not in fact made the right predictions, and that there are aspects of this great file of material which we have failed to appreciate. We therefore envisage the full exploitation of all this information as a long and continuing process, with a fresh set of questions occurring to us each time we look at the answers to the previous set.

One of the great advantages of using a computer is that it is relatively easy to change one's mind by making a minor change in a program, whereas if one were dependent upon hand calculation, the labour of a further attempt would be too enormous to contemplate. Another advantage of having stored all this information on magnetic tape is that it should be relatively cheap and simple to arrange for publication of the original sets of aggregative returns, possibly on a regional basis, so that they can be freely available to all. Meanwhile we might take this opportunity to remind readers of L.P.S. that it is the Group's policy that all our files of research material, such as sets of aggregative returns, are open for anyone to consult at 20 Silver Street, Cambridge.

<div align="right">
Peter Laslett
Roger Schofield
E.A. Wrigley
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Some notes on aggregative analysis in a single parish

Before embarking upon an aggregative analysis it is obviously prudent to scrutinise the register for signs of deficient registration and to discover as much as possible about the nature and strength of non-conformity in the parish. In all that follows it is assumed that the register is giving a fair picture of the vital events in the parish.

One aspect of population history to which aggregative analysis is well suited is the study of seasonality in the distribution of baptisms, burials, and marriages. Little need be said on this subject here because it is already the subject of an extended discussion in L.P.S. by Mr. Bradley (See L.P.S. No. 4, pp. 21–40, and below in this issue). I would only stress Mr. Bradley's point (L.P.S. No. 4, pp. 30-2) that where the numbers of events are small much of the apparent seasonal variation may in fact be due to chance variation.

In many of the smaller parishes it may therefore be necessary to take quite long periods to guard against this danger of small numbers. Mr. Bradley is also right to stress that, unless we are fortunate enough to have a register which gives dates of birth and death, we can only study the seasonality of the ecclesiastical ceremonies associated with vital events, not the seasonality of the vital events themselves. The discrepancy is not serious in the case of deaths and burials, for the necessity of disposing of the corpse led to almost all burials occurring within four or five days of death. In the case of baptisms, however, the immense variation in customs governing the age at which children were baptized, both as between parishes, and in the same parish over time, makes it impossible to calculate the seasonality of births or conceptions from the baptism register with any safety. Similarly widely differing customs with regard to betrothal, cohabitation, and the wedding ceremony solemnizing the marriage, make the wedding registers an uncertain guide to the seasonality of marriage.

Another topic which can readily be studied from a set of aggregative returns is what one might term 'crisis mortality', for it is a simple matter to pick out years with unusually large numbers of deaths (say over twice the average for the period) on the aggregative forms. This is a subject which has acquired an added importance with David Chamber's article in L.P.S. No. 3 in which he argues for the importance of changes in mortality in determining the course of population change in the past. It is therefore well worth while examining the number and timing of these years of 'crisis mortality'. In some parishes they may conform to what is now becoming general expectation: occurring particularly frequently in the mid-seventeenth century, and dying away in the early eighteenth century. Other parishes, however, may escape such crises altogether, or suffer them until well into the nineteenth century Some parishes may have been particularly vulnerable, or immune, because of their location, and in this respect it is useful to see whether the parish was affected by heavy mortality in some of the better known epidemic years, (for example, 1557-9, 1603, 1623, 1665, 1728-9). But a parish's vulnerability to crisis mortality may also have been determined by its social and economic arrangements, and in this way a study of 'crisis mortality' might suggest profitable lines of enquiry in these fields of local history. It often happens too that the seasonal distribution of burials in 'crisis' years is markedly different from the seasonal distribution of burials in normal years. Indeed some of the big killer diseases had characteristic seasonal profiles, for example deaths from bubonic plague often built up sharply to a peak in late

summer and fell off rapidly in October or November.   Although it
does not follow in this case that all seasonal patterns of this kind can
be attributed to bubonic plague, an unusual seasonal distribution of burials
in a 'crisis' year can often be a valuable clue in solving the cause
of the 'crisis'.

