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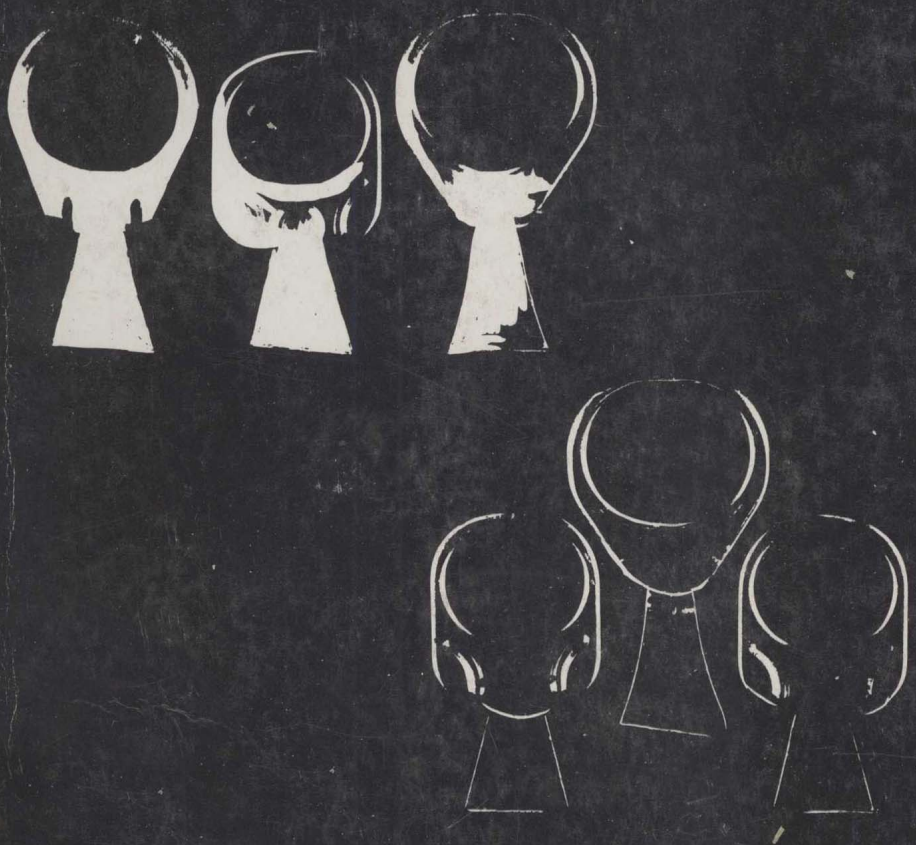
DEMOGRAPHIC TECHNIQUES

second edition



DEMOGRAPHIC TECHNIQUES

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Preface to second edition

This book has been prepared as an introduction to demographic techniques for students who have a general interest in population studies. The authors have been teaching demography at Macquarie University and elsewhere for many years and the material in this book has been used for that purpose. Although Macquarie University remains the only Australian university teaching demography at both undergraduate and graduate level, an increasing number of universities are realizing the importance of population studies and are introducing demographic components into their courses. The chapters on sources of demographic statistics, basic demographic measures, the life table, mortality, fertility and population projections have been found suitable for these short basic courses. The other chapters, in association with some social demography, have been used for more advanced students. For example, this book has been used as an introductory text for demography courses in our M.A. programme in Population and Development.

It is now six years since the first edition of this book was published. In this second edition sections of the book remain unaltered as many of the basic techniques have not changed. However, a number of chapters have been revised to include some of the more recent demographic techniques and slight changes have been made in emphasis and presentation in certain chapters, based on our experience in using this book as a basic text. Selected demographic and statistical data have also been updated. Since the object of the book is to explain clearly and briefly the basic techniques rather than to place emphasis on the actual numerical results, some data (e.g. life table) remain unchanged. Students are encouraged to repeat all examples and exercises using the most recent data available for their own country.

Finally, we have included a few exercises at the end of each chapter because we have found it most desirable for students to search through the usual data sources and attempt practical problems. In response to many requests, this edition includes the answers to selected exercises.

