another way to look to spatial discrepancies is to consider the relative number of spatial units that are close to the national average. Of course, such an approach is highly dependent on the regional disaggregation used, so that international comparisons should particularly be avoided in this case. Yet if all regions of a given country have an index of mortality differential close to zero, it may not be too rash to tentatively assume that this country shows a rather uniform regional pattern of mortality conditions. Let us consider that, as long as a region's standardized index of mortality differential is between -4 percent and +4 percent, this region's level of below- or above-average mortality is small enough to be ignored. There are 90 regions that fall into this category out of the total 151 regions.

But in some countries, all regions (as in the case of Hungary) or almost all regions (as in the case of the Federal Republic of Germany, the German Democratic Republic, Italy, Japan, and the United States) show mortality conditions [as summarized through our formula (6)] very close to the national average, while in other countries (Bulgaria, Finland, the Soviet Union, and the United Kingdom), only a small minority of regions have a mortality regime close to the national standard. It may be interesting to note that, except for the Soviet Union, all countries of the latter group are countries for which the index of regional mortality disparity is high (see Table 10). In other words, in Bulgaria, Finland, and the United Kingdom, we may observe, not only that there are relatively many regions where the mortality regime is significantly different from the national standard, but also that these numerous regions of above- or below-average mortality represent, in terms of population size and therefore number of deaths, an important share of the national total, so that the overall (national) level of regional disparity may be relatively high. In the case of the Soviet Union, however, even if there are relatively many regions

(5 out of 8) where mortality conditions significantly depart from the national standard (and in 2 of these 5 regions the differences are quite considerable, reaching 13 percent and 23 percent), these regions do account for only a relatively small percent of the total number of deaths in the country, so that the overall level of regional mortality discrepancy is rather moderate.

This clearly shows how important it is to introduce a weighting process in constructing a measure of regional disparity. Large regional differentials are not so important if the concerned regions are relatively small. For instance, the high level of below-average mortality in Vorarlberg (-10 percent) and above-average mortality (+12 percent) in Saarland do not prevent Austria and the Federal Republic of Germany to be countries where the overall level of regional mortality disparity is low, while the same high level of mortality differential in Quebec (+10 percent) leads Canada into the middle-range group, mainly because Quebec represents almost 30 percent of Canada's population, whereas each of the two former regions represent only about 2 percent of the total population of their respective country. Similarly, small regional differentials in the mortality regime become important if the concerned regions are relatively populous. This explains why Sweden and Italy, where the regional index of mortality differential is relatively small in all regions, have an overall middle-range index of regional disparity, while Japan and the United States, with more or less the same set of regional indices, are in the group of countries with low regional mortality disparity.

What has just been said about regional weighting may of course be extended to age weighting. Small (absolute) regional differences in the death rate for a given age group are not very important if, for this age group, the death rate is low, or if the population in this age group represents only a small part of the total population. For age groups with high death rates and a large share in total population, this obviously is not the case anymore. This was accounted for in the formulas on which the previous results are based. Our regional indices of mortality differential and our national indices of regional mortality disparity are age-weighted indices. It may be worthwhile to investigate to what degree this regional mortality disparity may vary between age groups. We thus now turn to the second main question we are trying to answer in this section.

In order to discuss this question, we applied formula (8) to each of the 18 age groups in each of the 17 IIASA countries. Results are presented in Table 11. It is obviously inappropriate to examine in detail each of the more than 300 figures produced in this table. Only some general comments will be made.

The main conclusion that clearly emerges from the data of Table 11 is that, on the whole, regional disparities in death rates are much lower for old age groups (65 years and over) than for other age groups. In order to correctly interpret this result, it should be stressed that our measure of regional disparity is based on absolute differences in death rates [$\delta_{ix} - \delta_x$ in formula (8)]. If we had used relative differences (δ_{ix}/δ_x) as is often done with other measures of regional disparity, we would, all other things being equal, have been led to even higher disparities for the young and adult age group, and even lower disparities for old age groups because a given absolute difference obviously produces a larger relative difference when the death rate is low than when the rate is high.