Aggregative returns can also be used to give a picture of the general
course of population change in the parish.   This comes out most
clearly if the annual frequencies of baptisms, burials, and marriages
are drawn on a graph.   It is helpful to use a different colour for
each series, and it is often easier to fit the marriage figures on the
graph if they are first multiplied by some convenient number (say 3
or 4) so that they are nearer to the totals of baptisms and burials.
The graph may show considerable fluctuations each year.   In a
large parish this is an interesting result in its own right, but in a
small parish it may merely reflect chance variation in the annual
figures.   If these fluctuations are so violent as to obscure the under-
lying trend, it is helpful to smooth the graph by replacing the original
figures by moving averages.   These are usually calculated by adding
up the annual number of events for a fixed number of years and then
dividing the result by the number of years taken;   for example the
annual totals of baptism for the five years from 1581-5 are added
together and this total is divided by five.   Conventionally this average
is entered on the graph opposite the middle year, in this case 1583,
which explains why moving averages are usually calculated for odd
numbers of years (3,5,7,9 etc.).   To find the moving average for
the next year (1584) all that is necessary is to subtract the figure for
1581 from the total obtained earlier, add in the figure for 1586, and
divide the new total by five again.   Calculating moving averages is
therefore not quite so laborious as it might appear at first sight.
The longer the moving average, in the sense of the more years that
are taken together in calculating it, the more short-term fluctuations
are averaged out and the smoother the graph will appear.   The
choice of the length of a moving average therefore depends on the
amount of short-term variation that one wishes to suppress or to
restrain.   There is one special form of moving average which is
particularly successful in dampening short-term fluctuations without
obliterating them altogether.   This is a binomially weighted moving
average which is calculated so that the figure for the central year is
given most weight and the figures for the surrounding years
progressively less weight in arriving at the average figures.
Because the weights change as the average moves along the series,
this is an impossibly laborious calculation to do by hand, and is only

really practicable if computing facilities are available.

The graph on the next page shows a nine-year moving average of baptisms and burials in Colyton, Devon between 1550 and 1830. I have chosen to use this graph yet again because it is one in which there is plenty of variety, and which illustrates the possibilities and difficulties in interpreting graphs of this kind. If we look first of all at the trend in baptisms, there would appear to be four main periods which can be distinguished. Between 1550 and 1640 baptisms are increasing in number, between 1640 and 1720 baptisms are running at a lower level and are declining in numbers, from 1720 to about 1780 they are almost static, rising only slowly, while from about 1785 they increase rapidly up to 1810 after which they level off. The trend in burials, however, is rather different. Although, like baptisms, they increase up to 1640, after the massive plague mortality in 1645-6 the number of burials declines during the rest of the seventeenth century and during the early eighteenth century, although in the seventeenth century burials are still more numerous than they were before 1620. From the mid-eighteenth century the number of burials is almost static, showing overall only a slight tendency to rise. If we now consider the relative position of the baptism and burial lines on the graph, we find a considerable excess of baptisms over burials during almost all of the period 1550-1640, but a dramatic reversal of the position with more burials than baptisms during the period 1640-1740. From 1740 to the mid-1780's baptisms and burials are more or less in balance with slightly more baptisms than burials, while from the mid-1780's until 1810 baptisms grow steadily away from burials.

From the graph we might be tempted to conclude that the population of Colyton grew between 1550 and 1640, fell between 1640 and 1740, remained stable or grew only slightly between 1740 and 1785, and then grew more quickly between 1785 and 1810. These may be the correct inferences to make, but it is important to realize that they are not the only ones which can be drawn from the graph. Let us consider, for example, the period from 1550 to 1640 when both the number of baptisms and the number of burials are increasing, and there are usually more baptisms than burials. Our conclusion that with a surplus of baptisms over burials the population was rising seems to be confirmed by the fact that the number of both baptisms and burials was also rising. But the same pattern could be produced by a rise in both fertility and mortality with no change in the size of the population. In this case the 'surplus' population (of baptisms