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Sources of demographic statistics

1.1 What is demography?

In the 1930s the population growth rates of a number of Western countries dropped to such low levels that there was considerable concern over future prospects for these countries. In the post-war period the growth rates of the developing countries have reached such high levels that the available resources cannot fully support the growing numbers of people, causing hardship, misery and starvation. On the other hand, the population growth rates in the developed countries, after experiencing the effects of a post-war 'baby boom', have again declined to very low levels and the problems of the developed countries now include excessive urbanization, pollution and general environmental deterioration and ageing of the population. In all countries the need for adequate demographic analysis and population planning remains essential for the future of mankind.

Literally translated from the Greek the term 'demography' means 'description of the people'. According to the United Nations Multilingual Demographic Dictionary, 'Demography is the scientific study of human populations, primarily with respect to their size, their structure and their development'. Demography is therefore concerned with the current size and characteristics of human populations, how they were attained and how they are changing.

It should be obvious that there are only three ways in which the number of people in a given area can change: a birth may occur, a death may take place, or a migrant may enter or leave. These three factors – fertility, mortality and migration – which continuously operate on a population and determine its size and growth form the major subject matter of demography and are referred to as 'components of population growth'. However, the demographer also studies other factors such as marriage, divorce, social mobility (change in social status and condition), etc., which do not affect the total size of the population but do determine the structure or composition of the population. Demography is concerned with the collection and analysis of data relating to all these factors and the interpretation of these data against their social, biological, economic, political, geographical, ecological and historical background.

Government and private enterprise need to consider anticipated changes in population size, structure and composition in making their short term and long term plans. Is the

population growing larger, smaller or remaining stationary? What are the ages and sexes of the population and how are the relative numbers of each age-sex group changing? What proportion are single, married, widowed or divorced and what are the current trends in marital status? Are people continuing to move from the rural areas to the cities or can this be arrested? Will immigration remain at current levels and what changes can be expected in the nationality of migrants? Are we having fewer or more children and what effect will this have on educational facilities in the future? What are the causes of deaths and how do these vary with age and sex? Will we need more homes for the aged, more doctors (and what kinds of doctors?) and where will they be needed? Some countries have introduced programmes designed to change the rate of population growth and a demographer is needed to evaluate the effectiveness of these programmes. Will monetary incentives have any real effect on the rate at which babies are born? Can we expect further improvement in the number of years a person expects to live? These, and more, are the questions a demographer endeavours to answer. In short, he is concerned with the careful, objective and systematic study of the population.

1.2 The beginning of demography

The study of the numerical size, growth and characteristics of human populations has a long history. Ancient Chinese, Greek and Arab philosophers such as Confucius, Plato, Aristotle and Khaldun concerned themselves with the various population issues of their days. The ancient statesmen and thinkers held opinions based on political, military, social and economic considerations about such issues as the most desirable number of people or the need to stimulate or retard population growth.

Confucius and other ancient Chinese philosophers noted that excessive population growth may reduce output per worker, depress levels of living for the masses and engender strife. Mention was also made of the concept of optimum population and some of the factors affecting population growth. Plato, Aristotle and other Greek writers discussed the question of optimum population with respect to the Greek city state and the ideal conditions for the full development of man's potential. The Romans viewed population questions in the perspective of a great empire and the advantages for military purposes and this is reflected, for example, in the laws of Augustus. The Hebrew sacred books also placed much emphasis on procreation and multiplication. Early and medieval Christian writers considered population questions almost entirely from a moral and ethical standpoint, but again favoured population growth. The views of Moslem authors on population resemble those of the Hebrew and Christian authors.

However it was the publication in 1662 of John Graunt's *Observations Upon the Bills of Mortality* that really marks the beginning of demography. Some (e.g. Sutherland, 1963) claim that Graunt was the founder of statistics as well. Early in the sixteenth century weekly bulletins on death from the plague were first published for each London parish. Gradually they became a more regular series and from early in the seventeenth century all causes of death were considered and the weekly totals of christenings were added. From this very limited data Graunt discovered what is now known as the principle of statistical regularity, obtained a constant sex ratio at birth of 14 males to every 13 females, estimated the crude death rate, and recognized seasonal and annual variations. He showed that the urban death rate was higher than the rural one and demonstrated that the popu-

lation of London was maintained by migration from the country and was not as large as was popularly believed. Graunt's investigation of mortality by cause of death makes interesting reading but his greatest achievement undoubtedly was the first life table. These and other 'observations' were the result of a systematic and thorough critical analysis of the most unpromising material which still serves as an example to all workers in the field of demography. After this beginning it was left to Graunt's friend, Sir William Petty, to convert his work into the beginnings of 'political arithmetic' which gradually became known as demography.