In order to analyze the age profile of the regional mortality disparities in each country, we will use the national figure (last column of Table 11) as a reference mark. It should be noted that this total (all ages) value is different and necessarily superior to the one obtained previously from formula (5) and presented in Table 10. This is because in the latter approach, for a given region above-average mortality (excess deaths) in one age group is neutralized by below-average mortality (missing deaths) in another age group. This seems appropriate when one wants to estimate the overall level of mortality differential for each region. However, when one wants to analyze the age profile of the regional disparities

Table 11. Index of regional mortality disparity, by age group and by country.

Country	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 +	TOTAL
	Age Group																		
Austria (1967-1973)	4.7	10.1	8.4	11.1	14.2	13.4	9.6	12.0	6.2	4.6	4.1	3.4	3.1	2.9	2.2	2.5	3.6	2.5	3.4
Bulgaria (1975)	6.2	11.5	17.8	10.0	11.8	10.4	0.2	8.9	0.1	8.2	0.1	5.5	0.0	11.6	12.6	12.6	12.6	12.6	9.7
Canada (1966-1971)	6.8	15.8	11.4	8.9	12.6	9.8	10.1	5.4	4.5	4.1	5.5	7.9	7.7	6.8	6.5	5.1	4.3	4.2	6.0
(1971-1976)	6.8	15.5	12.5	11.7	13.7	11.7	9.3	5.5	5.3	4.0	4.7	6.2	7.4	6.6	6.2	5.7	4.7	2.6	5.7
Czechoslovakia (1975)	14.3	19.6	15.4	14.6	8.4	9.7	11.3	11.3	10.3	8.8	4.0	6.7	6.1	7.0	6.7	5.5	3.9	3.4	6.3
Federal Republic (1974) of Germany	6.3	4.2	7.6	14.2	6.5	8.7	6.9	5.6	18.3	9.8	6.1	6.5	7.4	4.9	3.3	3.7	2.8	3.2	4.6
Finland (1974)	7.4	23.6	25.8	12.3	13.7	17.1	16.2	12.8	14.1	9.3	9.5	10.2	7.5	5.9	6.5		5.4		7.3
France (1975)	8.7	8.5	7.6	8.8	9.0	5.2	8.3	13.1	14.9	12.1	10.3	8.7	7.6	6.9	6.9	6.1	5.8	4.3	6.8
German Democratic (1975) Republic	7.9	10.8	14.1	8.0	5.9	7.9	7.7	7.0	4.0	7.4	6.6	4.7	5.1	4.3	4.4		2.8		3.9
Hungary (1974)	12.8	17.4	8.1	13.5	12.3	10.0	8.9	9.1	6.8	2.6	2.1	5.6	3.7	1.6	2.5	2.3	2.5	2.5	3.6
Italy (1971)	21.2	11.6	5.1	12.0	7.4	9.4	5.9	6.4	8.1	10.4	8.8	9.8	7.7	4.8	7.3	2.9	2.4	0.9	5.9
Japan (1970)	6.3	5.4	5.2	5.8	7.4	10.5	10.2	8.1	7.9	7.0	4.9	4.1	3.1	4.1	2.9	3.3	2.9	1.8	4.1
Netherlands (1974)	7.5	15.6	15.9	15.3	15.3	6.6	8.6	5.5	6.5	4.6	6.9	5.5	4.2	5.1	3.6	4.6	4.2	2.5	4.6
Poland (1973)	3.8	12.8	9.8	9.7	10.4	7.8	5.1	6.2	6.5	6.5	6.3	5.5	4.4	4.4	6.0	4.4	6.2	6.0	5.4
(1977)	5.0	9.5	13.4	73.0	10.4	14.7	10.9	7.0	6.4	7.3	7.3	7.8	5.7	3.8	4.0	4.4	4.5	6.0	6.2
Soviet Union (1974)	12.6	11.9	11.0	26.0	31.4	17.0	17.9	13.4	13.6	8.9	7.0	4.4	6.4	9.3	1.5	1.5	1.5	1.5	6.7
Sweden (1974)	10.3	11.8	19.7	19.5	11.8	10.2	12.2	8.4	11.0	9.8	6.8	7.3	5.2	4.9	4.0	5.3	4.5	2.5	5.0
United Kingdom (1970)	8.8	10.6	8.6	2.7	3.9	4.6	6.7	12.4	10.6	12.2	12.0	9.7	9.3	7.8	7.8	7.1	6.6	6.4	7.9
United States (1958)	11.4	9.2	7.7	12.8	14.9	16.2	15.3	12.8	11.0	8.0	6.6	6.9	6.5	5.6	4.9	4.7	5.1	4.5	6.6
(1970)	9.3	6.4	12.3	9.4	7.1	10.0	11.6	11.6	9.8	10.1	6.9	5.7	3.7	3.7	2.8	3.6	3.1	3.9	4.9

