Methods of school enrolment projection

by E.G. Jacoby
EDUCATIONAL STUDIES AND DOCUMENTS

Report on the Unesco La Brévière International Seminar on Workers' Education, by G. D. H. Cole and André Philip*

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Planning for the extension and improvement of education is no new development; for every major law on education represents an effort by the public authority to chart the future course to be taken by the educational system. But it is true that in recent years increasing attention has been given to the need for planning over the entire range of social policy, and educational administrators have been obliged to adapt their procedures to this trend. There is, in consequence, a demand for information about methods which may be applied to the data of education. The question is a legitimate one to raise internationally, since, despite differences between national systems of education, the methods available for planning do not greatly vary. What may vary, of course, is the extent to which such methods can be adopted at a particular stage of development.

In response to requests from Member States, Unesco has developed a certain number of activities in this direction, such as the provision of expert advisers and of fellowships for study abroad. Studies and consultations have borne on the problems of standardizing statistics(1) and of gathering documentation related to educational plans(2). The present case study is a further step in this programme: the Unesco Secretariat has asked Dr. E. G. Jacoby, research officer in New Zealand Department of Education, to set out his experience in the field of projecting school enrolments. It will be realized that the problem of forecasting school populations is an essential component of planning, but not the only component. Similarly, it should be kept in mind that the author is writing about a highly developed school system; the methods he uses cannot be applied everywhere, for the obvious reason that in many countries compulsory education has not yet been achieved, and information about the child population and the population as a whole is not so readily to hand as it is in New Zealand. In other words, this document is a case study, not an international manual. If the interest of readers seems evident, further case studies may be sought and published in the near future, leading perhaps to the issue of a more generalized and inclusive work on the subject.

Unesco is particularly grateful to Dr. E. G. Jacoby and to the New Zealand Department of Education for having set this programme in motion. The successive annual reports of the Department constitute an interesting example of the attempt, within a national system of education, to forecast needs and to take steps to meet these needs. But naturally the methodology employed does not appear in existing publications. The preparation of this study has therefore been an extra charge on the author and the Department he works for. The assistance and continuing interest of the New Zealand National Commission for Unesco must also be recorded.

(1) See especially "Draft recommendation concerning the international standardization of educational statistics" (General Conference, 10th Session 10C/11) / "Projet de recommandation sur la normalisation internationale des statistiques de l'éducation" (Conference Générale, 10e session 10C/11).

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CHAPTER I
THE WHY AND HOW OF PROJECTION

1.1 THE CHIEF CAUSES OF INCREASE IN SCHOOL ENROLMENT

In the most general terms, there are two chief causes of increases in school enrolment. The first is the absorption by the school system of children who at one time would not have attended school. This happens in various circumstances, the most important being the implementation of a system of compulsory education. Its introduction is in practice often a gradual process, so that over a period of years school rolls increase until eventually all children within an age range defined by statute are attending. Another instance of this kind occurs where the age range is an 'open-ended' one, i.e. where there is a tendency for the age range of children actually attending school to expand. For example, the New Zealand age range for compulsory education is from seven to under fifteen years. And more and more children started school at six, and this tendency extended to the five-year-olds, so that at present nearly the whole of these two youngest age groups go to school although not legally obliged to do so. At the opposite end of the age range more and more pupils continue to stay at school after their fifteenth birthday.

The second cause of increase in school enrolment is an increase in the size of those age groups in the general population from which the school population is drawn. Increases in total enrolment due to this demographic factor may be temporary or if considered over a fairly long period of years, permanent: whether they are temporary or permanent the implications for the educational administrator are the same, since the schools and other educational institutions of a country must be sufficient in number to cater for the maximum number of pupils at any time. And in either case, the making of enrolment projections depends on observable demographic trends of change in the size and composition of the country's population.

The two chief causes of rising school enrolment discussed in this section are to be found at work in a great many countries. To a greater or lesser extent, increases in the child population over the last twenty years have created a demand on school systems for accommodation of greater and greater numbers. And over a much longer period, one hundred years or more, education has become more generally available and wider in its scope. In some countries this democratization of education has been a development of much more recent date, so that in numerous instances the two factors, one demographic, the other educational, have operated jointly, and their combined impact upon school enrolments has been very considerable.

1.2 THE NEED FOR PLANNING

To ensure that in these circumstances the best benefits are obtained from a particular educational system, it has become necessary to plan ahead for adequate accommodation of all school children and students. Such plans will include school building programmes, measures for training enough teachers, provision of all kinds of school equipment, of textbooks and other teaching aids, and of school transport where needed, arrangements for examinations, for inspection, for building maintenance, and so forth.

It may be remarked in passing that in the case of population changes at the level of school-age population this planning activity consists merely in pointing out the consequences of a particular development. In the case of widening out an existing education system or of introducing a new system the function of the planner is somewhat different. This extension of education is a matter of educational policy, and the implications of whatever action is being taken are made clear by rendering them in the statistical form of probable school enrolment numbers and of probable increases in numbers.

1.3 SOME TERMS EXPLAINED

It will be as well at this point to clear up a few questions of terminology, in so far as this serves to ensure a better understanding of the statistical problem itself.

The term estimate will be used to refer to the assessment of numbers of school children in the past or the present. Although this assessment rests on simple enumeration, the latter is subject to all kinds of error, just as is the case with the population statistics that are obtained by

(1) I. L. Kandel, Raising the school leaving age, Paris, Unesco, 1951, 71 p. (Studies on compulsory education, no. 1).
means of a census (enumeration). The advantage of restricting 'estimate' to mean past or present assessment is that the term is thus not loaded with the additional degree of uncertainty that is inherent in a statement of future numbers. The term best suited to describe the forecasting of future enrolments is projection. It is now commonly used for this purpose by the United Nations' Population Division. One may admit the truth of the following statement made several years ago: 'Predictions, estimates, projections, forecasts - the fine academic distinctions among these terms are lost upon the user of demographic statistics...'. Nevertheless it seems worth while, as a matter of communication, to establish the connotation in which the words 'estimates' and 'projections' will be used throughout this study. The person who makes such projections will be referred to as a forecaster. Clarity on this point may assist in clear thinking on both the problems involved and the methods for their solution. Some minor points of terminology are as follows:

**Age:** A single year of age, e.g. '13 to under 14 years' will be given by a single figure: in this instance, '13'. It refers to any member of the population that on a stated date has reached his thirteenth birthday but not yet his fourteenth. An age group comprising several ages, e.g. '6 years to under 15 years', will be referred to as '6 through 14': where '6' stands for the lowest age '6 to under 7', and '14' for the highest age of the range, '14 to under 15'.

**Increase:** An 'increase' (or 'decrease') in numbers is the difference between the numbers stated for a defined population at two consecutive dates. This means that the increase itself may occur at any time between these dates; the shortest period of time will usually be one year. If the exact time of that increase is to be given, a further statement (based on an investigation of occurrence) is always required. For example, where children may enter school as soon as they reach their fifth birthday increases in the school roll take place throughout the school year. Similarly, if a pupil may leave school on his fifteenth birthday, a decrease in school roll may take place at any time during the school year. It is usual to summarize in one figure all such increases and decreases that take place during the period of 12 months. This summarized figure is compared for different years.

It is obvious that an increase in the number of people in a specific age group may refer to one or other of two things. Which of them is meant will always be stated explicitly if it is not clear from the context. The first case is where one compares the same group at different times, say five-year-old children at school in the year Y with the same group at school in the year Y + 1:

here, the increase is found by subtracting the number of five-year-old children at school in year Y from the number of six-year-old children at school in year Y + 1. This operation will be frequently employed, whether in estimates of enrolment ratios (that is, the proportion of a specified age group attending school) or in estimation or projection of progression from one class (or grade) to a higher one. In the latter case, the term 'survival' will be much used, and also its opposite 'drop-out'.

The other case of 'increase' is that where a comparison is made between two different groups of a given age at consecutive dates, say the number of five-year-olds in year Y with the number of five-year-olds in Y + 1. This operation will be used whenever increases or decreases in the number of pupils of a given age, or similarly, of a given class (or grade) are being measured at different times. For example, the question of what is or will be the number of school entrants at different times, or what is or will be the number of school leavers, is answered by noting this kind of change.

Finally, the term base years is used to denote the period of time for which statistical data used as the base of a projection have been collected.

1.4 THE BASIC OPERATIONS IN PROJECTION WORK

1.4.1 Statistical methods used

The statistical methods employed in this projection work are quite simple. They do not require any advanced mathematics. But as they involve the handling of numbers in a specific frame of reference, some facility in basic operations including ratios is necessary to ensure that basic data can be adequately summarized for the purpose in hand and that relevant comparisons can be brought into relief.

This need may be stressed by considering a circumstance which, strictly speaking falls outside statistical methods as such. It is the problem of making explicit the assumptions on

---

(1) The term prediction will be avoided because it presumes too much: it implies that a statement made on future enrolment does not admit of possible variation of the actual number that will be found at that future date. The term forecasting, on the other hand, appears to be less precise than the term projection as regards the assumptions on which a statement made on future enrolment has been based.

which projections - or, more generally, the extrapolation of trends observed in the past - are based.

These projections are the result of observation of the factors that in the past have contributed to changes in enrolment, such as increase or decline in the population groups of school age; changes in the rate of enrolment or attendance of certain age groups both outside and within the ages of compulsory education; the pattern of enrolment of boys against girls; the pattern of classification by grades, and reasons for its change; the proportions of pupils that reach stated levels of qualification whether on leaving primary or secondary schools, and so on. The behaviour of these contributory factors can be studied for past years by suitable methods of analysing total enrolment. If the observations can be made for a sufficiently long period, they will reveal trends of increase or decline. It becomes possible, then, to express the expectations as to how and at what rate these trends continue to operate as stated assumptions that can be assigned numerical values.

Making these assumptions involves in the first instance making a decision. It will often be a difficult one, but it is always a necessary step in projection work. The more we know about the trends in the past from an analysis of available information, and the closer the projection work is geared to the general administration of the education system, the easier this work will be. The next step is that of assigning numerical values to the expectations of change based on stated assumptions, so that they can be entered as factors in the computation of future enrolment.

1.4.2 An illustration of the basic operations

This basic process may be illustrated here by an example. Let us assume that in the past five years the number of five-year-old children that entered the infant departments of schools expressed as a proportion of their age group was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Proportion of 5-year-olds enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>.75</td>
</tr>
<tr>
<td>-3</td>
<td>.77</td>
</tr>
<tr>
<td>-2</td>
<td>.78</td>
</tr>
<tr>
<td>-1</td>
<td>.81</td>
</tr>
<tr>
<td>0</td>
<td>.83</td>
</tr>
</tbody>
</table>

(1) The notation of years as '0' for the latest year of known information, and as '-1' etc. for previous years removed by one, two etc. years from the latest will be found convenient as a means of distinguishing 'base years' from projection years.

(2) In practice, the decision to assume the continuation of an increase of 2 per cent would involve consideration of other factors than the rate of increase during past years. For example, there is of course an upper limit reached when 100 per cent - or perhaps more realistically, 95 per cent - of the whole age group are enrolled. The rate of increase may slow down as enrolment approaches the upper limit. On the other hand, it may become more rapid when the age group involved shows some decline, and enough school places would be available without overcrowding of classes.

A decision has now to be made on the probable trend of the enrolment proportion in the next five years. The past five years suggested a rate of increase of 2 per cent of the age group. The forecaster may therefore decide to assume a continuation of increase at a flat rate of 2 per cent, as is done in the example shown in Table 1. (2) The computational work is a straightforward operation, as set out in this table.
As this example shows, there are three phases involved in this kind of work, namely:

1. the collection of certain basic statistics,
2. the analysis and interpretation of these statistics,
3. the projection of enrolments.

It may be helpful at this stage to make some general comments that will stress some fundamental features of each of these phases.

1.5 COLLECTION OF BASIC STATISTICS

Two sets of statistical data will be needed: educational statistics and general population statistics. Depending upon the statistical organization in the administrative system of a country, the recording, collecting, compiling, summarizing, and publishing of both educational statistics and population statistics may be the responsibility of one and the same statistical agency (central statistical bureau), or the responsibility may be divided between two departments. In the latter case, there is usually provision for co-ordination of activities.

1.5.1 Educational Statistics

The minimum amount of educational statistics required is obtained from an enumeration of all pupils on the roll of each school at given dates. This should give the age and the class (or standard, or grade) of all pupils at the time of counting, which is the same for all schools. The total school roll will then be in a table with a frame giving each age one line and each class one column. With, say, ten ages and eight classes the body of the table will contain entries in up to eighty 'cells'. The columns (or the lines) may be divided for boys and girls. National summaries of these enumerations are compiled for all types of school and other educational institutions in the system. These summaries are made separately for full-time pupils and for part-time pupils on the roll. All such summaries can be combined in one grand summary tabulation which gives national enrolment specific for both ages and classes.

The pattern for the summaries need not be illustrated here. The reader is referred to the age, sex, grade distribution tables in Unesco's World Survey of Education, Vol. I., Handbook of Educational Organization and Statistics (1955), Vol. II., Primary Education, (1958). Some international agreement is expected to result from Unesco's work on the standardization of education statistics. (1)

The fact that summary educational statistics of this kind are statistically speaking - estimates has been remarked elsewhere (see 1.3 above). They are subject to enumeration errors at the source. In the process of compiling the summaries it may be possible, and is of course desirable, to correct enumerations for any errors whether of under or over-enumeration or of classification.

This pattern of age by class tabulation will serve as the basic material for school enrolment projections.

