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COMPUTER BASED MAPPING TECHNIQUES

In the construction of a series of data files at the Fraser of Allander Institute for use in the analysis of short-term movements in the Scottish economy, primary consideration is given to the time series data; for example, Scottish unemployment levels over the last ten years. However, there is a wealth of information available, chiefly from official sources, which, though not available over a period of time, can be a useful adjunct to a developing knowledge of the operation of the Scottish economy. Such data are frequently not strictly economic in character but may well interact with the economic system, sometimes as cause, sometimes as effect. Undoubtedly the richest source of such data is the Census of Population.

In this synopsis of recent work at the Fraser of Allander Institute we consider the efficacy of using computer mapping techniques to analyse such data. The great advantage of census data is the extent to which it is spatially disaggregated. Data are available down to enumeration district (E.D.) level. The average population of E.D.'s is well under 1000 persons. For small area studies the E.D. is the most useful spatial unit with which to operate. However, when considering the whole of Scotland such a detailed disaggregation would be extremely difficult to deal with.

The new local government district seemed the most appropriate areal unit to work with at the Scottish level. Such a breakdown gives 56 basic units. There are, of course, disadvantages inherent in aggregating to such a level. One major difficulty is that differences within the basic areal unit are masked out. These can be particularly important in an area which has both rural and urban features. Nevertheless, the boundaries of the local authority districts as currently defined, fairly well separate rural and urban areas. Initially census statistics were produced to accord with the old local authority structure. However, a recently published report* of the Registrar General gives a detailed breakdown of census statistics at the district level.

Given that this data, spatially, but not temporarily disaggregated, is available, one has to determine means of analysis and presentation. The technique of choropleth mapping is a most useful tool to effect these

* *Registrar General Scotland. 1971 Census Statistics. New Local Government Areas as constituted 16 May 1975. HMSO.*

aims. It operates as follows: given observations on each of a set of areas, intervals are chosen such that all observations lie within one or other of these. Then each area is assigned a different shading depending within which interval its observation lies. The maps on the following pages are examples of the choropleth technique. They have been produced by the program CAMAPG* developed at the University of Edinburgh. Such maps could, of course, be produced manually but the computer based map has a number of distinct advantages.

Firstly, a great deal of time can be saved if one is producing a large number of maps using the same areal units. Once one has invested the time in setting up the map framework the actual production of maps can be very easily accomplished. Secondly, a map produced by computer can be a much more powerful tool of analysis than a manually produced map. One can use a computer to relate different variables and plot the results of the analysis on a map, a technique which would be feasible but extremely tedious with hand-drawn maps.

Many techniques of analysis are available to combine data on different variables, e.g. rank scores, normal transformation, principal components, multiple regression. In this article, one simple analysis is undertaken using a method which has found successful application in Norway in dealing with political data. The methodology is as follows: one gathers an initial set of observations on a variable. These are mapped in order to clarify its spatial variation. From a comparison of this map with others one chooses another variable, thought to be related to the first, and tries to explain some of the variation in the first data series, using a simple regression. Should this be successful one then maps the residuals from the regression, i.e. the variability in the first data series which cannot be 'explained' by the second series. One then chooses a third series which it is hoped can be used to explain the variation in the residuals and so on. At each stage it is hoped that the relevant map can be utilised to suggest the next possible variable for inclusion.

Before considering an example of this technique (Maps 4, 5, 6) the first three maps are considered.

Map 1 % Households Owner Occupied

The first map shows how the pattern of home ownership varies across Scotland. From the map there are perhaps three particular contrasts worth noting, namely:

* We are indebted to Mr J Hotson of the Department of Geography at the University of Edinburgh for assistance in operating this program.

- (a) The generally low level of house ownership in most parts of the central belt relative to the rest of Scotland.
- (b) The contrast between the large cities, Glasgow and Dundee having considerably lower home-ownership levels than Aberdeen and, particularly, Edinburgh.
- (c) The sharp differences in levels within the Strathclyde region. Eastwood and Bearsden districts have home-ownership rates around 80% whereas Cumbernauld and Kilsyth district has the lowest rate in Scotland at 6.6%.

Map 2: % Old Age Pensioners Living Alone

Where social ties are strongest one would expect to find a low proportion of old age pensioners living alone. Thus, Map 2 shows a much higher proportion of old age pensioners living alone in the cities than, say, in the Highlands and Islands. Again, there is a sharp contrast within Strathclyde region. In Bearsden, Eastwood and Strathkelvin a much lower proportion of old age pensioners live alone than elsewhere in Strathclyde.

Map 3: % Population Born Outwith Scotland But Within the UK

Two particular aspects of this map are worth noting:-

- (a) Much as one might expect, there is a much higher proportion of persons not born in Scotland in the Borders than there is in the remoter areas of the Highlands.
- (b) The upper socio-economic groups, who tend to live in more affluent residential areas, who tend to be most mobile geographically. Thus there is a high proportion of people not born in Scotland in, say, Eastwood as compared with Glasgow district.

Maps 4,5, and 6

In Maps 4,5, and 6 we attempt to relate levels of basic amenity use to dependency ratios. To measure provision of amenities we use the percentage of population who have exclusive use of all basic amenities - hot water, fixed bath or shower and inside WC. The dependency ratio measures the proportion of the population who are considered to be economically inactive and are therefore dependent on the remainder of the population. The dependency ratios portrayed in Map 5 have been calculated using the formula

$$\text{Dependency Ratio} = \frac{\text{children up to 15} + \text{women over 60} + \text{men over 65}}{\text{total population}}$$

Map 4 shows how the proportion of households having exclusive use of all basic amenities is spatially distributed in Scotland. Particularly low levels of basic amenity provision are evident in the major cities and in the western highlands. In contrast, dependency ratios tend to be high in the western highlands (see Map 5).