in mortality, emphasis should obviously be put on the age groups as such, and therefore the total (national) value should represent the sum of all the differentials (positive or negative) observed in each age group and in each region. The latter national total figure should thus not be interpreted as a measure of overall regional disparity in the country.

In order to substantiate our conclusion on the relatively lower regional disparities for old age mortality, let us take a closer look to the figures of Table 11. For the three oldest age groups (75-79, 80-84, and 85+), the index of regional disparity is below the national (total) figure in almost all countries of our sample. The main exception is Bulgaria, but, as we will discuss later, there seems to be a serious data problem in this case. For the next (in declining order) three age groups (60-64, 65-69, and 70-74), the index of regional disparity is below the national total figure in a majority of countries, and in those countries where the index is superior to the national value, the difference is in most cases rather small.

If we now turn to the figures for infant mortality (0-4), child mortality (5-9, 10-14), and young adult mortality (15-19, 20-24, and 25-29), we see that in all (or almost all) countries of our IIASA sample, the index of regional disparity is significantly higher than the national total figure. Often the index for these age groups will be two or three times larger than the total figure. There are only two countries where the index for infant (0-4) mortality is below the all-age index: Bulgaria and Poland. For child mortality, there is no exception and for young adult mortality, only one exception (the United Kingdom).

As far as the six remaining five-year age groups (between 30 and 59) are concerned, one may observe that in a large majority of countries, the index of regional disparity is significantly above the all-age figure. For the 35-39 and 40-44 age groups, there are only two countries (Bulgaria and Canada) with below-average figures, whereas for the other age groups (30-34 and 45-59), there are four exceptions (Bulgaria being always one of them). If, on the whole, regional disparities are thus above average for all age groups between 30 and 59, these disparities are usually much lower than the ones observed for the younger (0-29) age groups.

We may summarize the global picture of regional mortality disparity by age by stating that the age pattern of this disparity is such that three main age groups emerge—0-29, 30-59, and 60 and over—and that there clearly is a declining trend of regional mortality with age. The two former main groups almost always show above-average levels of regional disparity; the latter, old age group, shows relatively small regional differentials.

There are four countries for which the general age pattern just described does not seem to be valid. In France and Japan, the "peak" (highest regional disparities) is not to be found in the first main age group but rather in the second one, more precisely between 25 and 44 years of age in Japan, and 35 and 54 years of age in France. The age profile of regional discrepancies looks rather irregular in the case of the United Kingdom. Above-average levels of regional disparity in the infant and child age groups (0-14) are followed by very low levels for young adults (15-29). The highest indices of regional disparity are observed for the middle-age groups (35-54), as in France, so that the level of regional disparity for old age groups, while below-average, remains relatively high, much higher than the one observed for young adults. From the information available, it is difficult to see whether this particular pattern reflects some real phenomena specific to the United Kingdom, or whether it also is the result of some data problems.