1.5.2 Population Statistics

The information in this group may be divided in two main sections:

(1) Breakdown of total population by age, particularly population of school age, obtained by a population census or by intercensal estimates;


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Table 1 - AN EXAMPLE OF PROJECTED ENROLMENT COMPUTATION

<table>
<thead>
<tr>
<th>Year</th>
<th>Multiplied by (2) Projected proportion of age-group enrolled</th>
<th>Estimated population of age 5 (3)</th>
<th>Enrolment projection (2) x (3)</th>
<th>Projection (4) rounded to the nearest 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>= .83</td>
<td>10 000</td>
<td>8500</td>
<td>8500</td>
</tr>
<tr>
<td>+1</td>
<td>= .85</td>
<td>9 500</td>
<td>8265</td>
<td>8275</td>
</tr>
<tr>
<td>+2</td>
<td>= .87</td>
<td>9 700</td>
<td>8633</td>
<td>8625</td>
</tr>
<tr>
<td>+3</td>
<td>= .89</td>
<td>9 400</td>
<td>8554</td>
<td>8550</td>
</tr>
<tr>
<td>+4</td>
<td>= .91</td>
<td>9 000</td>
<td>8370</td>
<td>8375</td>
</tr>
<tr>
<td>+5</td>
<td>= .93</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: (i) Ratios observed in base years extrapolated after decision on assumed rate of increase (2 per cent per annum)

(ii) Age estimates intercensal or derived from births in corresponding years adjusted for mortality at ages 0 through 4 and for migration. (See chapter III).
1.6 ANALYSIS OF BASIC DATA

(2) Records of events resulting in population change, such as:
(a) vital statistics of births; total numbers in periods of a year,
(b) vital statistics of deaths at pre-school and school ages, supported by life tables, (1)
(c) migration statistics.

Where intercensal estimates of population by age are not available, it remains possible to 'survive' a population enumerated at an earlier census to that at a later census. The population at the earlier census (if necessary after corrections for enumeration errors) will, age for age and year for year, be reduced by mortality, increased by births in each intercensal year, and increased or reduced by external migration. The records of vital statistics, and, if available, those of migration statistics (after adjustment to the dates of the censuses and the intercensal period) will be used for this purpose.

Neither the pattern nor the conventional methods used to secure this information need be illustrated further. They have been the subject of a number of most valuable publications by the Population Division of United Nations, including the issues of the Demographic Yearbook.

The general population statistics referred to also serve as basic material for school enrolment projections. They yield information on population of school age, classified by age, for certain dates, years and periods, that coincide with the dates, years and periods of educational statistics.

1.7 PROJECTION - PATTERN OF OPERATIONS

In section 1.6 the term enrolment ratio was defined as the proportion of the children in a given age group enrolled at school. This may be conveniently expressed by the following formula:

\[ R_e = \frac{E}{T} \]  

where \( R_e \) stands for the enrolment ratio, \( E \) denotes the number of children enrolled and \( T \) the total number of children in the age group or groups concerned.

In projection work the problem is to determine \( E \) for some future year or number of years, so the formula is written:

\[ E = R_e \times T \]  

(1a)

It is clear that \( E \) can be determined once \( R_e \) and \( T \) are known. Thus in table 1, where the total population \( T \) of children aged 5 as well as the enrolment ratio \( R_e \) were assumed to be known over a number of years, the various values of the projected enrolment \( E \), as shown in column 4, were easily obtained by multiplying the corresponding values for \( R_e \) in column 2 by those for the total population \( T \) in column 3.

However, it should be remembered that in this example \( R_e \) and \( T \), since they referred to the future, could not be assessed on the basis of direct enumeration, and were themselves projected from values for \( R_e \) and \( T \) in the base years. Indeed, the fundamental problem of enrolment projection work is to assign values to \( R_e \) and \( T \) for future years. The way this is done for \( R_e \) has already been explained in section 1.4.2. The next problem is how to estimate \( T \), the total number of children of a given age or age range at a future date.

1.7.1 Projection of total school-age population (T)

Let us begin with a concrete example. To find out how many five-year-old children there will be in two years' time we can look up the number of children born three years ago. Allowance will have to be made for mortality and migration but normally these two survival factors can be assumed to have only a minor weight that is approximately equal for a series of years. This is a comparatively simple calculation which can be used to discover the total number of five-year-old children there will be in any year up to five

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(1) Life table. 'A Table showing the number of persons who, of a given number born or living at a specified age, live to attain successive higher ages, together with the number who die in the intervals'.

years ahead, the total number of children aged 6 in any year up to six years ahead, and so on. Alternatively, instead of using the number of births as basic data, it is possible to arrive at a figure for \( T \) on the basis of intercensal estimates of the number of five-year-old children. In fact quite often both methods are used, in which case it is instructive to compare the results. Table 2 shows such alternative ratios and figure 1 represents them graphically. It will be noted that the broad trend is similar but the curves do not run exactly parallel.

Table 2 - A METHOD OF ALTERNATIVE RATIOS FOR USE IN PROJECTION

(School enrolment of five-year-old children in New Zealand schools)

<table>
<thead>
<tr>
<th>Date 1 July</th>
<th>Numerator</th>
<th>Alternative denominators</th>
<th>Alternative enrolment ratios (multiplied by 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School enrolment age 5</td>
<td>Age group 5 intercensal estimate</td>
<td>Births in year ending 30 June</td>
</tr>
<tr>
<td>1950</td>
<td>35 186</td>
<td>37 800</td>
<td>39 517</td>
</tr>
<tr>
<td>1951</td>
<td>37 687</td>
<td>42 400</td>
<td>43 107</td>
</tr>
<tr>
<td>1952</td>
<td>45 054</td>
<td>48 300</td>
<td>50 553</td>
</tr>
<tr>
<td>1953</td>
<td>45 956</td>
<td>48 300</td>
<td>49 238</td>
</tr>
<tr>
<td>1954</td>
<td>47 007</td>
<td>47 200</td>
<td>48 941</td>
</tr>
<tr>
<td>1955</td>
<td>46 539</td>
<td>47 600</td>
<td>49 321</td>
</tr>
<tr>
<td>1956</td>
<td>46 825</td>
<td>49 100</td>
<td>50 375</td>
</tr>
</tbody>
</table>
Figure 1. Alternative enrollment ratios obtained by dividing the number on the roll by (a) intercensal estimates, (b) number of births. Illustrated from New Zealand projections 1950-1956 for children aged 5.

The real difficulty in forecasting the total number of children of a certain age group in some future year occurs when one wishes to forecast, for example, what will be the total number of five-year-olds at a point in time six years or more from now, the total number of six-year-olds seven or more years from now, etc.

In this case we first need to know the birth rate, a term which may be defined as the number of births actually occurring in an area, in a given time period, divided by the population of that area. For any given year $Y$ this can be expressed as follows:

$$R_b = \frac{T_Y}{P} \quad \cdots \cdots \cdots \cdots \cdots \quad (2)$$

where $R_b$ is the crude birth rate, $T_Y$ is the total number of children born in year $Y$ and $P$ the total population of the country or area concerned, in the same year.

Since our object is to discover $T_Y$, it will be convenient to re-state the formula as follows:

$$T_Y = R_b \times P \quad \cdots \cdots \cdots \cdots \cdots \quad (2a)$$

This raises a problem similar to that discussed in 1.7. To discover the unknown $T_Y$, we must know $R_b$ and $P$, but since both the latter refer to future years they will have to be found by extrapolation from data available for a base period. This topic will be taken up in Chapter III.
2.1 EDUCATIONAL EXPANSION IN NEW ZEALAND

Methods of school enrolment projection to be discussed in detail in Chapters III and IV will frequently be illustrated by reference to New Zealand experience. Twice in the history of New Zealand education rapid increases in school enrolment have led to an approximate doubling of the number of pupils in a relatively short period. These developments were a challenge to the forecasters and a test of their ability to exercise that foresight that "requires due emphasis on the relevant facts from which the future is to emerge" (A. N. Whitehead).

The first of these increases occurred in the ten years that followed the passing of the Education Act 1877. It was the result of a vigorous policy of free and compulsory education - with all its administrative implications. (1) A second period of rapid increase began after 1945, when the combination of two factors - one demographic, the other educational - soon led to a doubling of secondary school rolls. From 1939 onwards a substantial recovery in the number of births took place, with consequent enrolment increases starting from five to six years later. At about the same time a policy of 'secondary education for all', with a reform of the secondary school course and the school leaving certificate in 1944, opened the doors of secondary schools wide. It also had the effect of encouraging pupils to stay longer at school. As a result, total secondary school enrolment will double between 1950 and 1960.

2.2 A COMPARISON OF PROJECTED AND ACTUAL ENROLMENTS IN NEW ZEALAND

In connexion with this recent phase of educational expansion, enrolment projections were carried out in 1948, 1950, 1953, 1955 and 1957. The existence of these series enables us to compare the projections made in the earlier years with actual enrolments obtained as the years went by. The 1948 projection was a short-term one (four years only). (2) In 1950 a more elaborate set of 'school population estimates 1950-1960' was published in a White Paper. (3) As the approximation to actual rolls of the forecasts was observed, a summary revision was made in 1953 for internal departmental use in planning both of school building and teacher supply. However, the methods underlying the 1950 forecast and the 1953 revision proved an insufficiently powerful tool to assess adequately the developments in secondary school enrolment. These developments were due to downward changes in transfer age and upward changes in length of stay at school. Further analysis was needed, and this led to a study of the relevant trends, with a longer series of base years to work from. In due course revised forecasts based on this new method of projection were made in 1955. During the next two years these forecasts were compared with actual enrolments and in 1957 they were replaced by a complete set of projected enrolments that tried to take into account all the relevant factors bearing on enrolment trends.

The comparison therefore comprises a series of five consecutive projections, each replacing the earlier one. The 1950 and 1953 projections were made as far ahead as 1960, thus including some years of unknown births. The 1955 and 1957 projections reached to 1965, the latter also including in a more summary fashion tentative projection figures up to 1972. Also in 1957, university enrolment projections were prepared that covered nineteen years to 1975. (4)

From this material two diagrams (fig. 2 and 3) have been prepared that illustrate separately for state primary and state secondary schools the approximation of the forecasts to the actual enrolment recorded year after year. The factors determining enrolment trend differ sufficiently for primary and secondary projections to suggest separate consideration of these two sets.

(2) New Zealand, Education Department, Annual report of the Minister of Education for the year ended 31 December 1947, Wellington Government Printer, 1948, pp. 2-3.
2.2.1 Comparison of primary school enrolments (fig. 2)

It will be noted (fig. 2) that the projection made in 1948 for a period of four years corresponds closely to the actual enrolment during these years. As to the 1950 projection, which covered a period of ten years, it turned out to be fairly accurate for the first five years; but since 1955 there has been a marked divergence between this projection and the actual rolls (e.g., in 1957 the difference was over 3 per cent). Further, figure 2 shows that there are also considerable differences between the projection made in 1950 and that established in 1957 (e.g., for 1960 the difference is more than 6 per cent); the 1957 projection is probably more accurate because it is based on known births for all years.

If approximation is measured not on total enrolment but on enrolment increases, the above statements appear as though under a magnifying glass. For example, the total enrolment increase in primary schools forecast in 1950 for the seven years 1951 to 1957 was 78,600 children but the actual increase in that period was 88,700. Of the difference of approximately 10,000 almost 7,000 was due to underestimation of 1956 and 1957 roll increases. Large though these differences are, they were not harmful because, long before 1956, the forecasts had in 1950 had been replaced by revisions with a higher degree of approximation.

The limitations inherent in even the best possible projection can therefore largely be overcome by a constant review of the projections; the revision consists in feeding improved basic data into the projection procedure. (1) If for the whole period 1948 to 1957 only the most recent roll numbers produced by consecutive enrolment projections are considered in terms of their approximation to the actual enrolment each year, the average approximation works out at 99.1 per cent of actual rolls.

2.2.2 Comparison of secondary school enrolments (fig. 3)

The same figure for the secondary enrolment projections is only 95 per cent, which means that the most recent of consecutive projections of secondary school enrolment fell short of actual rolls by 5 per cent. The curves in figure 3 of the of the 1948, 1950 and 1953 projections remained markedly below the actual enrolments. They had been based on the assumption that fixed proportions of the age groups 13 years and over would be enrolled in secondary schools. The age groups themselves could of course be estimated with a very high degree of accuracy but it was the proportions of a given age group being enrolled at secondary school that revealed a trend of rather rapid increase. This trend could be accounted for by two factors both operating in the same direction. The first factor was the rate of change in the proportion of the younger ages 13 and 14 (that is, below the minimum leaving age of 15 years) attending secondary schools: it was due to a downward change in age of transfer from primary to secondary school. The second factor was the upward change in length of stay at school, i.e. the proportion of the population groups of ages 15 and over that remained at school showed a tendency to rise.

It was one thing to identify these two factors; it was another to give a satisfactory statistical expression to these changes. The changing length of stay at school, which is influencing the enrolment ratio of pupils aged 15 and over proved especially hard to assess. It depends on a variety of circumstances other than merely educational ones. The diagram shows that for 1956 and 1957 a temporary decline in enrolment was projected in 1950, but a flattening-out in rate of increase was projected in 1953, and this was replaced by a continually increasing enrolment projected in 1955. This was the result of better identification of the two factors; in particular it was realized that the proportion of children of ages 13 and higher who would be enrolled at secondary schools, instead of remaining constant was likely to increase over the years. Indeed, the actual enrolments in 1956 and 1957 showed an even greater increase than had been forecast in 1955; and the latest projection of 1957, in view of this, consequently yielded even higher numbers of probable rolls. The rate of increase was then assumed to be more rapid for a short term, whilst the later projection years of 1962 and after suggest a corresponding slowing-down in the rate of increase.