To some extent variations in amenity provision may be explained by variations in dependency ratios. Where dependency ratios are high one might expect that per capita incomes would be low - thus making the provision of basic amenities more difficult.

A simple regression analysis on these variables for the 56 local authority districts in Scotland suggested that the above relationship cannot be rejected on statistical grounds. There is a significant, negative relationship between dependency ratios and amenity provision.

However variations in the dependency ratios pick up only 15% of the variation in the proportion of households having exclusive use of all amenities. Obviously further variables need to be included in order to increase this percentage.

In Map 6 the residuals from the regression analysis (the variation left unexplained) are mapped. The extremely low residuals which occur in the cities and in the islands suggest that these areas have a low proportion of households with exclusive use of all basic amenities, given their dependency ratios.

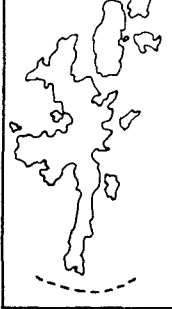
The next stage of the analysis would be to find a further variable, using the map of the residuals as a guide, to explain some more of the spatial variation in amenity provision, thus slowly building up a picture of the factors likely to affect it.

Conclusion

The intention of this article has been to demonstrate that computer mapping can assist the presentation and analysis of spatially disaggregated data. Though we are still experimenting with the technique we feel that it will provide us with valuable insights into Scotland's complex socio-economic structure.