A fourth exception to the general pattern of regional disparity by age is to be found in the Bulgarian case. Here it seems obvious that a large part of the irregular profile is due to data problems. A brief look at the Bulgarian figures in Table 11 will suffice to make us suspicious in this respect. Note for instance the negligible value (zero or very close to zero) of the index at ages 30-34, 40-44, 50-54, and 60-64. This is probably due to the way regional death data have been estimated for these age groups. In Bulgaria, regional mortality data are available only for 10-year age groups, except for the younger (0-24) age groups, for which the index seems indeed to behave normally. Another feature of the Bulgarian pattern lies in the old age groups. Because the last, open-ended, age group for which regional death data are available in Bulgaria is the 70 and over age group, regional death data for each of the four age groups 70-74, 75-79, 80-84, and 85+ had to be estimated from the 70+ total. It seems this estimation was performed by assuming identical levels of regional disparity for all four age groups and has led to levels of regional disparity that are very large indeed. As a result, if the Bulgarian pattern appears to be quite different from the one observed in all other IIASA countries (with an index of regional disparity increasing from infant to child mortality, decreasing to young adult mortality, being irregular but below-average for middle-age adult mortality, and reaching high above-average, levels for old age mortality), it seems that this exceptional pattern does not accurately reflect reality.

Until now, our discussion has been limited to the age pattern of regional mortality disparity in the various countries of our IIASA sample (looking along the lines of Table 11). Let us now consider the various national levels of regional disparity for each age group separately (looking along the columns of Table 11). This will be a rather brief analysis, however, because problems of international comparability remain, even if, as was stressed above, the index of disparity is constructed in such a way as to eliminate some of the problems related to the regional disaggregation.

As far as infant mortality is concerned, the most important regional disparities are observed in Italy (with the index reaching 21 percent), but Czechoslovakia, Hungary, the Soviet Union, and Sweden also have an index above 10 percent. Austria and Poland have particularly low indices. Finland shows the highest levels of regional disparity for child (5-9 and 10-14) mortality (with indices around 25 percent), followed by Czechoslovakia. Note also that the Netherlands has high levels of regional disparity (around 15 percent) for all age groups between 5 and 24, while Sweden has very high indices (close to 20 percent) for the 10-19 age group.

A record level of regional disparity was reached by Poland in 1977; this country shows an index of mortality disparity of 73 percent in the 15-19 age group. But, once again, it seems that data problems may be responsible for this extreme situation. This level of disparity is mainly due to the Polish Eastern region, which shows a completely abnormal death rate of 7 per thousand at age 15-19, while all other regions have a rate in the range 0.5-0.8 per thousand. Moreover, as Table 11 shows, in 1973 the Polish level of disparity at age 15-19 was only 10 percent. It therefore seems reasonable to consider the 1977 level as being the result of data errors. Even if the Polish figure is disregarded, the 15-19 age group shows a rather wide range of regional disparity. A similar wide range is observed for the 20-24 age group.

Starting with the 25-29 age group, the range of the index of mortality disparity becomes less important, with maximum values reaching 17-18 in the Soviet Union for ages 25-34 and the Federal Republic of Germany at age 40-44, 12 in the United Kingdom at age 45-54, and less than 9 after age 65-59 (if one rejects the highly dubious Bulgarian figures), whereas the minimum values decline from 4-5 at ages 25-39 to about 2 in the older age groups. Thus it seems that not only is there less disparity within countries (between regions) when age increases, but also there is less international variability in these regional disparities.

Table 11 also provides for three countries some sketchy information on the temporal evolution of regional mortality disparities by age. Between 1958 and 1970 the United States showed a marked reduction in these regional disparities for most age groups. Actually, there is an increase only among older children (10-14) and adults in the 45-54 age group. Its northern neighbor, Canada, shows quite a different evolution; between 1966-1971 and 1971-1976 regional disparities in mortality increased or remained about the same in most age groups, the only exceptions being 50-54 and 85 and over. The Canadian pattern seems to be valid for Poland as well (between 1973 and 1977), where the level of regional mortality disparity also increased for most age groups (the main exceptions being in the older age groups).