It will be noted from the scale on the left of figure 3 that the rate of increase was of considerable magnitude. The total secondary school roll of just under 45,000 in 1948 had risen to almost 80,000 by 1957. By 1959 the enrolment is expected to have doubled the 1948 figure, and by 1965 this figure will have been nearly trebled. This is not only the result of the specific factors determining the trend in enrolment proportions at work that have been briefly discussed. It is also due to increasing numbers in the population groups of secondary school age.

Figure 2. New Zealand: State primary school enrolment projections, 1948, 1950, 1953, 1955, 1957.
CHAPTER III
THE SCHOOL AGE POPULATION

3.1 AGE DISTRIBUTION

For the projection of school enrolment totals on a national basis it is convenient to start from the age distribution of children of school age in the total population. It is, moreover, preferable if these age groups can be given by single ages rather than by a broader grouping (such as 5-7, 8-11, 11-15, etc.).

3.1.1 Date of estimation or enumeration

A breakdown by single-year ages requires, of course, that the same date in the year should be consistently employed for estimation or enumeration. It is sometimes convenient to use as a date the middle of the school year (1 July in the Southern, or 1 January in the Northern Hemisphere). It may be more convenient to study 'opening' rolls or 'closing' rolls, and to make the age enumeration for a date adjacent to, or coincident with, the beginning or the end of the school year. But opening and closing rolls are subject to greater fluctuations than rolls in the middle of the school year.

Once a date has been agreed upon, the distribution of the entire population of school age should be adjusted to that date.

3.1.2 Tabulation of ages by single years

If data are available for single consecutive years, a tabulation can be made to see whether there are any changes in the strength of an age group through time. The general pattern of the table will be clear from Table 3.

This pattern should be noted very carefully because it forms a nucleus from which the further analysis to be made in section 3.1.3 has to start. In cases where statistical information is deficient, considerable modifications will be needed in the plans for compilation of basic data. This question will be discussed further in section 3.2 below.

3.1.3 Extension of age-by-year tabulations

This tabulation of age groups moving through time can be extended forward and backward both for age and for years of enumeration. This fourfold extension may be briefly considered.

In moving ages forward, the last entry will be the highest age at which pupils are normally still enrolled at school, say, 18 years. Beyond that point, the interest in future numbers ceases so far as school enrolment projections are concerned. Thus, the age group 6 in 1950 (= 13 in 1957) may be moved forward to 1962, the age group 7 in 1950 (= 14 in 1957) to 1961, and so on.

In moving years forward, the last entry will be for the most recent year - in Table 3: 1957 - for which an age enumeration is available. Beyond that point, a first step in projection must be taken. This would consist simply of an estimate of annual change obtained from the study of the size of the age groups in past years.

In moving ages backward, the limit is age 0. Thus, the age group 6 in 1950 (= 13 in 1957) may be moved back to 1944 at age 0. The age group thus obtained may be different from the number of births during the year ending at the date of

Table 3 - INTERCENSAL POPULATION ESTIMATE AS AT 1 JULY FOR SPECIFIED AGES (IN THOUSANDS)

<table>
<thead>
<tr>
<th>Age group</th>
<th>1950</th>
<th>1951</th>
<th>1952*</th>
<th>1953</th>
<th>1954</th>
<th>1955</th>
<th>1956</th>
<th>1957*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 through 13</td>
<td>34.6</td>
<td>34.4</td>
<td>37.3</td>
<td>37.6</td>
<td>37.7</td>
<td>37.8</td>
<td>37.9</td>
<td>36.8</td>
</tr>
<tr>
<td>7 through 14</td>
<td>34.2</td>
<td>33.9</td>
<td>30.4</td>
<td>33.6</td>
<td>33.7</td>
<td>33.8</td>
<td>33.9</td>
<td>33.9</td>
</tr>
<tr>
<td>8 through 15</td>
<td>35.9</td>
<td>35.6</td>
<td>37.4</td>
<td>37.6</td>
<td>37.7</td>
<td>37.8</td>
<td>37.9</td>
<td>36.8</td>
</tr>
<tr>
<td>9 through 16</td>
<td>35.5</td>
<td>37.6</td>
<td>37.8</td>
<td>37.9</td>
<td>38.0</td>
<td>38.1</td>
<td>38.1</td>
<td>37.1</td>
</tr>
<tr>
<td>10 through 17</td>
<td>32.9</td>
<td>33.5</td>
<td>33.7</td>
<td>33.8</td>
<td>33.9</td>
<td>33.9</td>
<td>33.5</td>
<td></td>
</tr>
</tbody>
</table>

*After adjustment on the basis of the population census enumeration in 1951 and 1956 respectively.
enumeration or estimate of age 0, because of infant mortality. This consideration will be important in connexion with methods that employ the number of births and survivals as a basis (see above 1.7 and below 3.2.3). Beyond the point of age 0, another step in projection must be taken. It involves 'expected' births, that is, an estimate of the number of births in future years. The methods available for this purpose and their implications will be discussed below (see 3.2).

Finally, in moving years backward, it becomes possible to extend the range of 'base' years for which data on population of school age are available for comparison. The choice of an adequate range of base years for analysis is a matter that is worthy of careful consideration. The only limit in this direction is that point in the past where the information sought is not available, or where the methods of compilation of basic data were substantially different.

The construction of a table representing age progression through years is, then, partly a matter of conveniently grouping available data, and partly a matter of changing from known data to projected data. And the purpose of the whole exercise in entering up horizontally, line by line, a table extended in the four directions discussed is to produce vertically, in each column representing consecutive years, total numbers of population of school age. (See table 3).

3.1.4. Intercensal age estimates

Before this procedure is considered further, another point requires attention. In the above table, which was entered up with intercensal age group estimates compiled each year by the New Zealand Department of Statistics, the numbers read horizontally - that is, the size of the same group of children at successive ages - reveal some small change.

The reasons are as follows. The intercensal age estimates must be adjusted, age by age, for mortality and external migration during the interval from one date to the next. The adjustments, based as they are on standardized data of mortality and migration, represent estimates that are, as usual, subject to an estimation error. The exact magnitude of this error is furthermore concealed by the customary rounding of the estimates. It follows that such estimates will gradually get more and more out of focus the further away they move from the last census enumeration.

Moreover, the series of intercensal age estimates as at 1 July of each year began with a shift of approximately three months from the census date in April. This introduced a further possible estimation error. An enumeration error at the census itself, due to age mis-statements, may be disregarded here. It is usually at a minimum for school ages, although at infant ages the census enumeration often suffers from marked understatement. On the whole, then, the use of age estimates of this nature introduces into the basic data a degree of uncertainty that is due to the various errors inherent in enumeration and estimation specific for age.

3.1.5 Observation of change

By observing the changes in size of an age group moving through time, some general measure of the amount of change that may be expected in future can be obtained. This measure merely summarizes the two factors that cause such changes, namely, mortality and net gains or losses in external migration. An investigation of these two factors will soon show whether a rate of change can be expected differing from that observed for older age groups at similar ages in earlier years. For mortality alone it is convenient to use survival values of a recent life table, specific for age. With regard to migration it may at this point become necessary to make an assumption as to how much migration specific for age is expected to take place in the years to come.

It should be stressed that for the assessment of the probable size of specific age groups in future years the comparison must always be made with comparable ages in past years. This point is of special importance with regard to mortality where the rate differs between the ages just after birth and later juvenile ages.

To illustrate the degree of change in this process of 'surviving' age groups at given ages, starting at age 0, to higher ages, figures from the same source as those given in table 3 were used in the compilation of table 4. This table shows the total size of nine age groups at age 0, and notes merely the decreases (-) and increases (+) as each group moves forward in time. The table has been limited to age 5 (school entry) and to the most recent year. This gives it a cut-off appearance, but enables us to read off horizontally the annual changes. The estimates of annual change are given in rounded figures to the nearest 100. Apart from some adjustment for intercensal estimation error to revisions after the 1951 and 1956 censuses, the changes are of the order of one per cent. The figures suggest that in the years under review the gains from migration in the age range 0 to 5 slightly exceeded the losses through mortality.

It will also be noted that the table, which comprises nine years (1949-1957), yields in only four lines a figure of net change for the complete age range from 0 to 5. If more such figures are required, an extension of the table becomes necessary. This is a consideration to be kept in mind when deciding on the length of the series of base years for which data should be compiled.
Table 4 - POPULATION OF SCHOOL AGE: CHANGES OVER TIME

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>net change</td>
<td>0</td>
<td>56700</td>
<td>0</td>
<td>55100</td>
<td>1</td>
<td>-700</td>
<td>0</td>
<td>53500</td>
<td>1</td>
</tr>
<tr>
<td>0 in 1948</td>
<td>1</td>
<td>48100</td>
<td>2</td>
<td>-100</td>
<td>3</td>
<td>-500</td>
<td>4</td>
<td>+500</td>
<td>5</td>
</tr>
<tr>
<td>0 in 1947</td>
<td>2</td>
<td>47200</td>
<td>3</td>
<td>+100</td>
<td>4</td>
<td>-500</td>
<td>5</td>
<td>-500</td>
<td>0</td>
</tr>
<tr>
<td>0 in 1946</td>
<td>3</td>
<td>42800</td>
<td>4</td>
<td>+0</td>
<td>5</td>
<td>+500</td>
<td>0</td>
<td>47200</td>
<td>1</td>
</tr>
<tr>
<td>0 in 1945</td>
<td>4</td>
<td>37600</td>
<td>5</td>
<td>+200</td>
<td>0</td>
<td>47200</td>
<td>1</td>
<td>+500</td>
<td>2</td>
</tr>
</tbody>
</table>

3.2 EXPECTED BIRTHS

The above table also shows that the group of children of age 0 in 1952 reached the lowest school entry age of 5 years in 1957, and those of age 0 in 1953 form the pool of school entrants in 1958. Similarly, age 0 in 1956 is the basis for estimating age 5 in 1961.

This method of 'surviving' population age groups from age 0 enables the forecaster to do no more than project the population of school age up to five years ahead. Ideally this will involve only a small margin of estimation error. Where the lowest school entry age is higher than five years, the term of projection can be extended accordingly.

3.2.1 Other than short-term projections

If projections beyond such a short term of five years are required, it becomes necessary to base the projections for further years on the number of expected births. This process is a far more hazardous one. But for middle and still more for long-term projections it is a necessity. Projections of the middle range, or of up to ten or fifteen years, have become customary in a number of countries because they afford a better view of the probable needs in administering the educational system. It should be stressed that the length of term in enrolment projection work depends first and foremost on the nature of these administrative needs. This will be evident, if one considers some relevant cases.

The most important case is perhaps that of planning for a system of compulsory education comprising a definite age range, whether the system is being introduced for the first time or extended from a restricted range, e.g. when the school leaving age is raised. Measures such as these will often have to be put into operation by degrees. To rely on information on probable future roll numbers for only a short term of five to perhaps seven years would place an undesirable restriction on the administrative work of preparing a reform of this nature.

Another case is that of reduction in the size of classes, a measure that requires a planned increase in the number of teachers to keep the schools fully staffed, and in the provision of additional classrooms. When an action of this kind is contemplated at a time of rising school rolls following an increase in the population of school age, a gradual introduction of new staffing schedules to allow for the reduction in the size of classes may recommend itself as a means of avoiding overstraining of available resources - whether of manpower or of the building industry.

This very problem arose in New Zealand in the post-war years. The age groups from which teachers could be recruited (between 17 and 18 years of age) were relatively small between 1949 and 1954 because of the decline in births that had taken place in the early thirties, with no compensation through substantial net gains in migration. But the school population increased rapidly from 1946 onwards. At the same time, the demand for labour and capital for other purposes of national development (such as hydro-electric works, post and telegraph communications, railways, highways, hospitals, etc.) set a limit on resources available for educational development.

The complexion of this kind of problem will naturally differ from country to country but it is easy to imagine the variety of factors that have a bearing on a particular situation. Considerable advantages are to be gained if their operation can be assessed without restriction to a short term forecast of expected developments.
3. 2. 2 Revision of projections

The possibility of revision of middle and long-term projections goes a long way towards compensating for the hazards of estimating expected births for several years ahead. This point was illustrated earlier (see 2. 2. 1 above) but it may be stressed here by some account of the New Zealand experience.

As has been shown, the projections made in 1950 went as far as 1960. For the years after 1955, they comprised 'expected' births in the years 1950 to 1955, on which the probable number of five-year-old children in 1956, of five-to seven-year-old children in 1958, and of five-to nine-year-old children in 1960 could be based. This meant that in 1956 only one year of age in eight or nine primary school ages had to rely on an estimate of expected births. But in 1960 it was five in eight or nine. This meant also that the projection error increased for the years furthest ahead. The need for review and revision became therefore the more urgent the further ahead in time the projections went.

3. 2. 3 Relating numbers of births to school enrolment figures

It will be supposed in the following discussion that the projection period is one of at least ten years; it will also be understood that the youngest group of children of primary school age is five years old and that the first year of projection is 1958 (1957 being the latest year of actual enrolment returns).