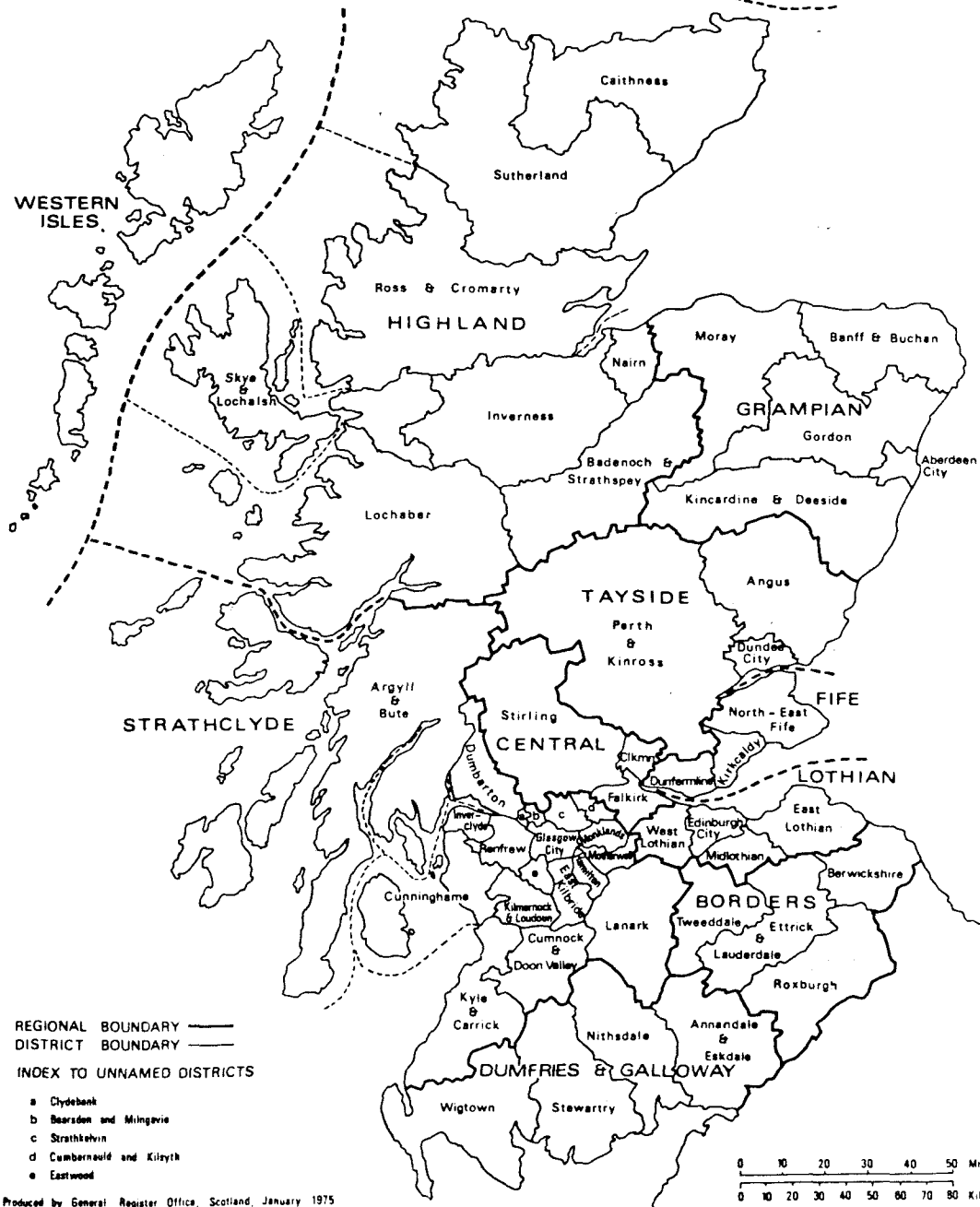
MAP 1 SCOTLAND BY LOCAL GOVERNMENT REGION AND DISTRICT 1975

SHETLAND

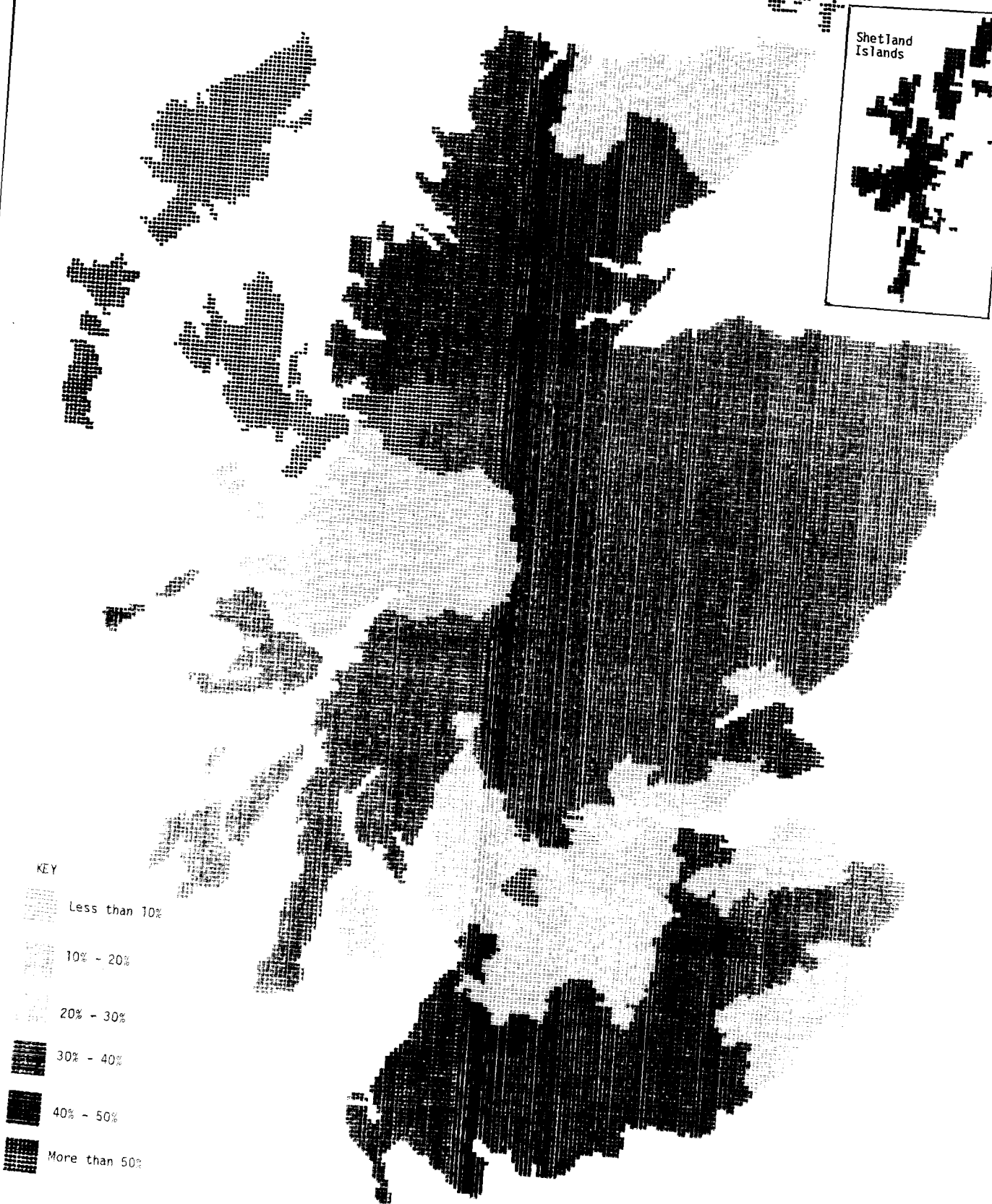


ORKNEY

WESTERN ISLES

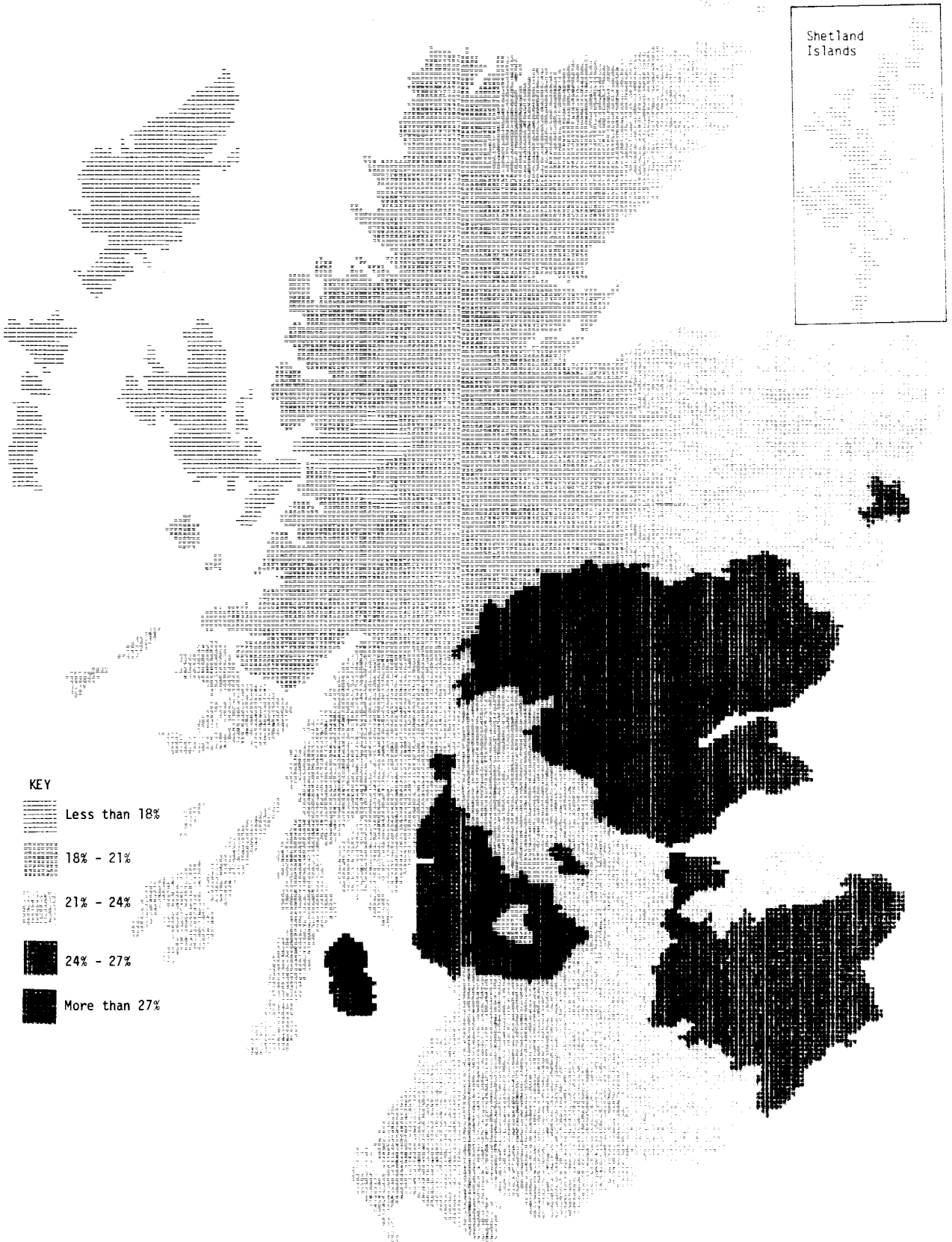