From the above discussion on regional disparities in the mortality level by age, one could conclude that, as these disparities are the lowest for the older age groups (65 and over) where also most deaths occur, the whole problem of regional inequality with respect to death is somewhat deflated. After all, if only a small minority of the population of a country is affected by really important regional mortality differentials, these differentials could be more easily disregarded. Thus it is worthwhile to consider the part each of the main age groups distinguished above (0-29, 30-59, and 60 and over) may represent in the overall level of above- or below-average mortality in each region of each country, and in the overall national level of regional disparity. For the sake of brevity, only the national results will be analyzed here. Table 12 provides for each country of our IIASA sample, the percentage of mortality disparity (measured in terms of excess and missing deaths) accounted for by the age groups of high mortality disparity (0-29) and by the age groups of low mortality disparity (60 and over).

The figures of this table show rather important international differences in the extent to which regional differentials in the mortality regime affect the various national populations. In almost half the countries (7 out of 17), about two-thirds (between 64 percent and 72 percent) of the impact of regional mortality differentials is concentrated among old age (60 and over) groups. In other words, the main part of regional mortality disparity is accounted for by age groups for which these regional disparities are relatively low anyway. Note that this group of seven countries comprises countries with an overall low disparity level (Austria and the Federal Republic of Germany), as well as countries with a middle-range or high disparity level (France). In four other countries, more than three-quarters of

Table 12. Part (in percent) of the 0-29 and 60+ age groups in total level of mortality disparity, by country.

Country (Period of observation)	0-29	60+
Austria (1967-1973)	14	67
Bulgaria (1975)	6	88
Canada (1966-1971)	16	64
(1971-1976)	16	65
Czechoslovakia (1975)	14	70
Federal Republic of Germany (1974)	7	70
Finland (1974)	10	77
France (1975)	6	71
German Democratic Republic (1975)	7	86
Hungary (1974)	27	53
Italy (1971)	24	52
Japan (1970)	16	53
Netherlands (1974)	12	69
Poland (1973)	12	68
(1977)	25	51
Soviet Union (1974)	33	33
Sweden (1974)	8	72
United Kingdom (1970)	4	75
United States (1958)	20	52
(1970)	16	50

regional disparity is accounted for by old age groups: Bulgaria (82 percent), the German Democratic Republic (86 percent), Finland (77 percent) and the United Kingdom (75 percent). With the exception of the German Democratic Republic, all these countries are in the group of high regional disparity countries. Simultaneously, these countries have only a marginal part of their regional mortality disparity due to regional differentials in infant, child, and young adult (0-29) mortality. In other words, in these countries a significant decrease in overall regional mortality disparity will not be obtained by policy measures concerning mortality in these young ages, even if in some cases (see for instance Finland) mortality differentials are particularly high at these ages.

Finally, there are six countries where a considerable part of overall regional mortality disparity is due to mortality differentials among young (0-29) age groups, with only about half of overall disparity being accounted for by old age (60+) mortality differentials. The Soviet Union seems to represent an extreme case, with one third of overall disparity due to the 0-29 age group mortality differentials, and only one third due to the older age groups (but remember the rather important data problems encountered here). Hungary, Poland, Italy, Japan, and the United States, with respectively 27 percent, 25 percent, 24 percent, 16 percent, and 16 percent, are the other countries where a significant reduction in overall mortality disparity could be obtained by policy measures promoting more uniform and lower death rates for the 0-29 age group. In these countries (except Poland, for which, as already mentioned, the figure is highly disputable because of data errors), a considerable part of overall regional disparity is actually due to infant mortality differentials, so that any intervention contributing to a reduction of infant mortality levels and infant mortality regional disparities could be highly rewarding in terms of regional equality.