In order to preserve uniformity of the basic material for all projection years, including the short-term ones, it is advisable to derive the projected population of school age from the numbers (real or projected) of births in corresponding years. This means that for both the short-range projection of school population and for the base years' school population specific for age, the number of children enrolled at school will, age by age, be related to the corresponding year's number of births. In linking known numbers of school rolls specific for age to known numbers of births in past years it becomes possible to be specific about the two factors of change over time in the size of age groups, namely, mortality and migration.

Of course, intercensal population estimates specific for age will not always be available. Even if they are, they may not always be for the same date as school enrolment statistics. Or, they may be only for age groups (e.g. quinary age groups 0 through 4, 5 through 9, etc.), in which case they would have to be broken down by single-year ages. In either case, the estimation error inherent in them tends to increase. On the other hand, a vital statistics system that includes full recording of births may be expected to become more and more widespread as countries adopt the recommendations of the United Nations. (1)

3. 3 BIRTH-RATES

3. 3. 1 Past experience and assumptions

When the New Zealand projections were prepared in 1950, it was assumed that following some decline in the marriage rate in 1948 and 1949 (i.e. number of registered marriages per 1000 of population) there would be a corresponding decline in the birth-rate (i.e. number of births per 1000 of population). Thus it was expected that the yearly number of births in 1950 and for several years thereafter would decline at a moderate rate of between 1 and 2 per cent. However, the actual number of births did not behave like that at all. After a brief levelling-off, renewed increases have continued up to the present. Figure 4 illustrates this situation.

To provide for some correction in the assessment of expected births when the general school enrolment projections were being revised, attention was paid to changes in the past of age-specific birth-rates (i.e. number of maternities of women of ages 15-19, 20-24, etc. per total number of women of the same child-bearing ages). Two courses were open: either to assume that future rates would remain at the level of an average of a number of base years, or to assume that they would follow whatever trend of increase or decline could be observed over a number of base years.

It was decided to use only one of the alternative lines of extrapolating age-specific birth-rates. It would have been possible to introduce alternative sets and, consequently, produce alternative school enrolment projections. If this was not done, it was because it was considered more practical to hand over to the administrator a single figure series rather than a series of alternative projections. The point is of course debatable. A different decision was made in the case of university enrolment projections, as will be shown below (Chapter IV under 4. 4. 3). What largely determined the decision in the case of New Zealand was the circumstance that there would at any rate be five years in which to revise the projections. For it would take five years for babies to grow up to the lowest school entry age.

Figure 4. New Zealand: Numbers of births (non-Maori and Maori) for successive years ending 30 June.
It is fair to stress that even in a national system of statistics which by reasonable standards may be claimed to be comprehensive and accurate, there comes the moment when an intelligent guess must be made. The sole resources then are a certain exercise of imagination and inventiveness that cannot be pressed to conform to a canon of strict rules of scientific inference. (1) The writer of the present study would hasten to add that any such guess involves an element of gamble that can be proved or disproved only by the events. Needless to say, in such 'guessing' no recklessness can be excused: the exercise of judgment will operate within the framework of secure basic data as far as they go.

As it turned out, the trend of increase that it was assumed age-specific birth-rates would follow after 1954 proved in the following three years to have been even 'under-guessed' in the extrapolations made. The actual number of births up to 1957 exceeded the numbers forecast in 1955. The approximation was 98.9 per cent for 1955, 96.0 per cent for 1956, and 95.5 per cent for 1957. Consequently the projections made in 1957 led to a further raising of probable numbers in the youngest population groups of school age between 1960 and 1962.

3.3.2 Some reasons for being conservative in making projections

In projecting future numbers of pupils enrolled, the forecaster will, as a rule, try not to exceed an ideal 'plimsoll line'. The difficulty the forecaster is faced with is to load his vessel up to but not beyond that line, without being able to see the line itself. As a result, his projections tend to be conservative. If he acts on this rule, particularly in conditions of continuing and foreseeable increases of school rolls, he will be able to justify a later revision of projections that he makes in the light of new evidence. He will not lose face with the administrator who uses the projections in planning action.

If, despite this caution, projected numbers later turn out to be excessive, the relationship between the forecaster and the administrator will tend to be reversed. And later projections may be under a shadow cast by the overstatement inherent in the earlier ones. On balance, then, a certain degree of caution should be a general guiding factor in making the decisions required in the course of projective work.

These general considerations have been inspired, as will be recalled, by the latest experience in New Zealand with regard to the extrapolation of birth-rates and the calculation of the number of expected births based on such assumed rates. Behind the guesswork lies the fact that at the present time demographic research in this particular field is in a considerable state of flux. In particular, the results of the recently developed approach to the problem, which consists in basing assumptions on a cohort analysis of reproduction, have scarcely reached a stage where this method can be employed for projections of future numbers of births. Since the topic falls outside the framework of the present study, this brief reference must suffice. It is therefore necessary to employ the more orthodox methods of surveying trends in periodic birth-rates (whether as crude rates, or preferably as age-specific rates). It is advisable to make allowance for unforeseeable variations by alternative assumptions.

3.3.3 An example of age-specific births projected

Where the vital statistics system of birth records is sufficiently comprehensive and accurate, the use of age-specific rates is to be preferred to that of the crude birth rate. The general point made above (1.7) on the operations involved in projection work holds true here, too.

Let \( R_s \) = the rate specific for a quinary age group of all women in the population (e.g. 20-24 years of age)

\( B \) = the number of live births in the period of a year to that quinary age group of women

\( W \) = the number of all women in the population of the age-group (e.g. 20-24 years of age).

Then it will be clear that:

\[
R_s = \frac{B}{W} \quad \text{(3)}
\]

For a series of past years the basic data for \( B \) and \( W \) will be available, but for future years we want to know the value of \( B \) (number of births). This may be determined once we know the value of \( R_s \) and \( W \). For the former we have to assume a value, by a method similar to that used in assuming an enrolment ratio for future years (see 1.4.2). The value of \( W \) (number of women) may be obtained by simply 'surviving' the number of women in the corresponding age group in specified past years. For the projection, therefore, the above equation may be more conveniently written as:

\[
B' = R_s' x W' \quad \text{(3a)}
\]

so that the left side contains the 'unknown' and the right side the known elements. This equation will be applied to as many quinary age groups of women as the vital statistics give in the breakdown of number of births specific for age of mother. There will usually be six or seven such groups (that is, from 15-19 to 40-44, or to 45-49+), covering the whole range of childbearing ages.

(1) The issue was once clearly defined by the Chief Research Officer of the New York State Education Department in a paper entitled Wanted: Guessers (1943).
It will be seen that the value for $B'$ may for a number of years continue to rise, even though the assumed value in those years for $R_{s'}$ is declining: this will be the case when the number of $W'$ increases at such a rate that the product $R_{s'} \times W'$ yields increasing numbers. The point has been illustrated in table 5; it is an example of extrapolation of New Zealand non-Maori live nuptial births made in 1955. The example reflects conditions in which births have increased in the past, so that consequently from some twenty years later one of the factors, namely, the number of women in the specific age group, can be expected to show corresponding increases in number.

The summary of all sets of all projected birth-numbers specific for quinary ages of mothers plus appropriate additions for extra-nuptial births and for multiple births (in the case of the vital statistics being for maternity incidence) will yield the total number of expected births for stated years.

Table 5 - EXPECTED BIRTHS 1958-1962 IN NON-MAORI FEMALE AGE GROUP 20-24

<table>
<thead>
<tr>
<th>Year</th>
<th>$B$ = number of live nuptial births</th>
<th>$W$ = estimated age group of women 20-24</th>
<th>$R_{s'} = \frac{B}{W}$ (multiplied by 1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Past years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1949</td>
<td>11 397</td>
<td>64 400</td>
<td>177</td>
</tr>
<tr>
<td>1950</td>
<td>11 680</td>
<td>63 900</td>
<td>183</td>
</tr>
<tr>
<td>1951</td>
<td>12 000</td>
<td>63 800</td>
<td>188</td>
</tr>
<tr>
<td>1952</td>
<td>12 728</td>
<td>63 000</td>
<td>202</td>
</tr>
<tr>
<td>1953</td>
<td>12 796</td>
<td>63 000</td>
<td>203</td>
</tr>
<tr>
<td>1954</td>
<td>13 423</td>
<td>62 300</td>
<td>215</td>
</tr>
<tr>
<td>1955</td>
<td>13 750</td>
<td>61 460</td>
<td>224</td>
</tr>
<tr>
<td>(B) Future years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1957</td>
<td>61 650</td>
<td>226</td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td>64 650</td>
<td>228</td>
<td></td>
</tr>
<tr>
<td>1959</td>
<td>67 800</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>71 950</td>
<td>232</td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td>74 100</td>
<td>232.5</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>77 350</td>
<td>233</td>
<td></td>
</tr>
</tbody>
</table>

3.4 MORTALITY

3.4.1 Life table survival values

The survival whether to school entry age or to a later school age of the number of children born in a given year can best be assessed by means of a life table. In its conventional form the life table states the probable number of survivors out of 100,000 born up to a specified age. When the number of births is multiplied by the ratio thus obtained, the product will be the probable number of children or adolescents in a given year, e.g., number born in 1957 x survival ratio to 5th birthday = number of five-year-old children in 1962.

The life tables give the survival values separately for male and female children; separate life tables are often constructed for different races.

The New Zealand life tables are separate for non-Maori and Maori lives. (1)

If numbers of births are not separately stated for boys and girls, it will usually be possible to estimate a sex ratio. It will then be possible to apply the specific life table values to each of the two groups (boys and girls) and thus obtain the expected number of boys and girls in any future year. The actuarial details are of no interest here.

3.4.2 Assessing future changes in survival

It must be borne in mind that the construction of a life table is based on past mortality experience. This means that estimation of the probable size

(1) After the population census 1951, compiled and published in 1953.
of future age groups may result in a small error if life table values of survival are applied to recent or to expected births even for a short span of five or more years. The error will be one of understatement when an observed decline in mortality at juvenile ages continues. It is of some interest to consider the result of such decline in mortality, or, in other words, of improved chances of survival.

For the Maori population of New Zealand, the 1950 projections of school enrolment may illustrate the point. Infant mortality had fallen from 114.92 per 1000 live births in 1939 to 76.67 in 1948. A further decline was expected, which meant that for this sector of the population the probable size of future school population would be understating the actual size. In the figures of the Maori life tables constructed for the first time after the 1951 census the survival figures are as follows:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Survival</th>
<th>Out of 1000 Born</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Age 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>appr. 893</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>appr. 906</td>
<td></td>
</tr>
<tr>
<td>To Age 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>appr. 879</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>appr. 893</td>
<td></td>
</tr>
</tbody>
</table>

Since this was the first table constructed for Maori lives, these values cannot be compared with earlier ones. But the marked reduction in Maori infant mortality, referred to above, suggests that survival must have improved noticeably during the last ten to fifteen years. Furthermore, continued future improvement is suggested by another consideration. In comparison with the non-Maori population, the survival of Maori children (per 1000 births) is still several points lower, namely:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Survival</th>
<th>Non-Maori</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Age 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>Maori 893</td>
<td>non-Maori 970</td>
</tr>
<tr>
<td>Girls</td>
<td>Maori 906</td>
<td>non-Maori 976</td>
</tr>
<tr>
<td>To Age 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>Maori 879</td>
<td>non-Maori 965</td>
</tr>
<tr>
<td>Girls</td>
<td>Maori 883</td>
<td>non-Maori 973</td>
</tr>
</tbody>
</table>

The 1950-1952 New Zealand life tables summarize the improvement in survival of non-Maori children during fifteen years (1936 to 1951) in the following figures:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Age 5</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>952 in 1936 to 970 in 1951, or by 18 per 1000</td>
</tr>
<tr>
<td>Girls</td>
<td>962 in 1936 to 976 in 1951, or by 14 per 1000</td>
</tr>
</tbody>
</table>

3.5 EXTERNAL MIGRATION

3.5.1 Varying particular circumstances and assumptions based on them

In countries where the inflow or outflow of population through migration from or to other countries is of an appreciable extent it is desirable to assess the effect of this population movement. In this context the need for assessing migration effects arises inasmuch as the movements may comprise children of pre-school age and of school age. The case of changes as a result of migration in the size of age groups of women of child-bearing ages need only be considered in connexion with a projection of expected births.

The New Zealand school enrolment projections of 1950 had disregarded the migration factor. In the base year period (1945-1949) the effects of migration on the population of school age had been very small. The decision to disregard them for the time being was made only after the approximate order of magnitude had been examined and found to be minute.

From the year ending 31 March 1950, however, net gains in migration markedly increased. They maintained a fairly high level in the years that followed. The average increase due to migration was .63 per cent per annum of mean population. The future could be envisaged with the help of approximate target figures entertained by the
immigration authorities. The projections of 1957 therefore made allowance for such increases in population of school age as were due to external migration.

The details of the method of estimating these numbers depend so much on the kind of migration statistics that can be exploited for the purpose that they hardly warrant an elaborate discussion here. (1) It is sufficient to remark that the estimated number of schoolchildren not born in New Zealand represented approximately one per cent of the school population in 1950 but three per cent from 1955 on. With an assumption as to future total net gains in external migration, and a further assumption as to the pattern of age composition of all migrants, an estimate of future numbers of children not born in New Zealand but enrolled in New Zealand schools could be made. The estimation must, of course, cumulate the migration gains for age groups moving through time. For example, the estimate for age 0 in 1952 was added to by the estimate for age 1 in 1953, etc. to age 4 in 1956, to yield an estimate of cumulative migration gains of five-year-old children in 1957. The total estimates represented up to 3 1/2 per cent of total school population in the late fifties, and will decline to perhaps 3 per cent between 1961 and 1965. These proportions were deemed sufficiently large for the migration factor to merit attention in the enrolment projections.