MAP 2 Owner occupied households as a percentage of total households








- KEY
- Less than 10%
 - 10% - 20%
 - 20% - 30%
 - 30% - 40%
 - 40% - 50%
 - More than 50%

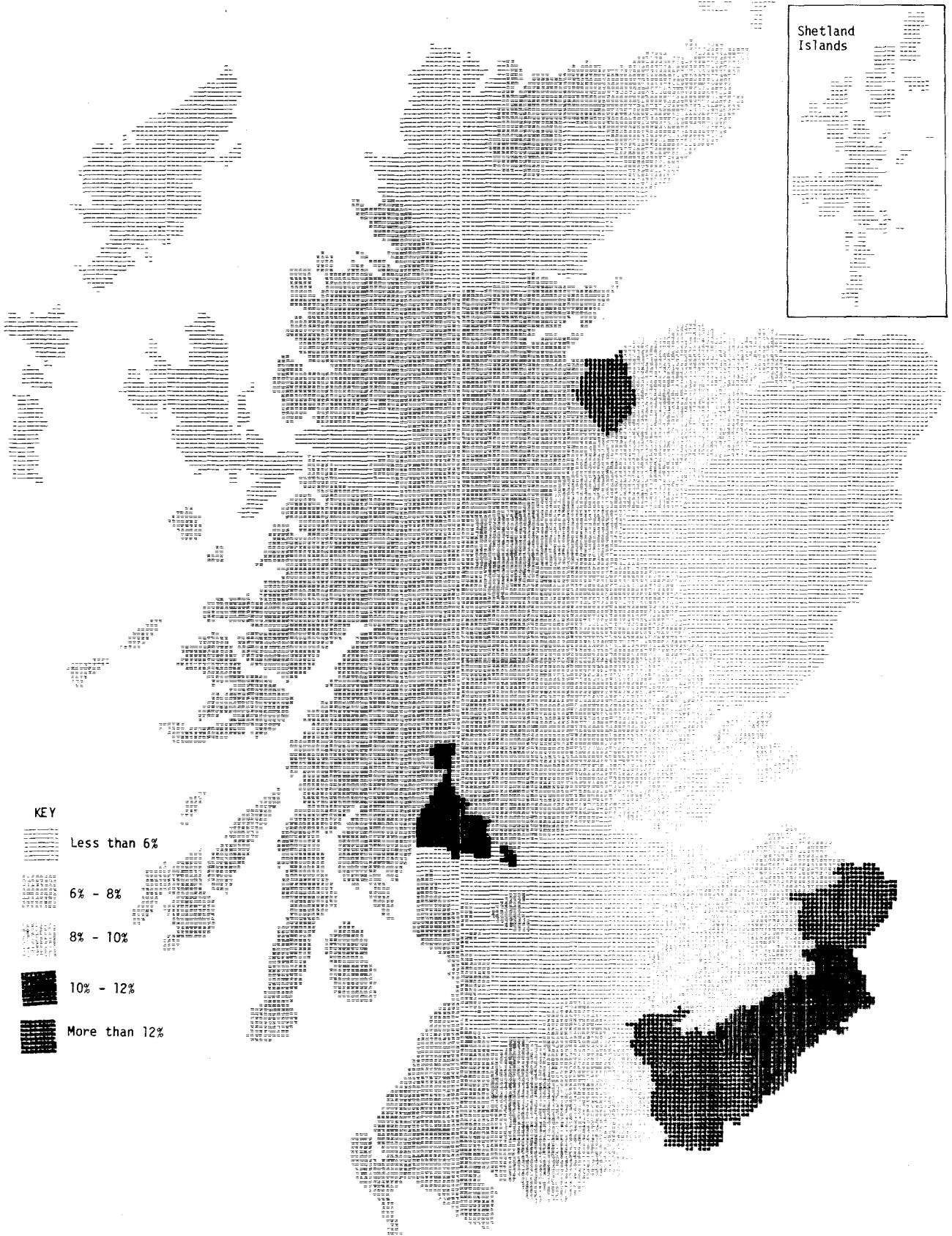
MAP 3 Percentage Old Age Pensioners living alone