5. CONCLUSIONS

Depending on the definition of regional mortality disparity used, conclusions on the level of regional inequality with respect to death will be highly divergent.

If we consider life expectancy at birth and analyze only the maximum regional disparity (difference between the highest and the lowest regional values), we could conclude that, in many of the socioeconomically "advanced" countries of our IIASA sample, regional mortality disparities are still significant. However, if these regional disparities are measured by using the mean absolute deviation between regional life expectancy and national life expectancy, then we would conclude that these regional disparities are rather marginal.

By using the gross death rate instead of life expectancy at birth, one obtains still larger regional disparities (measured by dividing the mean absolute deviation by the national figure), and, as expected, once one considers age- (and sex-) specific death rates, these regional differentials may become quite striking. On the whole, from the data available, it was clear that these regional deviations (in terms of death rates) could be very high for infant and young adult mortality, but much less so for old age mortality.

Instead of summarizing the mortality regime through traditional indicators such as life expectancies and gross death rates, and instead of comparing regional age-specific rates, one could analyze regional disparities directly in terms of regional differences in these age-specific rates. Following this second approach, we applied a measure of regional disparity where the level of regional mortality disparity is defined as being the percent of deaths that occurred in a country because of these regional differences in the mortality regime.

As a first step, we measured in this way the overall (summed over all ages) level of above- (or below-) average mortality observed in each region (with respect to the national standard), and from this, we obtained a global—national—measure of regional disparity, by relating the total number of excess deaths (in all regions of above-average mortality) and missing deaths (in all regions of below-average mortality) to the total number of deaths observed in the country. In this analysis, due account was made of regional differences in the population's age structure, but the results showed that these differences in most cases had no significant impact on the level of regional disparity.

The main conclusion of this second type of analysis seems to be that, within countries, there still are striking regional differences in mortality, with 17 regions (out of 151) showing a level of above- or below-average mortality representing more than 10 percent (in three regions, more than 20 percent) of the number of deaths that would have been expected if the national mortality regime had been applied. Among countries we also observed marked differences (actually a sixfold variability) in the national level of regional disparity. This international comparison was made possible because our national measure of regional disparity allowed us to take into account some of the problems due to differences in regional disaggregation. Finally, an analysis by age group showed that, on the whole, most of a region's above- or below-average mortality is concentrated in the older age groups, which are also those for which regional disparities are usually the lowest. A policy implication of this result is that, in most of the countries of our IIASA sample, policy measures favorable to a decrease in infant and young adult mortality rates and to a decline in regional disparity of these rates, will have only a marginal impact on the overall regional mortality disparity. Even if regional disparities are lower for old age groups, interventions in favor of these age groups would be more rewarding in terms of overall regional disparity, because it is at those ages that death rates are the highest and that most deaths occur.

But one could not put enough emphasis on the fact that our analysis has been merely descriptive. We did no more than try to estimate, through various indicators and measures, the degree of regional disparity in the mortality regime of the various IIASA countries. No attempt has been made to explain these disparities. Of course, one could find some indications that could lead to an explanatory analysis. For instance it is interesting to note that in some countries, there seems to be an inverse relation between infant mortality and old age mortality. This, of course, is not an explanation; such an inverse relation could be due as well to some exogenous phenomenon (natural selectivity: where only the fittest survive, they survive longer) as to socioeconomic environmental factors. (For example, factors that lead to high infant mortality also may represent favorable conditions for old age survival). The latter obviously brings us to an analysis of urban-rural mortality differentials. From the data available, however, we could not derive any clear relation between level of urbanization and level of mortality. Some regions of our sample are highly urbanized (some of them actually are city-regions). Their level of mortality (overall as well as age-specific) is in some cases above the national average, in other cases below. In some countries, where the overall level of urbanization is high, small regional mortality disparities exist, whereas others with the same level of urbanization have relatively high regional differentials in mortality.