COLYTON

Baptisms and Burials (9-year moving averages)
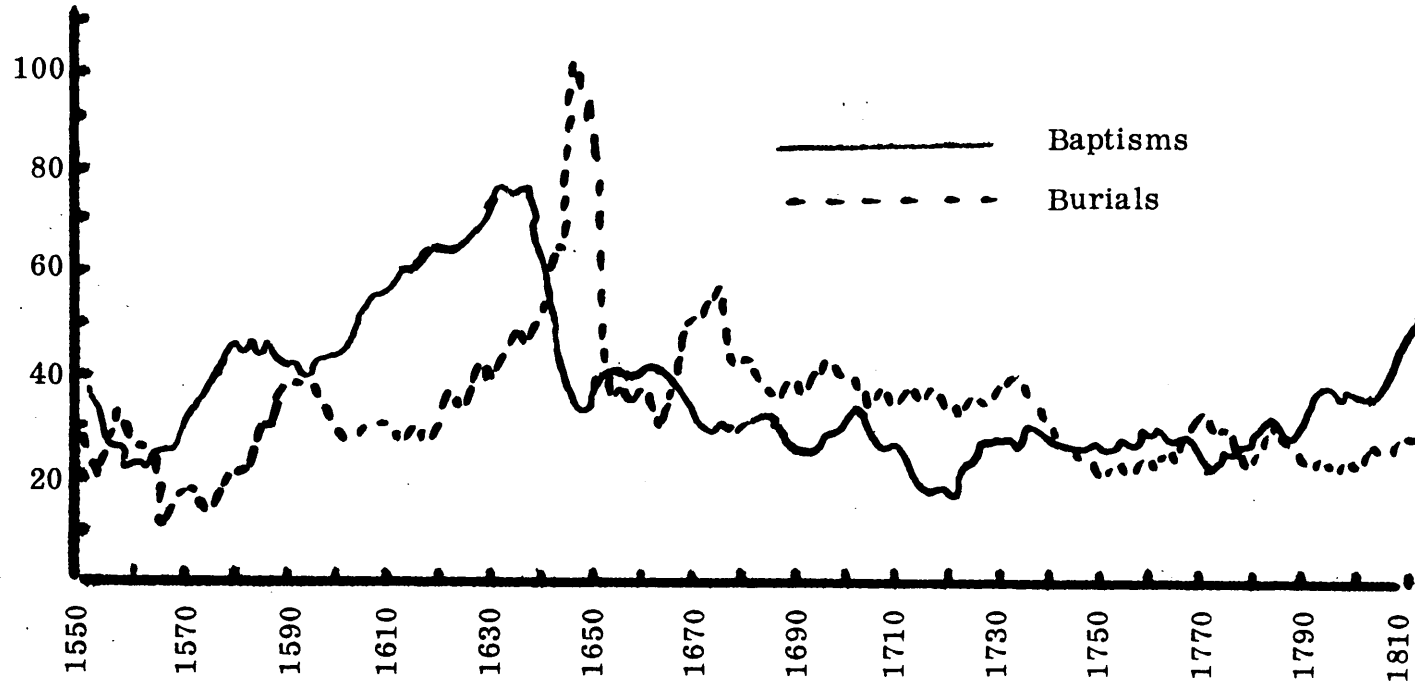
over burials) will have emigrated.   The difficulty is that when we are considering number of events alone we have no means of separating the effects of changes in fertility and mortality from the effects of changes in population size.

The usual solution to this problem has been to control for the size of the population by calculating baptism and burial rates (e.g. so many baptisms per thousand population).   This is a proper procedure to follow, providing the size of the population is known.   Unfortunately, however, the size of a parish population is rarely known before the national Censuses in the early nineteenth century.   The most that is usually available is an uncertain estimate based on the number of communicants or the number of houses recorded in the late seventeenth century.   Several methods have been suggested for interpolating population sizes for intermediate dates, say for 1760, but all are based on inferences from the surpluses, or of deficits, of baptisms over burials.   This way of proceeding is scarcely satisfactory because it assumes that changes in the size of the parish population only come through 'natural' increase or decrese, and that there was therefore no migration (or in some cases no changes in migration) in to, or out of, the parish.   As a result most baptism, burial and marriage rates are based on estimates of population size which are almost complete guesswork.   An even less satisfactory procedure, which is occasionally adopted in parish studies, is to estimate the size of the population by adopting Dr. Cox's ancient suggestion of simply multiplying the number of baptisms by 30.   This assumes that the baptism rate was at all times 33 per thousand, which is, one might say, an assumption of heroic dimensions.   Rates calculated using this method of estimating the size of the parish population are likely to be seriously in error.   Indeed, if it has already been assumed that the baptism rate was 33 per thousand, there would seem to be little point in then going on to calculate actual baptism rates.