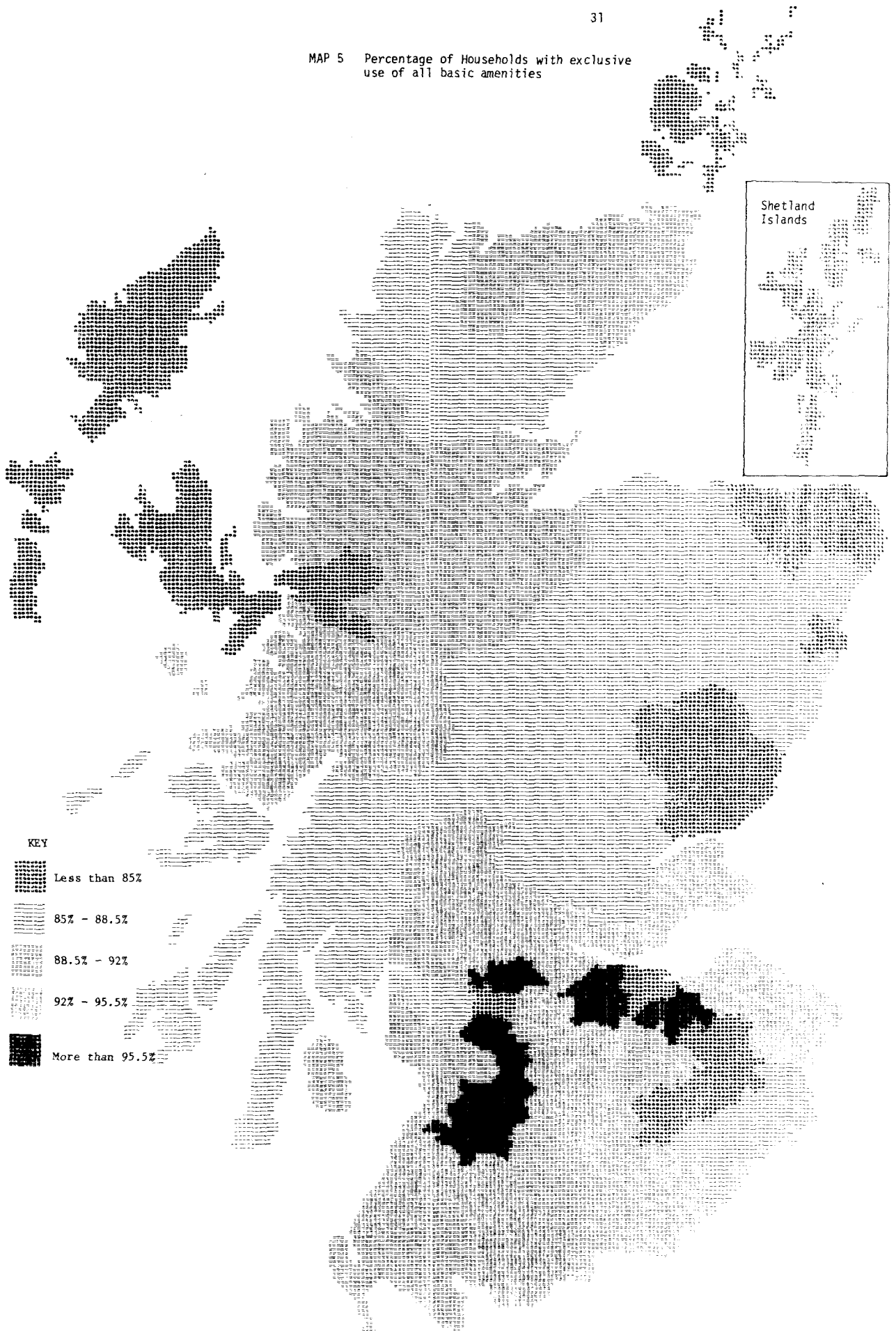
KEY

-  Less than 18%
-  18% - 21%
-  21% - 24%
-  24% - 27%
-  More than 27%

MAP 4 Percentage of population not born in Scotland



MAP 5 Percentage of Households with exclusive use of all basic amenities



MAP 7 Residuals from regression of % exclusive use of basic amenities on dependency ratios