Perhaps the main conclusion that should be derived from this analysis is that no conclusion should be made. Indeed, even the merely descriptive results obtained are disputable. We have mentioned quite a number of times in this paper that serious data problems seem to exist. Even for such a "vital" phenomenon as mortality, even in the statistically most advanced countries of the world, there are still considerable problems of data quality. Among all social disciplines, demography is probably the field where respect for data, as expressed through critical analysis of these data, has been strongest. One of the first tasks of multiregional demographers is to push toward a higher quality level of the data they use, now that most of the "merely" methodological problems have been solved. Regional mortality data do not represent an exception in this highly needed effort.

Another reason why it is perilous to derive any firm conclusions from our results, resides in the highly contingent nature of the observations on which they are based. Let us remember here that, except for two countries, all our data are single-year data. To derive any conclusion on only a one-year observation is obviously highly disputable. If we wish to obtain more meaningful indications on the levels of regional mortality disparity in the IIASA countries, we should start by using yearly averages, for instance of five-year data. There are indeed too many incidental, sporadic phenomena that otherwise may intervene. Extending the period of observation is, however, not enough. We are still left with all the problems arising out of the static nature of this type of analysis. If we wish to progress toward a more explanatory type of analysis, if we want to obtain some policy-oriented results, we need an analysis of the temporal evolution of regional mortality disparities. In some countries, reliable data are available, so that such a temporal regional analysis of mortality differentials does not seem to be merely a utopian dream.

All of this shows clearly the limits of our analysis. In view of the importance of the regional mortality differentials still observed in many of the so-called advanced countries of the world, and in view of the social implications of these inequalities, we dare hope that this first step will be followed by many more.

APPENDIX: OBSERVED AND STANDARDIZED INDEX OF MORTALITY DIFFERENTIAL FOR EACH REGION OF EACH IIASA COUNTRY

Country and Region		Observed	Standardized
Austria (1967-1973)	Burgenland	7	7
	Kaernten	-1	-1
	Niederösterreich	2	2
	Oberösterreich	2	3
	Salzburg	-4	-5
	Steiermark	3	3
	Tirol	-8	-9
	Vorarlberg	-7	-10
	Wien	-2	-1
Bulgaria (1975)	Northwest	-12	-7
	North	-5	-4
	Northeast	7	8
	Southwest	-1	-0
	South	5	6
	Southeast	3	3
	Sofia	8	22
Canada (1966-1971)	Newfoundland	2	2
	Prince Edward Island	-4	-2
	Nova Scotia	3	3
	New Brunswick	1	1
	Quebec	8	10
	Ontario	-0	-0
	Manitoba	-6	-5
	Saskatchewan	-11	-9
	Alberta	-8	-9
	British Columbia	-5	-4
Canada (1971-1976)	Newfoundland	3	4
	Prince Edward Island	-4	-2
	Nova Scotia	3	3
	New Brunswick	1	2
	Quebec	8	10
	Ontario	-1	-1
	Manitoba	-5	-4
	Saskatchewan	-10	-8
	Alberta	-6	-7
	British Columbia	-5	-4
Czechoslovakia (1975)	Prague	1	1
	Central Bohemia	6	5
	South Bohemia	-3	-3
	West Bohemia	9	9
	North Bohemia	14	16
	East Bohemia	-4	-4
	South Moravia	-6	-5
	North Moravia	2	2
	Bratislava	-6	-8
	West Slovakia	-2	-3
	Central Slovakia	-4	-5
	East Slovakia	-2	-4