If Graunt is considered to be the father of demography, then the Reverend Thomas Robert Malthus (1766–1834) is generally considered to be the father of substantive demography, and is certainly the better known. He achieved this position not because what he said was all new, not because what he said was all true, but because he initiated tremendous controversy and debate over the relationship between food and population – debate which has continued from his lifetime to the present day and is as relevant today as it was when first proposed. His essay was first published in 1798 as *An Essay on the Principle of Population*. It was revised and substantially expanded as a second edition in 1803 and further revised in 1806, 1807, 1817 and 1826, with a final posthumous seventh edition in 1872.

Basically Malthus' principle of population was that human populations tended to increase at a more rapid rate than the food supply needed to sustain them. To balance the two, checks would be imposed on population growth and these were all resolvable into vice and misery and (added in the second edition) moral restraint. The only moral restraint recognised by Malthus was the postponement of marriage with no extramarital sex during the postponed period. Moral restraint was to be the saviour of mankind.

The checks on population growth noted by Malthus were described as 'preventive' and 'positive' checks or, as they are now called, factors affecting fertility and mortality respectively. Positive checks were identified as causes which shorten human life, e.g. diseases, epidemics, famine, plague, etc. (all forms of misery) and wars, excesses of all kinds, etc. (forms of misery brought about by vice). Preventive checks were the kind which reduced fertility and – apart from moral restraint – included promiscuity, homosexuality, adultery, abortion and birth control (all vices). Malthus recognised that preventive and positive checks varied inversely, i.e. fertility and mortality must be either both high or both low. Finally, it should be noted that Malthus' great hope, 'moral restraint' or delayed marriage, did not encompass abstinence or any birth control* after marriage, partly because of their immorality and partly because of their tendency to remove a necessary stimulus to industry. The fear of having a large number of children causes man to work much harder than he would if the family size could be knowingly controlled.

From the technical methods of Graunt and the substantive arguments of Malthus the subject of demography has developed to a major field of study in the social sciences. In this book we consider the basic demographic techniques required by students specializing in population studies as well as those specializing in such fields as economics, sociology and human geography. Population questions cannot be examined seriously

*Proponents of birth control, who otherwise support the Malthusian argument, became known as neo-Malthusians.

without at least a basic grounding in the precise statistical analysis of population data. The biological, historical and social contexts in which population changes take place cannot be overlooked in any interpretation of the data, but the emphasis given here is clearly on the technical aspects.

1.3 Demographic data

Almost all basic demographic data come from censuses or surveys (to determine size and composition) or from the vital registration system (to determine change).

The statistical distributions of the individuals in a population according to such characteristics as age, sex, marital status, education, occupation, etc., are referred to broadly as the 'population composition'. Changes in the size and composition of a population are brought about through the occurrence of what are called 'vital events'. Some of these events, such as births, deaths and migration, alter the population size. Others, for example marriages and divorces which transfer people from one marital status category to another, merely affect the population composition.

A population is thus subject to constant change as a result of these vital events. Consequently, statistics about population composition and size always refer to the position at a particular date, for example a census conducted on 30 June 1976.

On the other hand, since vital events do not all occur at once, statistics relating to them are expressed as the number of events which occurred during a specific period of time, for example during the period 1 January 1980 to 31 December 1980.

Information about the size and composition of a population is usually obtained from censuses or demographic surveys, while statistics about vital events are usually collected through what is known as the vital registration system. These are the three major sources of demographic data. In some countries where the registration system is not in operation or is ineffective, attempts have been made to collect statistics about vital events through demographic surveys. Some Scandinavian and other countries maintain a continuous registration of their population in the form of population registers, in which all vital events and population movements are recorded. There are many other minor sources such as social security records or family planning records from which some limited information can be obtained.