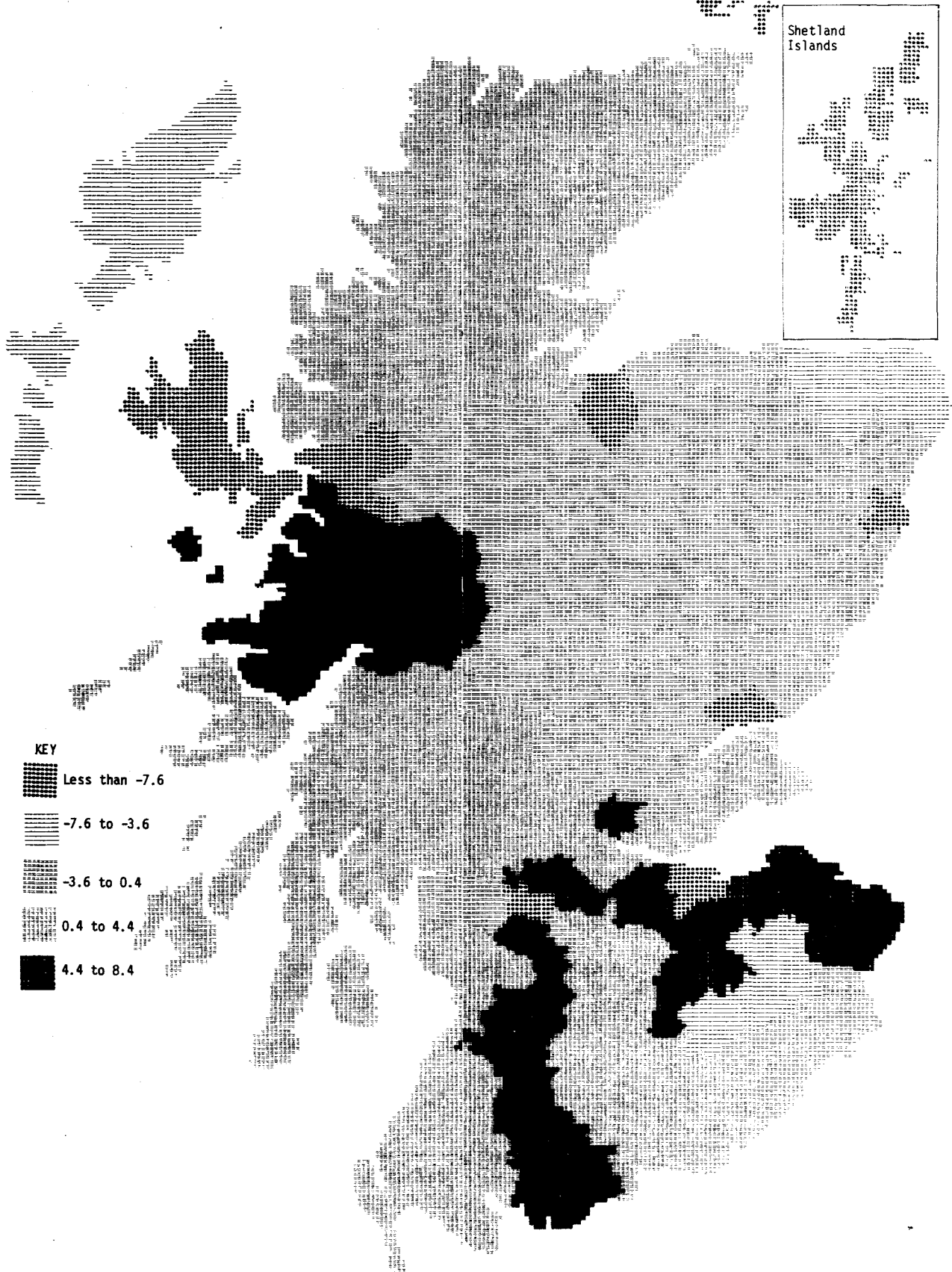


TABLE 1 Unemployment and Vacancies in the Regions of the UK June 1976

	Unemployment (Thousands)	Unemployment Rate (%)	Vacancies (Thousands)	Unemployment/ Vacancies
South-East	308.5	4.1	61.0	5.1
East Anglia	33.6	5.0	4.7	7.1
South West	97.6	6.3	10.7	9.1
West Midlands	127.1	5.6	10.3	12.3
East Midlands	74.2	4.9	8.6	8.6
Yorks & Humberside	115.8	5.7	11.6	10.0
North West	199.1	7.1	12.2	16.3
North	104.7	8.1	9.5	11.0
Wales	73.8	7.2	6.1	12.1
Strathclyde	85.3	7.9	9.4	9.1
Rest of Scotland	58.8	5.3	8.6	6.8
Scotland	144.1	6.7	18.0	8.0

TABLE 2 Unemployment in the Scottish Regions

	Unemployment (Thousands)		% Change (Mar-June)	Unemployment Rate June 1976
	March 1976	June 1976		
Highland	4.6	3.9	-16	5.9
Shetland	0.3	0.2	-29	3.5
Orkney	0.2	0.2	-9	3.4
Western Isles	1.3	1.1	-13	14.5
Grampian	6.1	5.4	-11	3.3
Tayside	10.8	10.5	-3	6.3
Fife	8.0	8.1	+1	6.4
Strathclyde	83.4	85.3	+2	7.9
Lothians	18.2	17.9	-2	5.5
Central	6.9	6.6	-5	6.1
Dumfries & Galloway	3.9	3.7	-5	7.4
Borders	1.5	1.4	-6	3.7
Scotland	145.1	144.1	-1	6.7