It will be appreciated that a fairly substantial projection error in this section of population movement has only a minor influence on total population of school age and consequently on total enrolment. For example, if the total school population is 500,000, of whom 3 1/2 per cent or 17,500 represent immigrant school children, an estimation error as large as 20 per cent in the number resulting from migration projections affects the expected total enrolment by not more than . 7 per cent.

3.5.2 A complete schedule for estimated population of school age

It depends therefore on the circumstances whether, in the interests of the best possible approximation of projected enrolments to future actual numbers, it is considered desirable to make allowance for the influence of external migration movements.

In Australia, for example, school enrolment projections both for the States and the Commonwealth are set out separately for Australian-born children and for all children, assuming stated annual net gains in external migration in future years. (2)

The New Zealand projections also took this factor into consideration, partly for methodological reasons. It will be recalled that the estimate of population of school age relied on births in corresponding years rather than on intercensal population estimates specific for age. It therefore became necessary to estimate separately the numbers of schoolchildren who were not born in New Zealand. This necessity will have to be given due weight by the forecaster when he makes his choice between estimates of population of school age based on intercensal estimates on the one hand, and estimated survivals from birth on the other.

For base years as well as projection years, then, the schedules of estimated population of school age (specific for single years of age and for future dates) consisted in the case of New Zealand of two items, namely:

(a) the number of births adjusted for survival to a specified age (see 3.3 and 3.4 above)
(b) cumulative net gains in external migration up to a specified age adjusted for age-specific mortality.

The two items (a) and (b) combined represent the total age group.


CHAPTER IV
ENROLMENT RATIOS

4.1 SOME GENERAL CONSIDERATIONS ON
THE FUNCTION OF ENROLMENT RATIOS

This chapter is concerned with the various values of \( R_E \) in the basic equation

\[
R_E = \frac{E}{T} \quad \ldots \ldots \quad (1)
\]

The general function of this equation in projection method was outlined above (see 1.7). How it operates was illustrated by an example (see 1.4.2 above). Figure 1 gave a further illustration to emphasize alternative values for \( R_E \), according to whether \( T \) was an enumeration or an estimate based on the number of births.

Within the range of ages covered by compulsory education the enrolment ratio serves to test whether all children of these ages are in fact enrolled. If they are, the ratio will be approximately equal to 1. This test is worth making.

When compulsory education for a given age range is statutory but not fully effective, the enrolment ratios for those ages express the degree of effectiveness. In these circumstances the projection of ratios involves a decision on the time when the system is expected to be effective. The ratios, then, act as an instrument for measuring trend, and the projected ratios directly reflect the administration's plan to implement the law gradually. This situation is of great practical importance in many countries but offers no special methodological problems.

Outside the age range of an operative system of compulsory education, the variation of enrolment ratios involves a decision on the time when the system is expected to be effective. The projection of ratios involves a decision on the expected time of effectiveness. In these circumstances the projection of ratios involves a decision on the time when the system is expected to be effective. The ratios, then, act as an instrument for measuring trend, and the projected ratios directly reflect the administration's plan to implement the law gradually. This situation is of great practical importance in many countries but offers no special methodological problems.

The ratio method has another important use in what may be called 'school survival' ratios, or progression ratios. At this point it becomes possible to change over from enrolment ratios specific for age to ratios specific for classification of pupils (see below 4.3). The resulting enrolment projections classified by grades or forms will be of greater practical use.

In the projection work itself several further estimates can be built upon projection by secondary school grade classification. These later stages include university enrolment projections (see 4.4) and projection, by educational level reached, of school leavers (4.5). The advantages of establishing a firm link between the projection
of secondary school enrolment and those later stages will become manifest as these stages are reached.

4.2 SECONDARY SCHOOL ENROLMENT RATIOS (NEW ZEALAND)

4.2.1 Base year analysis

The age range of secondary school pupils in New Zealand comprises both ages of compulsory education (13 and 14) and ages above the legal school leaving age (fifteenth birthday). Enrolment ratios must be distinguished for ages below 15 years and for ages of 15 and higher. An increase in the secondary school enrolment ratios at ages below 15 is accompanied by a corresponding decline in the primary school enrolment ratios, for the two sections by definition add up to a maximum ratio approaching unity. This aspect will be further considered below (4.2.4). An increase in the secondary school enrolment ratio of pupils aged 15 years or more, who are outside compulsory education, is essentially dependent on the trend of a total enrolment ratio that is some distance below the maximum.

This distance is represented for all pupils of ages 14, 15 and 16 over a period of twenty years (1937-1956) in figure 5. The development of the ratio for 14-year-old pupils is shown because the school leaving age was not raised to 15 years until 1944. As the eye travels from left to right towards the most recent years, the space below the maximum or 'saturation' line diminishes as the curve of enrolment ratios rises. The figure shows increases in ratio over a period of twenty years from .37 to .66 for pupils of age 15, and from .17 to .36 for pupils of age 16. The increase in ratio for the 17-year age group during the same period (1937-1956) was from .08 to .13. All these figures were computed by using intercensal age estimates, as of the date of enrolment enumeration, in the denominator. The enrolment statistics used in the numerator refer to full-time pupils enrolled in state schools and private schools at all levels.

![Figure 5. New Zealand: Total enrolment ratios for ages 14, 15 and 16, 1937 to 1956.](image-url)
If however, instead of the intercensal age estimates the denominator contains the somewhat larger number of births in the corresponding years, the ratios will appear with a correspondingly smaller value. For the reasons given above (3.2.3) it was considered preferable to base projections on the numbers of children born, with an appropriate adjustment for gains in immigration. After calculating all ratios accordingly for the base years, total enrolment ratios were obtained for all ages of 15 and higher, as follows:

<table>
<thead>
<tr>
<th>Age</th>
<th>1950</th>
<th>1956</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>31.4</td>
<td>34.9</td>
</tr>
<tr>
<td>16</td>
<td>13.3</td>
<td>12.9</td>
</tr>
<tr>
<td>18+</td>
<td>3.6</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Note: The 18+ ratio consists of enrollment at ages 18 or higher divided by births 10 years earlier.

4.2.2 Extrapolation

For the extrapolation of these enrollment ratios to 1965 it was decided to use the following ratios:

<table>
<thead>
<tr>
<th>Age</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>71.75</td>
</tr>
<tr>
<td>16</td>
<td>41.5</td>
</tr>
<tr>
<td>17</td>
<td>12.75</td>
</tr>
<tr>
<td>18+</td>
<td>3.0</td>
</tr>
</tbody>
</table>

The assumed end-point to be reached by the ratios in 1965 means that for ages 15 and 16 the average annual rate of increase will be somewhat accelerated. The following calculation based on 1950 as reference year shows this:

Age 15
- net increase 1956 over 1950 in six years:
  \[ 62.2 - 57.1 = 5.1 \]
  \[ \text{i.e.,} \quad 5.1 \div 6 = 0.85 \text{ per cent per annum} \]
- net increase 1965 over 1956 in nine years assumed:
  \[ 71.75 - 62.2 = 9.55 \]
  \[ \text{i.e.,} \quad 9.55 \div 9 = 1.06 \text{ per cent per annum} \]

Similarly, for age 16
- annual average increase
  \[ (1956 \text{ over } 1950) = 0.59 \text{ per cent per annum} \]
- assumed annual average increase
  \[ (1965 \text{ over } 1956) = 0.73 \text{ per cent per annum} \]

On the other hand, the enrollment ratios at ages 17 and 18 in 1965 assume a very small decrease.

This decision on the points to be reached in 1965 was influenced by a number of considerations. The general secondary school leaving examination (school certificate) is taken at an age of around 16 years and increasingly acts as a kind of magnet. It tends to accentuate the observed trend for pupils to stay longer at school. The decision was also informed by the fact mentioned above (2.2.2) that past understatements in the projection of secondary school enrollment were due to over-cautious assumptions.

Lastly, consideration was given to the question of how school leaving affects secondary school enrollment. This introduces the aspect of labor market absorption of additions to the labor force. The total population at these ages is known to increase markedly in the projection period, probably rapidly after 1960 and 1961. Assuming a pattern of the labor market in which the capacity to absorb juvenile labor increases not rapidly but more gradually, it seems reasonable to expect that the desire of more pupils to qualify by the general school leaving examination will be strengthened. If consequently more pupils stay longer at school, this will have the effect of some slowing down in output of school leavers and intake of the labor market. The real situation is of course more complex than such a simple pattern of absorption of school leavers in commerce, farming, and manufacturing industries might suggest. The probable future labor market intake is modified to the extent to which school leavers at secondary level go on to institutions of higher education, including full-time professional training for teaching, engineering, nursing and so on. The future demand for recruits in these professions has some bearing on the number of school leavers going direct from school to work. If this demand is rising it will act as a further incentive for more pupils to qualify at a higher level before leaving school.

So much for the guiding assumptions. In assigning a numerical value to expectations of this nature, the forecaster will of course be well aware that he introduces an element of arbitrariness into his projection. But he has no choice but to state explicitly what he believes, after careful consideration, to be the implications of the general development for his particular problem.

4.2.3 The projection method

The enrollment ratios assumed for 1965 were plotted on a graph which also gave the base year ratios as an indication of previous trends. It then remained to interpolate the projection years 1957 to 1964. This was simply done by a straight line connecting the 1956 (last known) with the 1965 (assumed) point. The procedure was modified in the projections made in 1957 by extrapolating an expected ratio not only for 1965 but for 1960 as well. However, the last known point (1956) and the two extrapolation points (1960 and 1965) are on a straight line. This will be seen from figure 6 illustrating projections for total enrollment ratios at ages 15 and higher, where the direction of the curve does not change after 1956. The main purpose of this was to provide a quotable figure for short-term projection to 1960.
Figure 6. New Zealand: Projections to 1965 of total enrolment ratios at ages 15 and higher.
Graph readings for each year from 1957 to 1964 represent, then, the assumed ratios for those years. All ratios were multiplied, in this case, by the numbers of births corresponding to ages 15 through 18 in 1957 to 1965. The products were adjusted for expected net migration gains cumulative to the same ages. The adjustment was of course not by the whole of cumulative migration but only by a proportion approximately equal to the age-specific enrolment ratios. This work is set out for age 16 in table 6. An examination of the figures will show how population increases and increases in ratio combine to produce total projected enrolments.

In the next phase the projected total enrolments specific for secondary school enrolment ages were broken down age by age in sub-divisions of primary and secondary enrolment, as well as by enrolment at state schools and private schools.

Attention should be called here to two further points. First, to the need for continuous observation of the degree of approximation to actual enrolment achieved by the projections: as indicated by circled points over 1957 in figure 6, the projections of total secondary enrolment for the first projection year 1957 represented 98.9 per cent of actual enrolment returned. This proved that the projection was still a somewhat conservative one.

Secondly, in respect of the method of computation: the more elaborate methods of trend-fitting described in all statistical handbooks did not come into play. It was considered sufficient to plot the ratios extrapolated for the limits (in the above case: 1960 and 1965) on graph paper and to estimate other ratios by straight-line interpolation. Straight-line interpolation refers here, of course, only to the expected ratios themselves, with size of age group held constant. A disadvantage of the graphical method is that it is not possible to compute statistically confidence belts, or a probable error inherent in the projection. But the discussion of the projection method will have shown that the material is of a different kind from that for which the more elaborate statistical techniques (based for instance on sampling) were designed.

Table 6 - NEW ZEALAND: PROJECTION OF TOTAL ENROLMENT AT AGE 16, 1957-1965

<table>
<thead>
<tr>
<th>1 July of Projection year</th>
<th>Enrolment ratio (multiplied by 100) (graph readings)</th>
<th>x Number of births 16 years earlier in year ending 30 June</th>
<th>= Product (R x B)</th>
<th>+ Estimated migration cumulative to age 16 in proportion of R</th>
<th>= Total enrolment projection (N + M) rounded</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>35.5 (1941)</td>
<td>39 126</td>
<td>13 890</td>
<td>510</td>
<td>14 400</td>
</tr>
<tr>
<td>1958</td>
<td>36.5 (1942)</td>
<td>39 628</td>
<td>14 464</td>
<td>560</td>
<td>15 025</td>
</tr>
<tr>
<td>1959</td>
<td>37.0 (1943)</td>
<td>33 764</td>
<td>12 493</td>
<td>610</td>
<td>13 100</td>
</tr>
<tr>
<td>1960</td>
<td>38.0 (1944)</td>
<td>38 019</td>
<td>14 447</td>
<td>655</td>
<td>15 100</td>
</tr>
<tr>
<td>1961</td>
<td>38.75 (1945)</td>
<td>39 517</td>
<td>15 313</td>
<td>695</td>
<td>16 000</td>
</tr>
<tr>
<td>1962</td>
<td>39.5 (1946)</td>
<td>43 107</td>
<td>17 027</td>
<td>750</td>
<td>17 775</td>
</tr>
<tr>
<td>1963</td>
<td>40.25 (1947)</td>
<td>50 553</td>
<td>20 348</td>
<td>800</td>
<td>21 150</td>
</tr>
<tr>
<td>1964</td>
<td>41.0 (1948)</td>
<td>49 238</td>
<td>20 188</td>
<td>835</td>
<td>21 025</td>
</tr>
<tr>
<td>1965</td>
<td>41.5 (1949)</td>
<td>48 841</td>
<td>20 311</td>
<td>865</td>
<td>21 175</td>
</tr>
</tbody>
</table>

4.2.4 Enrolment ratios specific for secondary school enrolment

A special problem is raised by the fact that in many school systems the 'intermediary' age range (e.g. 13 to 15) will include some children still attending primary school and others who are at secondary school. When the total school-going population is projected how can the administrator 'split' his age-specific projection by level of schooling?