1.4 The population census

History

The practice of census-taking, in some form or another, is almost as old as civilization itself. There are records of statistical enumerations in Babylonia (4,000 B.C.), China (3,000 B.C.) and Egypt (2,500 B.C.). References to census type operations in Palestine and Rome and eventually the whole Roman Empire are found in the Bible. Most of these population counts, like the English Domesday inquest of 1086, were partial in coverage because of the rather limited use to which these data were to be put. Generally they were limited to landholders or heads of households or males of military age or taxpayers, and were for military, labour or tax purposes. Few results survive. Among the first censuses in the modern sense were those of Quebec (1666), Italy and Sicily (seventeenth century), Sardinia, Parma, Tuscany, Prussia, Iceland, Denmark and Sweden (eighteenth century). The U.S.A. commenced census-taking in 1790 and the U.K. and France in 1801. Up to

the beginning of the twentieth century less than 20 per cent of the world's population had been counted by population censuses. Today only eleven countries (six in Africa and five in Asia), out of 200 countries with populations exceeding 5,000 persons, still have never taken a census. With the assistance of the United Nations-sponsored World Population Census Programme, the majority of countries took censuses during the period 1965–74 and have repeated or will repeat the performance during 1975–84.

Definition

The modern population census may be defined as the process of collecting, compiling, evaluating, analyzing and publishing demographic, social and economic data about the entire population of a well defined territory at a specified time. It is a massive, complex and costly statistical operation and thus is usually carried out by the government, which has the necessary legal authority to ensure completeness of coverage. The census usually requires some years of careful planning so that often plans for the next census are well advanced before the complete results of the previous census are known. The actual field-work does not take more than a couple of weeks, but even with the help of modern electronic data-processing equipment, the compilation and publication of census data takes years to complete. Censuses are usually taken at regular intervals (say five or ten years) to ensure that comparable information is collected in a fixed sequence.

Planning and execution of the census

During the planning stage of a population census the persons responsible have to:

(i) decide on the system of enumeration to be used;
(ii) fix the date of the census and set out the pre-census programme;
(iii) decide on the type and content of the questionnaire;
(iv) test all forms and procedures including final pre-test;
(v) prepare detailed maps and list all dwellings;
(vi) recruit and train the field staff;
(vii) plan the programme for processing of the data;
(viii) inform the public and obtain their co-operation.

Some of these points require further discussion to appreciate the alternatives available, the expected problems and how they are overcome.

Populations are usually enumerated either on a *de facto* or a *de jure* basis. Under the de facto system a person is counted wherever that person is found at the time of census enumeration. Under the de jure system, people are enumerated at their *place of usual residence*, irrespective of where they were at the time of the census. Both systems have their particular advantages and disadvantages. The main advantage of the de jure method is that it gives a picture of the permanent population. The main advantage of the de facto method is that it offers less chance of double counting or omission of persons. The de facto system is the more commonly used and is recommended by the United Nations Population Commission. Theoretically speaking both de facto and de jure systems should yield the same population total, provided there is no migration in and out of the country. However, significantly different population figures at sub-national level could result if different systems of enumeration are used.

As regards the timing of a census, it is clearly better for it to be conducted at a time when population movement is at a minimum. The height of the holiday season, for example, would not be a good time to conduct a census. Also, when a series of censuses is conducted

in respect of a particular territory the censuses should, if possible, be conducted on the same day of the year.

There are two basic types of census questionnaires – the 'individual' type and the 'household' type. The former is required to be filled in separately in respect of each individual, while the latter asks for information in respect of all members of the household. The household questionnaire which, except in countries with low literacy levels where interviewers or canvassers are required, is usually completed by the head of the household, is being increasingly used in both developed and developing countries. A census questionnaire usually asks for the age, sex, marital status, place of birth, nationality, relationship to head of household, ethnic origin, educational level, occupation, religion, etc. of each member of the household. In countries where information about vital events is lacking or inadequate, questions on fertility and sometimes on mortality are also asked in the censuses. If the questionnaire is of the individual type, what is called a housing census is often conducted either concurrently or before the population census in order to obtain information about the type of house, the form of ownership and other related questions. With the household type questionnaire this information is usually asked for on the population census questionnaire.

It is most important to have the questionnaire thoroughly pre-tested in the field in order to ensure that it will yield the required information. This pre-tests both the questionnaire and the field operations.