Source: *Department of Employment*

TABLE 3 Earnings by Local Authority Region in Scotland⁺

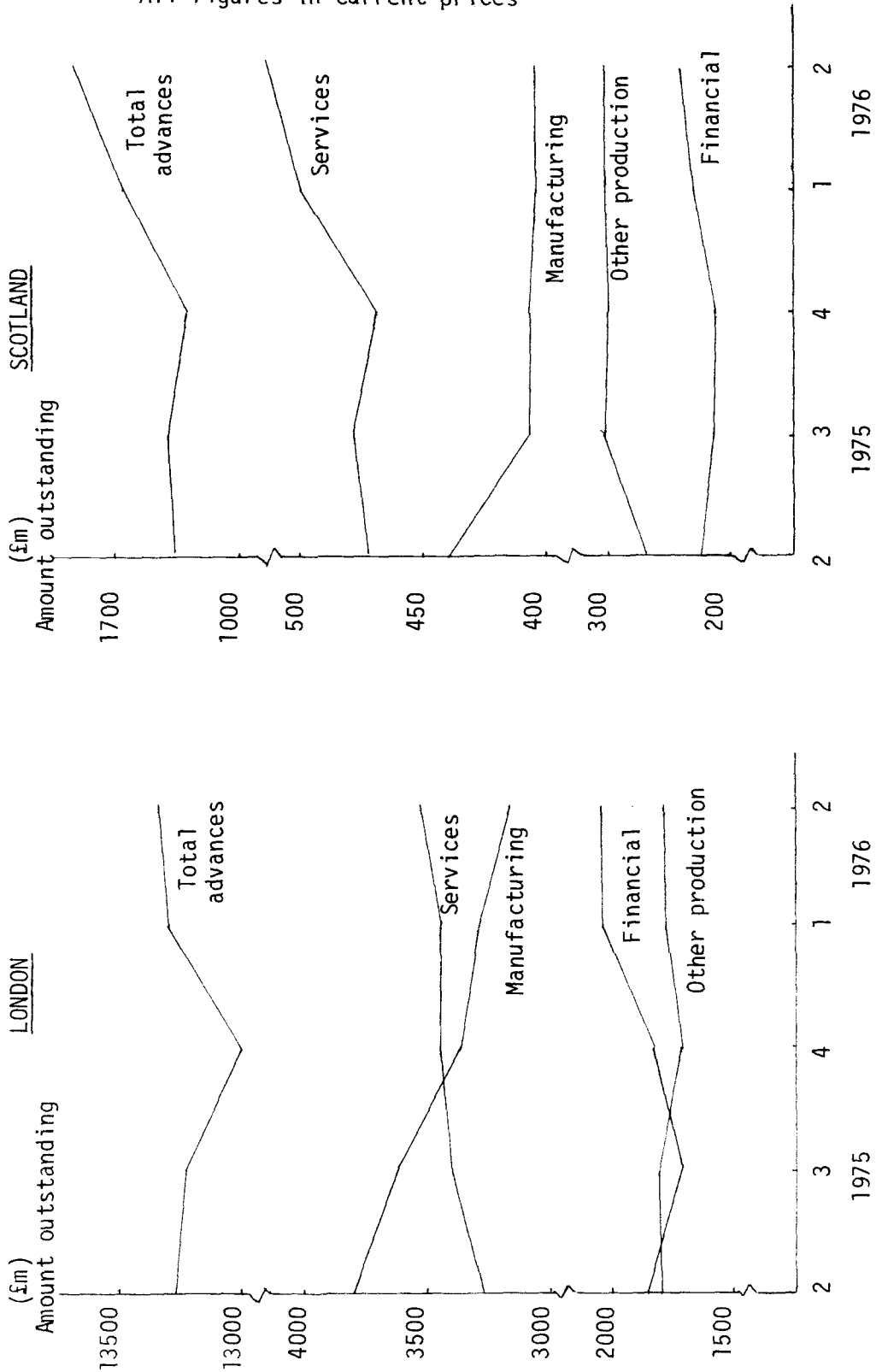
REGION	Average Gross Weekly Earnings (£)					
	Men (over 21)			Women (over 18)		
	All	Manual	Non-Manual	All	Manual	Non-Manual
Central	60.9	56.9	∅	∅	∅	∅
Dumfries & Galloway	49.9*	46.9	∅	∅	∅	∅
Fife	61.9	59.7	66.9*	36.2*	∅	∅
Grampian	60.1	56.1	∅	37.4*	∅	∅
Highland	65.3*	∅	∅	∅	∅	∅
Lothian	59.7	55.4	65.4	35.1	31.6*	36.3
Strathclyde	61.6	58.4	67.6	35.9	32.8	37.6
Tayside	56.6*	48.4	∅	36.6	∅	∅
Borders	∅	44.7*	∅	∅	∅	∅
Scotland	60.3	56.7	67.1	35.9	32.1	37.8
Great Britain	60.8	55.7	68.4	37.4	32.1	39.6

∅ *No figure available because sample too small*

* *Standard error greater than 2%*

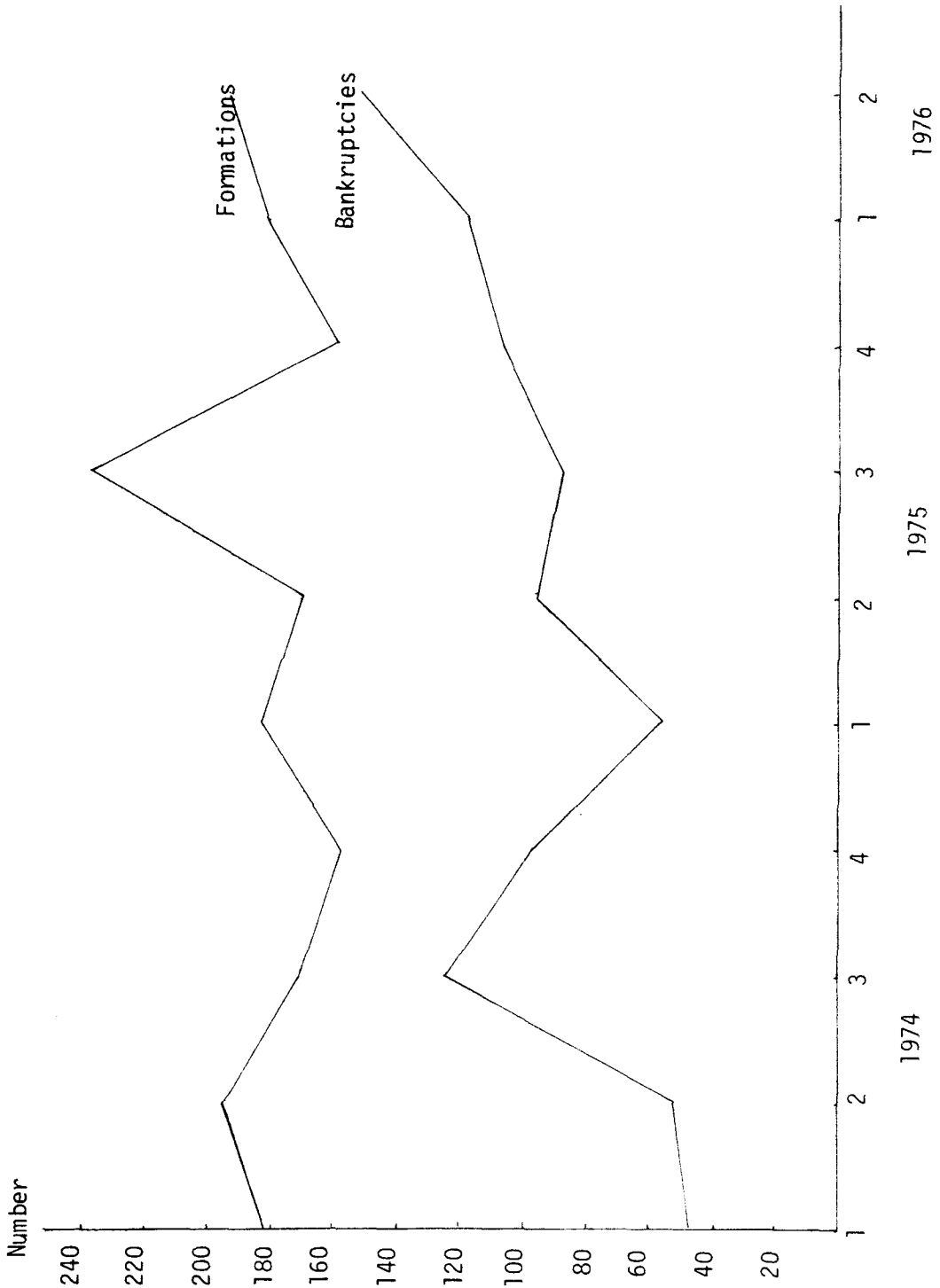
+ *New Earnings Survey Part E Tables 108 - 113*