Consider the following formula:

\[
\frac{E \times Es}{T} = Rs \quad \ldots \ldots \ldots (3)
\]

where

- \(E\) is the total number enrolled
- \(E_s\) is the number enrolled at secondary schools
- \(T\) is the total population
- \(R_s\) is the secondary enrolment ratio, i.e. the proportion of the total population enrolled in secondary schools

each specific for the same age. It will be noted that the numerator of the first factor and the denominator of the second factor are identical, so that algebraically they could be cancelled. For the purpose of projection, however, it is important to observe the variation of each factor, each representing a significant ratio. By computing the two sets of ratios independently for a
series of base years, two trends, instead of one composite one, are obtained for the ages of overlapping primary and secondary school enrolment.

The point may be illustrated by the behaviour of these ratios in the case of ages 13 and 14. They are the highest ages of compulsory education. The \( E \) factor is therefore approximately unity but the \( \frac{E_s}{E} \) factor exhibits the trend of change in transfer from primary to secondary school.

This change is indicated by the proportions in selected years, in the following figure (\( E_p = \) primary enrolment): (multiplied by 100)

\[
\begin{array}{ccc}
\text{Age} & \text{1945} & \text{1955} & \text{1965 (assumed)} \\
\hline
\text{Age 13} & 64 & 50 & 38 \\
\text{Age 14} & 32 & 16 & 2 \\
\end{array}
\]

Age-specific series of ratios of this kind are used to multiply total enrolment specific for age. This is done for those ages at which some or all pupils are found to be enrolled at secondary schools.

The totals for all these ages represent total secondary school enrolment, whether in a series of base years or a series of projection years. They will also be used as a limit to control the results obtained by the supplementary method of survival ratios (see below 4.3.3).

4.3 SCHOOL SURVIVAL RATIOS

A supplementary method consists in 'surviving' pupils through the secondary school course. This method can be applied in secondary school enrolment projection when the first method described above has produced a set of projections specific for age. These can be summarized for secondary school enrolment alone, by splitting those age-specific enrolment ratios that comprise both primary and secondary classes.

4.3.1 Survival to higher classes - base year observations

The aim of this method of surviving classes is to obtain projections specific for grade (or class, or form). The method at first disregards the distribution of ages in each class (or grade, or form). It simply notes survival of the same group of pupils to the next class in the following year, and is here defined as the ratio of the number in a higher class in a given year and the number in the lowest class in the corresponding earlier year.

For an assessment of secondary school survival the last primary class can conveniently be used as base and serves as denominator. The last primary school class represents the potential number of pupils who subsequently may be found on the roll of a secondary grade. With the denominator in the ratios thus held constant, the change in survival ratios can be observed as an independent variable.

An illustration of the method is given in the five sections of table 7. They show the operation step by step in five phases. The notation refers to the New Zealand school system which has form II as the highest primary school class and forms III to VI as secondary school classes, with the two senior forms V and VI in many schools being divided into lower and upper classes. Progression from form III to IV and from IV to V is normally year by year. At lower form V most pupils enter as candidates for the school certificate examination and those who pass go into lower form VI. Those who fail go into upper form V for their fourth year and repeat the examination.

University entrance is normally taken at lower form VI, and the special scholarship entrance examination at upper form VI.

1. The first phase sets out accordingly a detailed schedule of working. In the following steps this schedule has been simplified, so that the forms III to VI correspond to the first to fourth secondary school years.
2. The second phase notes the reference years of survival within a series of base years.
3. The third phase shows the ratios specific for these years where form II enrolment is used as the denominator, and the forms to which pupils progress as numerators.
4. The fourth phase substitutes the actual enrolment records of the base years.
5. The fifth phase tabulates the survival ratios.

The survival ratios in section 5 reveal a trend of increase under each form. A comparison with section 2 will show that the ratios that refer to enrolment in the same year are those on the diagonals reading from upper left to lower right. This is the same pattern as that illustrated above under 3.1.4.
Table 7 - SECONDARY SCHOOL SURVIVAL RATIOS

(1) Schedule

<table>
<thead>
<tr>
<th></th>
<th>F II</th>
<th>F III</th>
<th>F IV</th>
<th>F V lower if repeated</th>
<th>F VI lower if repeated</th>
</tr>
</thead>
<tbody>
<tr>
<td>first year</td>
<td>lower</td>
<td>if lower</td>
<td>if repeated</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>first year</td>
<td>repeated</td>
<td>repeated</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>F VI</td>
<td>upper</td>
<td>upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F VI</td>
<td>lower</td>
<td>lower</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2) Base Years

<table>
<thead>
<tr>
<th></th>
<th>F II</th>
<th>F III</th>
<th>F IV</th>
<th>F V</th>
<th>F VI</th>
</tr>
</thead>
</table>

(3) Survival to

<table>
<thead>
<tr>
<th></th>
<th>F III</th>
<th>F IV</th>
<th>F V</th>
<th>F VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>by ratios:</td>
<td>1949</td>
<td>1951</td>
<td>1953</td>
<td>1955</td>
</tr>
<tr>
<td>1950</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
</tr>
<tr>
<td>1951</td>
<td>II</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>1952</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
</tr>
<tr>
<td>1953</td>
<td>II</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>1954</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1955</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

(4) Rolls (denominators)

<table>
<thead>
<tr>
<th></th>
<th>F III</th>
<th>F IV</th>
<th>F V</th>
<th>F VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>F II</td>
<td>Y</td>
<td>Y+1</td>
<td>Y+2</td>
<td>Y+3</td>
</tr>
<tr>
<td>Y</td>
<td>25 857</td>
<td>23 547</td>
<td>18 742</td>
<td>14 390</td>
</tr>
<tr>
<td>27 169</td>
<td>25 159</td>
<td>20 559</td>
<td>15 796</td>
<td>5 730</td>
</tr>
<tr>
<td>28 424</td>
<td>26 686</td>
<td>22 283</td>
<td>17 238</td>
<td>6 146</td>
</tr>
<tr>
<td>31 026</td>
<td>29 487</td>
<td>24 895</td>
<td>18 907</td>
<td>6 961</td>
</tr>
<tr>
<td>34 315</td>
<td>33 006</td>
<td>28 202</td>
<td>21 603</td>
<td>8 402</td>
</tr>
</tbody>
</table>

(5) Survival ratios (multiplied by 100)

<table>
<thead>
<tr>
<th></th>
<th>F II to F III</th>
<th>F IV to F V</th>
<th>F V to F VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949</td>
<td>91.1</td>
<td>72.5</td>
<td>55.7</td>
</tr>
<tr>
<td>1950</td>
<td>92.6</td>
<td>75.7</td>
<td>58.2</td>
</tr>
<tr>
<td>1951</td>
<td>93.9</td>
<td>78.4</td>
<td>60.7</td>
</tr>
<tr>
<td>1952</td>
<td>95.0</td>
<td>80.2</td>
<td>60.9</td>
</tr>
<tr>
<td>1953</td>
<td>96.2</td>
<td>82.2</td>
<td>63.0</td>
</tr>
</tbody>
</table>
The tabulation for the lower forms can, of course, be extended until the most recent year is reached, and the tabulation for the senior forms can be extended backwards to include earlier years. If this were done, the array of survival ratios of the kind set out in table 7 (5) would be in a rhomboid shape, containing basic data taken from altogether fourteen different years, with nine ratios at each level. The latter will be sufficient for plotting the trend of survival ratios specific for class. The whole operation can also be carried out separately for boys and girls. This procedure is to be recommended if there is reason to assume that the survival to higher classes shows differentials between boys and girls. In the base year analysis total enrolment by classification is of course equal to total enrolment by age.

A more complex pattern results when proportions of pupils repeat a given form. This will be the case whenever promotion to the higher form depends on an examination. By means of a survey of pass-percentages it will usually be possible to ascertain how many of the pupils enrolled in a given form in a given year belong to the group enrolled in the lower class in the previous year, and how many entered the lower class a year earlier but repeated it. Some illustration of this point was given for forms V and VI in the complete schedule of classification by years. (See table 7 (1)).

4.3.2 The projection of survival ratios

Figure 7 illustrates secondary school survival by classification, the data used being those listed in table 7 (5). The four curves, representing ratios at forms III to VI, were extrapolated to points representing the probable enrolment in 1965. Each point was connected by a straight line with the 1956 ratios, so that readings for the years 1957 to 1964 could be taken. For 1957 both the actual ratio and the ratio assumed in the 1957 projections are plotted. They do not coincide but their distance apart indicates a small amount of underestimation in survival at form V and form VI level; this concurs with the observations made above. (See figure 6 and section 4.2.3).
The figure is drawn so that the horizontal scale is marked off by the years in form II (= denominators). The 1965 projection point for form VI falls therefore on the abscissa (x-axis) at form II in 1961, assuming simplified progression in four years. For form V the 1965 point falls on the abscissa at form II in 1962, for form IV in 1963 and form III in 1964. The reason is of course the time elapsed in the simplified progression pattern of form per year.

If the survival ratio is subtracted from unity (marked by a shaded line at 100), one obtains "drop-out" which represents the 'early leavers'. As the survival ratios increase, the drop-out declines. In figure 7 one can, for example, read off the decline in drop-out before form V is reached from 45 per cent in 1950 to 32 in 1957 and to 23 assumed in 1962.

This method of form-survival ratios is of material assistance in giving a picture of probable staffing and equipment needs of secondary schools, particularly at the senior level. It is of help in assessing the size of the future entry of candidates for the school certificate examination, and (assuming the pase-percentage) of probable numbers qualified by school certificate. The School Certificate is the minimum qualification for various vocations, such as primary school teaching and dental nursing. The future number of passes therefore determines the pool from which the trainees are selected. It will be shown later that the survival to the most senior form VI, and consequently the probable number of duly qualified entrants to the university, is indispensable information for projecting university enrolment (see below 4. 4. 3).

The survival ratios in the projection years are multiplied by the form II enrolments in corresponding years to obtain the projected numbers enrolled in forms III to VI. The projection of secondary school rolls by form-survival depends therefore on a similar projection by primary school survival ratios. The New Zealand primary school enrolment projections of 1957 were carried out in this way. The results were used independently for various administrative purposes, among them the budgeting for production and distribution of school publications. (1) In countries where the principle of free and compulsory education is not fully implemented, projection by the method of school survival ratios has the added advantage of indicating from what level the system is still defective.

Secondary school enrolment projections, then, are by this method linked to the primary school enrolment projections which precede them. This can be called a vertical link between projections at different levels. A similar link can be established between secondary school enrolment projections by grades and university enrolment projections. But if the projections by grades are consistent they must also be linked to the results of projection by the first method, that is, by age-specific enrolment ratios (see 4. 2 above). This link between the two sets of secondary school enrolment projections deserves further attention.

4. 3. 3 The linking of survival ratio with enrolment ratio projections

The minimum of educational statistics, it was said above (1. 5. 1), is a cross-tabulation of pupils by ages and by classification. Such a table (with enrolment by age in the lines and enrolment by class in the columns) will have two sets of totals, namely, in the bottom line the class-totals, and in the right-hand column the age-totals. Both sets of totals, when added give the same grand total of enrolment.

The projection of enrolments by the method of enrolment ratios referring to total population specific for age produces the age-totals column in such a cross-tabulation. The projection by the supplementary method of school and class survival ratios produces the class-totals in the bottom line of such a cross-tabulation. If these latter are cross-added, the sum must be the same grand total as that given by the age-totals.

The 1965 secondary school survival ratios for forms III, IV, V, and VI were chosen in such a way that total enrolment (as the sum of the products of each ratio and the corresponding number of form II pupils projected for 1964, 1963, 1962, and 1961 respectively) coincided with the grand total obtained from the enrolment ratio method (see table 8).

Table 8 - NEW ZEALAND: TOTAL SECONDARY SCHOOL ENROLMENT PROJECTION 1965

<table>
<thead>
<tr>
<th>Age</th>
<th>F III</th>
<th>F IV</th>
<th>F V</th>
<th>F VI</th>
<th>Age totals by enrolment ratio method</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1 500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>30 800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>48 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>56 900</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>21 200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>6 600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18+</td>
<td>1 500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form totals</td>
<td>47 700</td>
<td>47 300</td>
<td>38 200</td>
<td>13 400</td>
<td>146 600</td>
</tr>
</tbody>
</table>

The total of enrolment in all forms obtained by using survival ratios may be higher or lower than the total number of enrolments by age obtained by applying enrolment ratios to age groups. The form totals will have to be lowered or raised

accordingly, until they reach the grand total enrolment figure. This 'smoothing' operation is controlled not only by the grand total but by the general pattern of classification by age and its expected changes.

When this has been done, the corrected projections of form enrolments can be divided by the projected form II enrolment in the corresponding years, always using the pattern of progression by years - e.g. dividing form V in year \(Y + 2\) by form III in year \(Y\). (See table 7 (2) and (3)). The resulting fractions represent the corrected survival ratios. Table 9 sets out this information for a series of base years and for projection years to 1965. The ratios in each column are related to form II enrolments which are represented by index numbers with the base 1945 = 1000. A table of this kind is the best means of studying the implications of school survival, as it results from the enrolment projections.