Before starting the actual census enumeration, the whole country has to be divided into census blocks of a size which can be handled by one interviewer. The size of a block varies according to the density of population, geographic characteristics of the area, means of transport and communication, etc. If a housing census precedes the population census, the job of specifying the boundaries of census blocks (which includes preparing lists of dwellings) is done as a part of the housing census. Otherwise it has to be done as a separate operation prior to the actual population census.

Recruitment of qualified and conscientious field staff and their proper training is an extremely important aspect of the planning of a population census. In some of the developing countries certain government officials are required to carry out the enumeration in addition to their normal duties. This is a rather risky practice, as the quality of census data depends to a great extent on the proper training of the field staff and on their efficiency, conscientiousness and motivation.

With the use of modern high-speed electronic data-processing equipment it is hoped that the time lag between the collection of census data and their publication will be shortened substantially. However, it must be recognized that one of the most time-consuming operations is the coding and preparation of the census input data for computer use. Once the data are in a computer-acceptable form, programmes can be written to edit the data for internal consistency and the occurrence of errors. Tabulating the census data is a fairly routine and standard operation.

Informing the public that the census is to be taken and requesting their co-operation is an important stage in both developing and developed countries. In developing countries the presence of interviewers requesting personal information is likely to be viewed with some suspicion unless the population is adequately warned. In developed countries invasion of privacy may be a problem affecting completeness of coverage, and confidentiality, together with the national importance of the census, should be stressed.

The voluminous information collected in a census may be tabulated separately for each item of information appearing on the questionnaire, or in cross-classifications using two, three or more of the items. *Table 1.1* shows the distribution of West Malaysia's population by age, sex and ethnic origin, as reported in the 1970 census. If we consider only columns (1) and (12) of this table we have the age distribution for the population of West Malaysia. This is a one-way table. If we consider columns (1), (10) and (11) we have a two-way table giving the age-sex distribution of the population of West Malaysia. If we consider columns (1) to (9) inclusive we have a three-way table giving a cross-classification by age, sex and ethnic origin.

Table 1.1

Population (in thousands) of West Malaysia by age, sex and ethnic origin

Age	Malay		Chinese		Indians		Others		All ethnic origins		
	M	F	M	F	M	F	M	F	M	F	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0–14	1,069	1,054	685	642	213	204	13	12	1,980	1,912	3,892
15–44	914	962	652	654	193	182	17	15	1,776	1,813	3,589
45–64	259	261	172	183	74	43	5	4	510	491	1,001
65 and over	66	62	64	65	14	6	1	1	145	134	279
Unknown	13	12	8	8	3	2	1	0	25	22	47
Total	2,321	2,351	1,581	1,552	497	437	37	32	4,436	4,372	8,808

(*Source:* 1970 census of West Malaysia)

It should be pointed out that certain items of information collected in the census are tabulated for the country as a whole, others may be tabulated for various states or provinces and still others may be tabulated for local government areas.

The range of questions asked at a census has gradually extended over the years. However, quite recently, in many countries, there have been campaigns to protect the rights of individuals and to prevent the invasion of privacy. With the advent of computer-stored data banks, fears have been expressed that the guarantees of confidentiality, which apply to most government-collected data and particularly the census data, may not be strictly enforced. The questions asked in a census can, and in some cases have, become a political issue and some authorities have expressed the opinion that it may become necessary to eliminate some of the more personal questions or even to change from a compulsory census to a voluntary one.

1.5 The registration of vital events

History

The modern civil system for the compulsory registration of births, deaths and marriages is the end result of an evolutionary process that began with the recording of christenings,

burials and weddings by the clergy in parish registers. In the early sixteenth century as a result of the plague epidemic, weekly statements of deaths from plague called the 'Bills of Mortality' were required to be compiled by each parish priest in London. Gradually other causes of deaths were included, as well as christenings and weddings, and extended to cover all English parishes. However it was not until the 1837 Births, Marriages and Deaths Registration Act that registration became a civil event and a central records office was established. Perhaps the longest continuous series of national vital registration statistics is that of Sweden, for which the data are available since 1748, although compulsory civil registration was enacted in the various Scandinavian countries in the seventeenth century. Vital registration systems have since been established in most developed countries and are gradually being introduced in developing countries. In Australia, provisions for the registration of births, deaths and marriages have been in force since the middle of the nineteenth century.