Country and Region		Observed	Standardized
Federal Republic of Germany (1974)	Schleswig-Holstein	-2	-2
	Hamburg	-1	-1
	Niedersachsen	-1	-1
	Bremen	-0	-0
	Nordrhein-Westfalen	3	3
	Hessen	-3	-3
	Rheinland-Pfalz	1	1
	Baden-Württemburg	-6	-6
	Bayern	-1	-1
	Saarland	11	12
	West Berlin	8	6
Finland (1974)	Uusimaa	-5	-5
	Turku and Pori	-7	-6
	Ahvenanmaa	-7	-5
	Häme	-4	-4
	Kymi	7	7
	Mikkeli	13	11
	Northern Carelia	11	12
	Kuopio	8	8
	Keski-Suomi	6	6
	Vaasa	-4	-4
	Oulu	8	10
	Lapland	8	8
France (1975)	Paris Region	-9	-10
	Paris Basin	1	1
	North	24	27
	East	11	12
	West	3	3
	South West	-4	-4
	Middle East	1	1
	Mediterranean	-9	-8
German Democratic Republic (1975)	Rostock	3	3
	Neubrandenburg and Schwerin	3	3
	Berlin	9	9
	Erfurt, Gera and Suhl	1	1
	Leipzig and Halle	0	0
	Karl-Marx-Stadt	-4	-4
	Dresden	-8	-7
	Cottbus	-2	-2
	Frankfurt	3	3
	Postdam and Magdeburg	3	3
Hungary (1974)	Budapest	1	1
	North Hungary (Miskolc)	1	1
	North Plain (Debrecen)	-3	-3
	South Plain (Szeged)	-0	-0
	North Trans-Danubia (Győr)	-2	-1
	South Trans-Danubia (Pécs)	3	3

Country and Region		Observed	Standardized
Italy (1971)	Northwest	5	4
	Northeast	3	3
	Central	-7	-7
	South and Islands	-1	-2
Japan (1970)	Hokkaido	4	4
	Tohoku	8	8
	Kanto	-1	-1
	Chubu	-1	-1
	Kinki	-2	-2
	Chugoku	-4	-3
	Shikoku	2	2
	Kyushu	1	2
Netherlands (1974)	Groningen	-5	-4
	Friesland	-1	-1
	Drenthe	-1	-1
	Overÿssel	4	4
	Gelderland	1	1
	Utrecht	-1	-1
	Noord Holland	0	0
	Zuid Holland	-4	-4
	Zeeland	-10	-7
	Noord Brabant	5	7
	Limburg	10	13
Poland (1973)	Warzawa	-11	-9
	Krakow	-1	-1
	Lodz	3	3
	Poznan	-1	-1
	Wroclaw	2	2
	Bialostock	-6	-5
	Gdansk	-0	-1
	Katowice	8	8
	Lubelsk	-2	-2
Poland (1977)	Warzawa	-6	-5
	Lodz	3	3
	Gdansk	-6	-6
	Katowice	8	8
	Krakow	-5	-5
	East Central	2	2
	Northeast	-7	-7
	Northwest	4	4
	South	-1	-1
	Southeast	-1	-1
	East	3	3
	West Central	-1	-1
	West	1	0
Soviet Union (1974)	Russia (Urban)	1	1
	Ukrainia and Moldavia(Urban)	-7	-6
	Byelorussia (Urban)	-21	-23
	Central Asia (Urban)	5	0
	Kazakhstan (Urban)	4	5
	Caucasia (Urban)	-12	-13
	Baltic (Urban)	-7	-7
	Rural areas	2	3

Country and Region		Observed	Standardized
Sweden (1974)	Stockholm	1	1
	East-Middle	2	2
	South-Middle	-3	-3
	South	-5	-5
	West	-3	-3
	North-Middle	6	6
	Lower-North	1	1
	Upper-North	5	6
United Kingdom (1970)	North	8	8
	Yorkshire	6	6
	North West	11	11
	East Midlands	-0	-0
	West Midlands	2	3
	East Anglia	-11	-11
	South East	-9	-9
	South West	-5	-5
	Wales	7	7
	Scotland	13	14
United States (1958)	North East	5	4
	North Central	-5	-4
	South	3	3
	West	-5	-5
United States (1970)	North East	2	1
	North Central	-1	-1
	South	3	3
	West	-7	-7

Note : The "observed" index is obtained from formula (5), the "standardized" index from formula (6).

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