<table>
<thead>
<tr>
<th>Table 9 - ADJUSTED SURVIVAL RATIOS AT THE SECONDARY LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>F II</td>
</tr>
<tr>
<td>(Y_n)</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1945</td>
</tr>
<tr>
<td>1946</td>
</tr>
<tr>
<td>1947</td>
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<tr>
<td>1948</td>
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<td>1960</td>
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<td>1961</td>
</tr>
<tr>
<td>1962</td>
</tr>
<tr>
<td>1963</td>
</tr>
<tr>
<td>1964</td>
</tr>
</tbody>
</table>

Note: All figures inside the box are projected ratios.

It is perhaps worth reiterating here that the procedure and results are the same when the method of survival ratios is applied to primary school enrolment.

4.4 UNIVERSITY ENROLMENT PROJECTIONS

Secondary school enrolment projections by means of the survival ratio method are of special use in the projection of university student enrolment. A brief discussion of methods of projecting university enrolment will make this clear.

4.4.1 In a system of university education with a relatively unrestricted number of places available

It is assumed in this context that access to the university is not 'closed', that is, not limited to a fixed number of available places. Where it is so limited selection of students is usually made by a competitive entrance examination. A different system of university education gives free access to the university to everybody who has gained a prescribed minimum qualification, and there is no definite upper limit to the number
of students that may be admitted. These two systems must be thought of as the extreme points on a scale with a variety of intermediate systems. For example, a 'closed' system creates a pressure on admission if the qualified student potential is increasing. This will often coincide with the need for an increased output of graduates, according to the economic and social conditions of development, and may then lead to raising the number of available places. On the other hand, a system of free access to the university may be modified by changing the qualification requirements, which may mean a 'stiffening' of entrance qualification and act as a temporary restriction on the number of entrants.

It is only in a relatively free system of university education that the need for projection of future enrolment arises. In a more or less 'closed' system it is, strictly speaking, not the future enrolment itself that is being forecast but the probable number of potential students claiming admission. If this distinction is borne in mind, the conditional nature of all university enrolment projections will be appreciated.

4.4.2 Enrolment ratio-by-age projections

In a number of countries(1) the projection method has been based in the first instance on the predictable increases in the age group to which the majority of university students belong. Age ranges such as 18-21 or 17-22 have been employed for this purpose. The second variable employed by this projection method is an enrolment ratio (usually per 10,000 of the university age population). Its changes are observed over a number of base years and then suitably extrapolated by an operation similar to that described in this study on the projection of secondary school enrolment ratios. Where the university age population is increasing and the enrolment ratio is expected to increase for future dates, the combination of the two factors will result in often substantial rises in future enrolment.

4.4.3 Projections linked to secondary school survival ratios

When secondary school enrolment projections have already been made that, in the manner described (see 4.3 above), offer a forecast of numbers likely to reach the senior classes in which students may qualify for university entrance, a somewhat simpler procedure becomes applicable. It avoids the concept of 'university age population' because, with a high proportion of part-time students, a large number of students enrolled at university are actually outside such a restricted age range. It is further based, as were the secondary school classification projections, on observed survival from the highest secondary class to the freshman year at university and survival at university in subsequent years to graduate and post-graduate status. University enrolment projections were recently made in New Zealand on this basis. (2) The stages, for each of which a projection decision had to be made in extrapolating trends, may be briefly summarized as follows:

1. primary school enrolment projections by classification (i.e. by grade, form or class) leading to projected enrolment at form II level;
2. secondary school enrolment projections, based on survival ratios from form II to form VI;
3. ratio of university entrance passes (whether by accrediting, or by internal or external examination) to form VI enrolment;
4. freshmen enrolments as a proportion of university entrance passes;
5. number of university students in their second or a later year as a ratio of the number of first year students, obtained over a number of base years.

The information under 1 and 2 was available from the primary and secondary enrolment projections. The ratio under 3 (entrance passes per form VI enrolment) was a fairly constant one over a series of base years. The proportion under 4 revealed a trend of increase during the base years. For the projection to 1975 four alternative proportions were used: one showing a moderate decline, one maintaining the 1956 level, one showing a slight increase until 1960, and a fourth maintaining this increase for a further five years - that is, until 1965.

The task of estimating survival from the first to later years was somewhat troublesome, for lack of suitable statistical information on 'survival'. Four alternative cumulative survival ratios were therefore used.

The combination of four alternative figures used in step 4 and again in step 5 meant that there were altogether sixteen alternative projections of total enrolment. In a graph of these projections (figure 8) the lowest and the highest set define a band that grows wider with each successive projection year. The remaining sets fall within this band and, on the assumptions made, actual future enrolments may be expected to fall at points somewhere within it.

As this illustration shows, it was thus possible to give a reasonably definite expression to the fact that projections of this nature must be considered the best possible approximation in the circumstances to future actual enrolments.

An important aspect of this projection method is, then, the advantage to be gained from making

(1) Compare, for example, for Australia: W. D. Borrie and Ruth M. Dedman, University enrolments in Australia, 1955-1970, a projection, Canberra, Australian National University, 1957, 20 p. (Social Sciences monographs, no. 10).

The total student number will under stated assumptions fall within the sixteen alternative projections lower and upper limits marked by the shaded area.

**Figure 8.**

NEW ZEALAND: UNIVERSITY ENROLMENT PROJECTIONS TO 1975
alternative assumptions in extrapolating specific trends. One of the difficulties inherent in alternative projections is that they seem to give a less handy set of figures for practical use. And it will often happen that two alternative figures will be used, represented by one intermediate one: or three alternatives, of which the middle one is favoured and the two extreme ones disregarded. When four alternatives are given, such a choice becomes less easy to make. An even greater number of alternatives turns what was a difficulty into almost an advantage, by putting the strongest possible emphasis on the fact that any projection is merely an approximation to actual future numbers.

4.5 SCHOOL ENTRANTS AND SCHOOL LEavers - PROJECTIONS BY A METHOD OF DIFFERENCING

Where no complete statistics on the yearly number of pupils entering school and on pupils leaving school are available, a simple method of estimation is as follows. It is applicable to the projection of future numbers of school leavers once enrolment projections have been made, whether in the form of projections specific for age or specific for grade.

Suppose that projections specific for age (by single years) have been made. Suppose further that the projections distinguish between primary school enrolments and secondary school enrolments specific for age. Suppose also that the lowest age of primary school attendance is five years.

We shall consider first the simple operation, i.e. estimation of the number of school entrants.

4.5.1 School entrants at the primary and secondary school levels

At the primary school level, the number of all five-year-old schoolchildren on, say, 1 July of year Y are counted as entrants. To these is added the difference obtained by subtracting from the number of six-year-old children enrolled in year Y the number of five-year-old children enrolled in year (Y - 1), that is, one year earlier. The same comparison is made for seven-year-old and six-year-old children in these years, and the difference again added to the total. Beyond age 7 all children are presumed to be at school. The total represents the estimated number of school entrants at the primary level. A refinement would be to adjust this number for probable changes in either mortality or migration. It will usually not be necessary because such adjustments being minute will be absorbed in the rounding of the final figures. For future years, age-specific enrolment projections are used instead of enrolment records, and a forecast of the total number of school entrants can be obtained in the same manner. Where the projections are separate for state school and private school enrolments, the number of entrants to state schools can be computed separately.

If a system of compulsory education is not yet fully effective, the items in the series of differences must be continued to an age higher than 7, until the difference becomes zero. If the differences become negative ones, some children must be presumed to have left between the dates of (Y - 1) and Y. Should the actual period of being enrolled at school be a very short one, it is possible that the age ranges of school entrants and of school leavers will be very close to each other.

For the secondary school level a similar additive process of the differences between two years of secondary pupils from the most junior age onwards is carried out. For example:

\[
\begin{align*}
(1) \text{ twelve-year-old pupils at secondary schools in year } Y & = \text{ age } 12 \\
(2) \text{ difference: thirteen-year-olds in year } Y & - \text{ twelve-year-olds in year } Y - 1 = \text{ age } 13 \\
(3) \text{ difference: fourteen-year-olds in year } Y & - \text{ thirteen-year-olds in year } Y - 1 = \text{ age } 14 \\
\text{etc. etc.} & \\
\text{Total in year } Y. &
\end{align*}
\]

This last computation gives at the same time a summary of the age-range of secondary school entrants for different years. Median or average age of entrance to secondary school (or, transfer from primary school) can be calculated from these figures. But if the aim is to observe changes in age of transfer, it is necessary first to standardize each age group by estimating changes in size. This can be done simply by computing the average age not from the absolute number of entrants but from the ratio of that number to the total population of the same age.

If the number of secondary school entrants is written as the numerator of a fraction and the number of primary school leavers in the previous year as the denominator, a ratio will be obtained which over a number of years will show the trend of transfer to secondary level. The annual statistics on education in New Zealand contain information for all public schools on probable destination of pupils leaving the various groups of primary school. The most important destination is 'to post-primary school'. As the information is tabulated separately for Maori pupils, it is possible to extract over a series of years these transfer ratios and compare them with the transfer of all primary school leavers to secondary school. For Maori pupils alone, the
percentage increased from 62 in 1948 to 89 in 1957. (1)

When secondary school survival ratios, with the last primary school class (form II) as a basis, have been computed (see 4.3 above) the projection of the number of secondary school entrants is much simplified. Assuming that the number of form III pupils is equal to the number of entrants at the secondary level, the form III enrolment projections are acceptable as projections of the number of entrants.

4.5.2 School leavers

The same method can be used in reverse for estimating the number of school leavers in years to come. This number is of importance for assessing future inflow of juvenile labour to the labour market, the number of places required for continuation classes, and the like. The differences are 'in reverse' because the number of the higher age (e.g. 16) is subtracted from the number of lower age (e.g. 15) in the previous year. In the case of entrants, the lower age was subtracted from the higher age.

Furthermore, the differences between enrolments in successive grades in two consecutive years yield the number and distribution of school leavers according to the highest level reached on leaving. This method is, of course, applicable only when all pupils are promoted from one grade to the next at the end of each school year. Where classes are repeated by pupils failing a class examination at the end of the school year, it is necessary to make an adjustment for such 'repeaters' by adding the latter to the number enrolled in the higher class, thus restricting the difference to genuine school leavers.

An illustration of the projection of numbers of school leavers from all schools in New Zealand(2) classified by grade reached on leaving school, will be found in figure 9. The upper part exhibits the increase in number, the lower one emphasizes the proportionate change in level reached on leaving school.

4.6 AREA PROJECTIONS

The methods of school enrolment projection that have been discussed so far referred to national forecasts. Projections for a defined region or smaller area within a country are in certain respects more difficult to make, their necessary assumptions less secure, and their results subject to a greater margin of error.

4.6.1 The area ratio method

We have already observed (see 1.5.2 above) that national projections require basic population data on size of age groups, vital statistics on births and age-specific mortality, and external migration statistics. The school statistics, particularly for the estimation of enrolment ratios in the base years, are usually available on a national basis (see 1.5.1 above).

Let us assume first that all these statistics are also available in a regional breakdown (by districts, provinces, etc.). This will usually be the case.


(2) New Zealand Labour and Employment Gazette (Wellington), May 1958.
in a federal system, where the constituent states or provinces have their own statistical agencies for the compilation of some or all of these statistics. Even in this favourable case, however, one important condition for making area projections is not fulfilled: that is, that no information on the movement of population of school age between federated states or provinces, geographic regions or administrative districts, is available. The reason for the lack of this information is that the current recording of population movements is restricted by the criterion of citizenship. Movements that do not involve citizens of other countries escape statistical recording. This movement of population within a nation is referred to in population research as internal migration. Direct information on internal migration as to the number of people, classified by age, who enter or leave a defined area within the period of a year is seldom available. Such movements have to be estimated where possible. Sometimes, the schedule of a national population census includes an item on changes of domicile between census dates, and an analysis of this item can lead to an approximate assessment of population shifts. But very often there are no data whatever on which estimates of internal migration can be based.

A realistic approach to the special problem of area projections of school enrolment will, therefore, often have to make do without that matching of general population statistics and school statistics that enables the forecaster to base his projections on the observation and analysis of enrolment ratios. This approach will be expedient, too, if the classification of areas used in national statistics is different from that used in educational statistics; in New Zealand, for example, general population statistics are sub-divided for 'provincial districts' (which have only historical significance), but educational statistics are for the districts of education boards. In circumstances such as these the only solution is the use of what may be termed the 'area ratio method'.

By area ratio method is meant the employment of the ratio of area school enrolment to national school enrolment. There will be as many ratios of this kind as there are areas. If these ratios are observed over a fair number of base years, they may be found to increase or decrease. By definition, the sum of all area ratios equals unity, just as all area enrolments add up to national enrolment.

Once ascertained for the base years, the rate of change in the area enrolment ratios can be extrapolated in the same direction for a number of years ahead. The procedure is the same as that described in Chapter IV (see 4.2.2 above). In this case, extrapolation rests on the assumption that whatever factors caused the change in the past will continue to operate in a similar way in the future. This assumption is admittedly a hazardous one. For the change is due not only to internal migration movements but to other area differentials influencing school enrolment: different age composition of the population, different birth-rates, or different schooling habits. They depend on circumstances such as the predominantly urban or rural character of different areas or districts. All these factors, without being analysed in detail, find a composite expression in the area ratio of school enrolment and its change. The change is, however, one of relatively small variation, especially within a short projection period of perhaps five years.