Definition and collection procedure

Information about vital events is usually collected by means of the compulsory registration of such events within a short time after their occurrence. The registration method is defined as 'the continuous and permanent, compulsory recording of the occurrence and the characteristics of vital events primarily for their value as legal documents as provided by law and secondarily for their usefulness as a source of statistics'. In almost all developed countries such registration of births, deaths, marriages and divorces is compulsory, and must be made by lodging a standard form giving certain essential information. Certificates issued by the official legally responsible for administering the registration system (called the Registrar) are used for purposes of identification and for legal contracts, life assurance policies and so on, where proof of such characteristics as age, marital status, etc., is required. The appropriate certificates are also required before payment of social welfare benefits, settlement of estates and inheritances, etc. In many countries, particularly in developing countries, the registration system does not work very efficiently. This is at least in part due to lack of interest by the general public who do not find in their daily activities much use for the certification of vital events. The data collected, when incomplete, are of little use in estimating birth and death rates and other methods (see Chapter 12) must be used. The dual function (legal and statistical) of the registration of vital events must be stressed as this affects the questions asked and the data collected.

Vital statistics data collected

The birth registration form usually includes characteristics of the event or child such as date of occurrence, date of registration, name, sex, type of birth (live or still, single or multipe), legitimacy and place of occurrence, and characteristics of the parents such as date of birth (or age), name, date of marriage, occupation, usual residence and names and ages of the previous children born to the mother. The form also usually includes the names of medical personnel who attended the birth of the child. This form usually has to be completed in respect of a still birth, that is a baby born dead, as well as in respect of a live birth.

The death registration form usually records the name, age, sex, marital status, occupation, place of birth, date and cause of death of the deceased.

The marriage registration form includes dates of birth (or ages), occupations, religions, birth-places, places of usual residence, previous marital status of both the bride and

bridegroom, together with the date and place of the marriage. Divorce data collected includes date of divorce, dates of birth (or ages) of both partners, date of marriage, number of children, occupation and place of usual residence.

Migration data

Information about international arrivals and departures is collected by immigration officials at all ports of embarkation and disembarkation. Information is therefore collected on the day of the event by immigration officials rather than there being a legal responsibility for individuals to report vital events to the Registrar of Births, Deaths and Marriages. For this reason migration data are not always included in the definition of the vital registration system, although the demographic importance of migration as a vital event must be recognized.

All international passengers (or, where the volume of traffic is very large, a sample of passengers) have to complete an embarkation card (for departures) or a disembarkation card (for arrivals). These cards seek information such as age, sex, marital status, occupation and nationality of the passenger, as well as the purpose of visit to the country and the expected length of stay in the case of arriving passengers, and the reason for leaving and expected length of stay overseas for departing passengers.

Processing the data

Information collected through the registration system is usually passed to the official central statistical agency for compilation and preparation of tables. Elaborate tabulations are usually published. The more important of these are, in the case of births, listings by duration of marriage, number of previous children, ages of parents and various cross-classifications of these; in the case of deaths, listings for each sex by age and cause of death; and in the case of marriages, listings by age and birth-place of bride and of bridegroom. For arrivals and departures, tables are prepared separately for long-term and short-term population movements, giving details such as age, sex, marital status, occupation, nationality, and expected length of stay.

1.6 Sample surveys

Another major source of demographic data is the sample survey. Some examples of its use are:

(i) To collect vital statistics where the official registration system is inadequate or non-existent, as is the case in most developing countries.

(ii) To collect supplementary demographic and other data where it is not feasible to collect the same from the population census (e.g. public opinion polls; surveys on topics such as labour force and invalidity; and surveys on the knowledge, attitude and practice of family planning methods called KAP surveys).

(iii) To test the accuracy of the traditional sources of demographic data (e.g. census pre-testing of questionnaire and census post-enumeration quality check in a sample of census blocks).

(iv) To conduct a sample census (e.g. collecting data for only 10 per cent of the population; collecting age and sex data for the whole population but socio-economic data for only a sample of the population; processing only a part of the information collected to save time and money and present a wider range of tabulations).