Unless therefore one is fortunate enough to have a number of reliable counts of a parish population spread right through the period under study, calculating the traditional baptism, burial, and marriage rates adds nothing to the rigour of one's interpretation of aggregative material, indeed it usually merely brings an unknown element of distortion into the results.   The critical point at issue is the one of migration, for if we could assume that the parish comprised a closed population, then we could rule out some of the possibilities.   In one example we could dispose of the possibility that the graph of baptisms and burials at Colyton between 1550 and 1640 reflects a rise in fertility and mortality coupled with emigration.   Fortunately the

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problem is somewhat eased when large numbers of parishes are under consideration, for if many parishes show the same pattern of baptisms and burials, it becomes progressively less likely that in every case this was caused by migration into, or out of, the parish. But when we are dealing with a single parish we clearly cannot rule out migration, and unfortunately migration is a matter which is exceedingly difficult to document in the past. However, since much migration occurred at marriage, it might in favourable circumstances be possible to get some hint of the extent of migration by studying the origins of marriage partners.

Aggregative analysis is only a summary method of procedure and there is no simple solution to resolving conflicts between a number of alternative explanations. Some possibilities, however, can occasionally be ruled out. For example in Colyton in the period 1550 to 1640, both baptisms and burials were between two and three times as numerous at the end of the period than they were at the beginning. It is most unlikely therefore that changes in fertility and mortality without any increase in the population size can have accounted for this rise, because this would have obliged the inhabitants of Colyton in the early seventeenth century to suffer outrageously high fertility and mortality rates. In this case we might reasonably conclude that the population of the parish did grow during this period, but we cannot tell whether fertility and mortality rates may not also have changed. To discover this we should have to abandon aggregative analysis for family reconstitution. Again, if we consider the period after 1785 when the graph again shows a surplus of baptisms over burials, we find ourselves in a similar difficulty. In this case the number of baptisms increases rapidly, but the number of burials remains more or less the same. We might conclude from this that following the 'natural' surplus, the population grew, but that burials remained at the same level because this growth in population was offset by a fall in the death rate. Alternatively we might say that the death rate remained constant indicating a static population, the number of baptisms rising because of increased fertility, and the population failing to rise because of emigration. Thus once more aggregative analysis takes us a certain distance, and to go further we have to adopt more powerful demographic techniques.

But studying graphs of moving averages of baptisms and burials does not exhaust the possibilities of study from a set of aggregative returns. For example, if a moving average of marriages is plotted on the graph, this may help to decide between several possible interpretations of the graph. Further, a rough indication of fertility can be gained

by dividing the total of baptisms by the total of marriages five years earlier, or an index of nuptiality can be calculated by dividing the number of marriages by the number of births 25 years earlier. [1]

Although graphs of this kind for individual parishes vary widely, there are some features which are common to a substantial proportion of parishes, and it may be helpful to list some of the point which we look out for whenever we receive a set of aggregative returns. The first point is whether there was a surplus of baptisms over burials in the sixteenth and early seventeenth centuries, and when this surplus reached its maximum. Then we look to see if there was ever a period in which burials exceeded baptisms, when this period began and ended, and how serious the deficit was. Finally in such cases we look for when the first signs of population growth are to be found, usually in the eighteenth century. This is a subject of particular interest in view of Chambers' article in L.P.S. No. 3 in which he argues, against Wrigley, that in some parts of the country, especially in the Midlands and the North, there are clear signs of population growth in the late seventeenth or very early eighteenth centuries. Often these years are marked by sharp fluctuations of baptisms and burials, with years of surplus being followed by years of deficit. One way of tackling this question comparatively between parishes is to start at an arbitrary date (say 1660), and to keep a running cumulative total of the baptism/burial surpluses and deficits. The year after which the cumulative total is never below zero can then be used as an indication of the parish's speed of recovery in this controversial period.

Finally there is a whole aspect of aggregative analysis which has not been touched upon here, namely when aggregative returns are studied in detail in conjunction with the social and economic history of the parish. Readers will probably already be familiar with the discussion of techniques and results by D.E.C. Eversley in chapters of Introduction to English Historical Demography ed. by E.A. Wrigley, and with the model studies by D.E.C. Eversley and J.D. Chambers 'The Vale of Trent' Economic History Review Supplement both reprinted in Population in History ed. by D.V. Glass and D.E.C. Eversley.

R.S. Schofield

NOTES

1.   D. Turner, 'The Effective Family', L.P.S. No. 2, pp. 47-52.