The ratio method can, of course, be applied in a single district. But when a national agency undertakes projections, it can take full advantage of the area ratio method by producing area enrolment projections for all districts, since these are controlled by the national enrolment projections representing the sum of all district enrolments. It follows that district enrolment ratio may decline although the district enrolment may be increasing; this will be the case if the rate of increase in national enrolment is greater than the rate of decline in a district ratio. For example, let a district ratio in year Y of 23 decline to 21 in year Y+1, and let the index of national enrolment rise from 105 in Y to 120 in Y+1, then the district enrolment will rise from 24.15 in Y to 25.20 in Y+1.

4.6.2 An application of the area ratio method

This method was used for the first time in New Zealand in 1951 for the projection of primary school enrolment five years ahead. The area units chosen were the nine (or since 1954: ten) education boards which administer the schools in their district as local authorities, and the group of schools (Maori and special schools) directly administered by the Department of Education. The boundary lines of the education board districts coincide neither with those of the old provinces nor with combinations of smaller administrative units (boroughs, counties, etc.), for which the enumeration of census population is made and vital statistics of births are compiled. External migration statistics are available only in national figures. No information on internal migration is available.

For each of the districts ratios were calculated for five base years. The ratios were computed once as regional ratios of total enrolment, and once as regional ratios of enrolment increase from one base year to the next. The latter, being the more sensitive, were also used for projection purposes. Several districts revealed marked increases in ratio, which were compensated for by decreases in other districts. The base year ratios of each district were plotted on graphs and extrapolated five years ahead in the approximate direction of the trend observed over the base years. The projection points for each
year were adjusted, so that the sum of the district graph reading became 1.0. It was then merely necessary to multiply each district ratio by the national enrolment projected for the corresponding year. Since national enrolment was rising rapidly during most of these years, even districts with a decline in ratio showed some school enrolment increase. Districts with a rising ratio, on the other hand, showed marked increases in projected enrolment. The district increases in projected enrolment were then tested by converting them to district ratios of increase, and by inspecting these ratios of increase for smoothness.

In the furthest year of projection, that is, 1955, the greatest district projection error (adjusted to actual enrolment in the national return) amounted to 8.3 per cent of actual enrolment. The average error (disregarding plus or minus sign and unweighted by the variation of size of districts) was 3.7 per cent. An examination of the individual district errors in projection had a rather interesting result. In the five districts where the assumed regional enrolment increase was expected to be less than the national increase in five years, the district projection contained an understatement. In the two districts where the district increase was expected to exceed the national figure, the regional projection contained an overstatement. In the two districts where the regional rate hardly differed from the national one, the projection error was least (.76 and .35 per cent respectively above and below the actual roll). This result would seem to indicate that the regional differentials assumed in the projection were exaggerated. It would follow that the facts of the case were such that a past trend of rapid increase in district enrolment should perhaps be assumed to slow down somewhat during the projection period. Conversely, a trend of only moderate district increase should perhaps be assumed to accelerate somewhat during projection years, and a trend of some decline in a district ratio during the base years might turn into an upward trend.

The chief function of these area projections was to give a basis for adjudging the relative merit of claims of district authorities on school building funds which are allocated by a nationally-financed building programme. Allowing for programme carry-overs of up to approximately three years, short-term projections were sufficient for this purpose, and a constant review of the development of district ratios was possible.

The same method was used again in 1957 for regional secondary school enrolments, also for the education district areas, and combined for the (then) three inspection districts. It is too early yet to report the degree of approximation to actual district enrolment achieved. A special difficulty was due to the circumstance that the projections referred only to secondary schools under State control. The private school sector is somewhat larger at the secondary school level, and much differentiated as between the districts. The opening of a large new private secondary school in a particular district may possibly upset that district's ratio to an unforeseeable extent.
As one reviews the descriptive demonstration of methods of school enrolment projection, one fact becomes clear. Refinements in method ultimately depend on what statistical information can be exploited for the purpose. If the records are of a high standard the forecaster can set himself a target of approximation that maintains a standard of high validity for his projections. Validity may be considered high if the permissible projection error is not more than one per cent of total enrolment in short-term projection under some conditions (compulsory education) or at most five per cent in other conditions. Continuous review and revision of earlier projections in the light of further observation and analysis of the relevant facts is an important means of maintaining, if not improving this degree of validity.

Conditions under which projections have to be made are not always so favourable. But one need not despair in less favourable conditions. It is true that the projections will be of a lesser degree of validity but they will nevertheless serve a useful purpose. The problem is important enough to deserve some further remarks in this concluding chapter.

5.1 A RETROSPECTIVE VIEW OF THE INTRODUCTION OF A SYSTEM OF FREE AND COMPULSORY EDUCATION

The typical situation of this nature will be one where the introduction of a system of free and compulsory education is being planned and gets under way. The decision to introduce it will naturally be guided by some consideration of its implications. In the past, when administrators were less 'statistics-conscious' than today, this consideration would perhaps have taken the form of assessing very broadly the quantitative aspects of the proposed expansion.

For example, at the 1878 population census in New Zealand the number of children of ages 10 to 14 was 46,000. Some 24,000 were attending public schools. An unknown number - unknown because they had not been counted - attended private schools of various denominations. But allowing, again by a rough guess, for between 10 and 20 per cent in the private school sector, for a small number in secondary schools, and further for a portion being exempt from attendance for various reasons, it was nevertheless clear that the 53 per cent enrolment ratio obtained was much too low.

What this figure should have been was apparently not exactly stated at that time. The Department of Education, charged with the administration of the Education Act, and the district education boards simply went ahead providing school buildings, teachers, and other facilities to keep pace with rising numbers. From 1878 uniform attendance registers were kept by the public schools.

It soon appeared that some schools were inclined to return somewhat exaggerated numbers of pupils nominally on their rolls - as though that would enhance their prestige. This practice did not, of course, help increase the funds being made available to the school. For the grant for classroom accommodation, staffing, salaries of teachers and incidental expenses had wisely been based not on enrolment but on average attendance. ('Average attendance' is the mean number of children actually attending school at different dates during the school year; a 'ratio of attendance' can be obtained by dividing the average attendance by the number on the roll). Obviously, then, an exaggerated number on the register, that is, of enrolment would merely tend to depress the attendance ratio and give a false picture of the effectiveness of the new educational system. If that was the case, it meant also that any enrolment ratio computed from such totals would have been too high. And there would be even more room for growth up to maximum enrolment.

Ten years later the system of statistical reporting had developed to the point where an approximate comparison of statistical information from different sources could be made, and also an appraisal of the quality of the enrolment statistics based on school returns. In 1886 the school enrolment statistics could be reconciled with the population census of that year which gave the number of children reported as attending public or aided schools. The grand total agreed, with a margin of error of less than
2 per cent, with the total enrolment as returned for educational purposes. This latter total was of course an estimate. It had to be reduced by the estimated number of Maori children attending public schools (to whom the census figures did not refer) and had to be increased by an estimate of the number enrolled at some special schools and at secondary schools for which no statistics were kept.

While this reconciliation of returns from different sources served to indicate the validity of the educational statistics of enrolment, the figures themselves offered at the same time a basis for reviewing progress in the implementation of compulsory education. The approximate enrolment ratio of .53 in the 10-14 age group had risen to .64. It stood at .69 in 1901 and .76 in 1911. These last figures, one may conclude, represented maximum enrolment up to age 13, allowing for reduced exemptions and for the number of pupils in this age group who went to private schools and to secondary schools.

Total population had rapidly increased during that period of continuing settlement of the country. The whole age group 5 to 14, as the relevant one for school enrolment in public schools, increased from 105,000 to 150,000 between 1878 and 1886, and further to 171,000 in 1896, to reach 197,000 by 1911. Public school rolls, then, under the double impact of rapid increases in both enrolment ratio and size of child population, doubled between 1877 and 1887, and nearly trebled between 1877 and 1911.

5.2 PREPARING FOR UNIVERSAL EDUCATION IN WESTERN SAMOA

At the present day, administrative action is normally prepared by more exacting observation and analysis of the relevant facts, and a consequent prognosis of future developments. But this requires adequate data from which the forecaster can make that appraisal of trends which is the basis of projection. Only too often some of these data are unavailable.

This situation arose a few years ago in Western Samoa. After an interval of eight years the New Zealand Director of Education was invited in 1953 to take another look at schooling facilities in this Trust Territory, which is a rapidly developing group of tropical islands in the Pacific. It was natural that at that moment a survey should be made with a view to deciding whether a full system of free and compulsory education might be introduced, and if so when. The question could be put in fairly precise terms: what would be the increase in the number of pupils enrolled in government primary schools in 3, 5, 10, or 15 years, if universal education were introduced?

But the basic information obtained was unreliable. School statistics were for government schools, giving an age classification of pupils.

The statistics were the 'sum of the numbers on all school registers, but, as records of age classification and attendance, they 'varied greatly in value'. Few parents bothered to produce a birth certificate, but many were, it is reported, 'guided by the dictates of expediency rather than by any disinterested delight in accuracy' when stating the ages of the children they wished to enrol. The age distribution shown in the school registers could not but be a faithful mirror of this lack of accuracy.

Mission school statistics were incomplete; some groups of schools were omitted but there were possible double counts of children who also attended government primary schools. The estimate of this sector varied between 43 and 50 per cent of the enrolment at government schools, equivalent to 30 to 33 per cent of total enrolment.

So much for the numerators that were available for estimating enrolment ratios. In the denominators, there were, firstly, the results of the last census (1951). This, however, suffered from some inevitable inaccuracies. Moreover, the adoption of a system of single year-age enumeration 0 to 4 and of quinary age groupings above the age of 5 years, to replace the unsuitable traditional system of grouping by infants (under 2), children (2-14), older married and unmarried males and females, and heads of families, made it impossible to compare results with those of a previous census, or to correct the previous enumeration. Secondly, there were registers of births and deaths, but these were even less satisfactory. The records suffered from under reporting. An earlier estimate of the Samoan birth rate, though perhaps on the high side, was 45 per 1000 of population. The nominal birth rate computed from registered live births in 1952 was only 32 per 1000 which was obviously far too low. For 1956 it worked out at 41.3 per 1000. The increase by almost one-quarter in four years was, then, not to any

(3) New Zealand, Department of Island Territories, Western Samoa, reports for the calendar years 1952 and 1955, Wellington Government Printer, 1953, 1956.
(4) Western Samoa, Population census 1951, Wellington, New Zealand, Government Printer, 1954. In 1956 another census was taken for which a professional demographer was employed.
appreciable extent a real one but must rather be considered the result of more efficient registration.

Middle term projections to 1964 or 1969 were, moreover, dependent on an assessment of the probable future size of the population of school age, which in turn depended on expected births five to ten years ahead. This assessment was unsupported by an analytic study of birth rates. Such a study, it was felt, would only lead once more to highly speculative inferences. The assessment of future births was therefore a straight-out numerical assumption, checked only by broad expectations suggested by earlier observations. Nor was an attempt made at that time to apply one or another of the demographic techniques that have since become better known. In retrospect it appears that their application might have induced a less conservative forecast of school age population.

One example may be of interest in this context where the focus is on the youngest age groups rather than on total future population. If a figure of total population at a future date can be ventured as a plausible one in the light of general observation, one can apply to it, at least tentatively, the 'forty per cent rule'. According to this rule, a population with high fertility and fairly high mortality has a proportion of infants and children (up to 15 years) that represents some 40 per cent of the whole population. Such a population may be represented by a pyramid which will have a very broad base but which will not be very high. The 40 per cent rule is an entirely empirical one derived from data for a large number of population studies where a breakdown by age could be accurately determined.

It can be shown that to maintain a child population representing 40 per cent or more of total population, a crude birth rate, with certain probable rates of infant and child mortality, of around 40 per 1000 of total population is necessary.\(^1\)

It must be emphasized again that this figure as an indicator of order of magnitude is a probability rather than a measure of some exactitude. It is nevertheless a useful guiding figure, and allows a forecast of births in the broadest terms, in the absence of complete vital registration. One of the most elaborate investigations ever made to estimate birth rates from census data alone represented the child population (up to 15 years) as being between 42 and 44 per cent of the total population.\(^2\)

School enrolment ratios based on material of the kind described above were, then, subject to a considerable margin of error. Even so, they could be used to assess the number of children of school age (7 to 13) that were not being catered for. As this number would decline with the implementation of a system of universal education for that age range, enrolment ratios for the adjacent ages of 6, and perhaps 5, at the lower end and of 14, and perhaps 15, at the upper end, stood some chance of a complementary increase. This increase could be assumed by a reasonable guess. A further assumption had to be made as to the future proportion of the private school sector in total enrolment; it was assumed either to remain constant (at 35 per cent) or to decline to 30 per cent. Total enrolment at government primary schools could then be estimated for future dates by adding to the current enrolment figures the estimated increase in total school attendance and perhaps also the number of pupils who would formerly have been enrolled at private schools.

These projections were made by establishing two limits within which it was deemed likely that enrolment increases would fall. They were expected to be valid within a 90 or 110 per cent approximation as far as 1959, and a wider margin beyond that date. The limit figures meant a probable doubling of enrolment within twelve to seventeen years - with a consequent doubling of the number of teachers and classrooms needed. Imprecise though this projection was, it gave some basis for a recommendation on the best timing for a system of universal education.

A review of the figures in the light of enrolment and vital statistics records since 1953 showed three things:

1. that the assumed number of births had been understated,
2. that the increases in enrolment at government primary schools were greater than had been thought probable, which implied more rapid improvement in enrolment ratios,
3. that the proportion of the private school sector had declined more than had been assumed (to 27 per cent).

Altogether, the total enrolment recorded for 1956 nearly reached the projected total for 1959. The 1953 projection must therefore be expected to have been understated by around ten per cent.


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