FIGURE 5 Bank Advances - Amount Outstanding *
 * All figures in current prices



Source: Bank of England Quarterly Bulletin

FIGURE 6 Company Formations and Bankruptcies in Scotland



Source: *The Registrar of Companies*

FIGURE 7 Unemployment rates in Strathclyde, Lothians, Central and Scotland (January 1968 - June 1976)

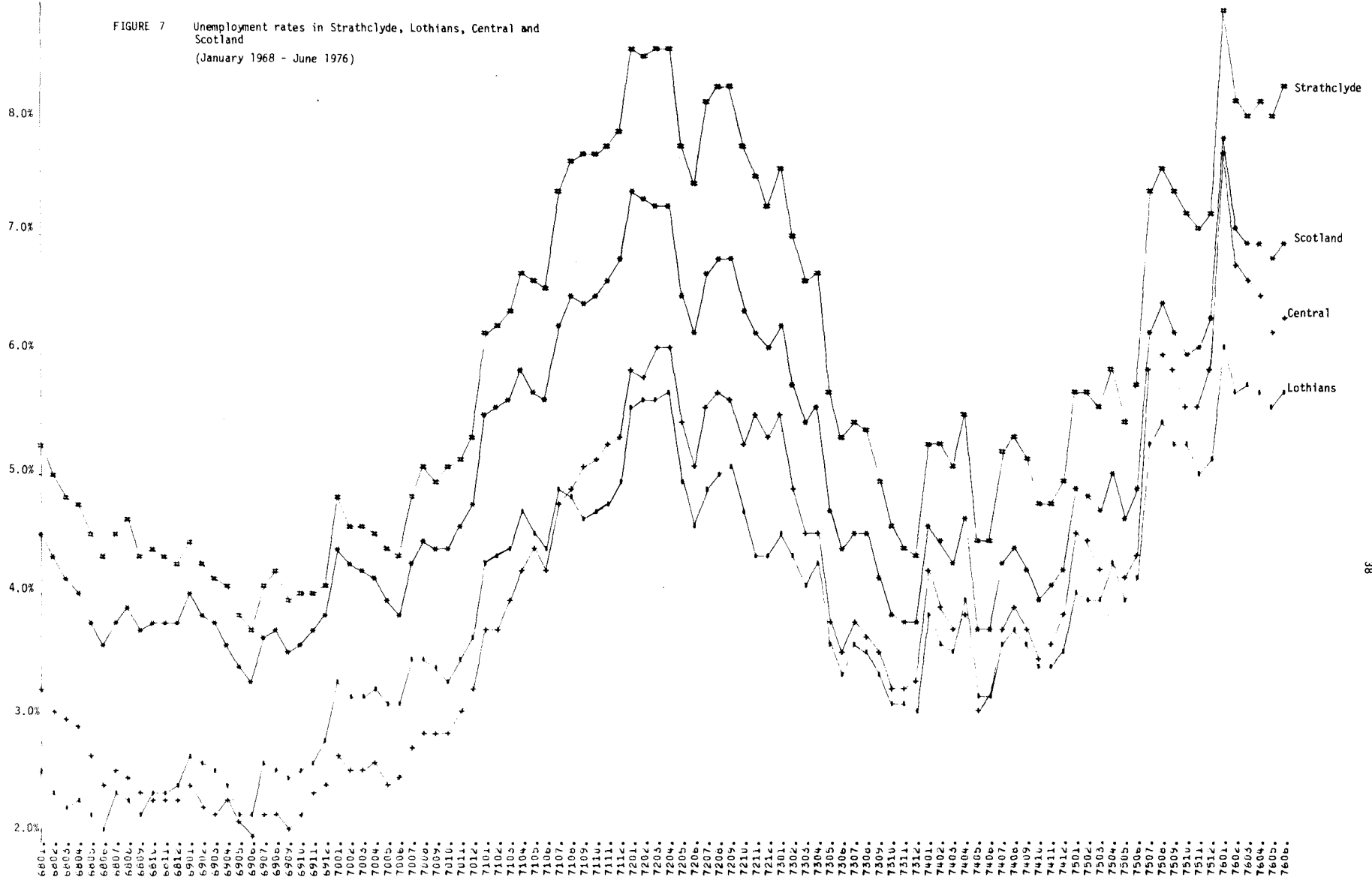


FIGURE 8 Unemployment rates in Highland Region, Shetland, Orkney and Scotland
(January 1968 - June 1976)

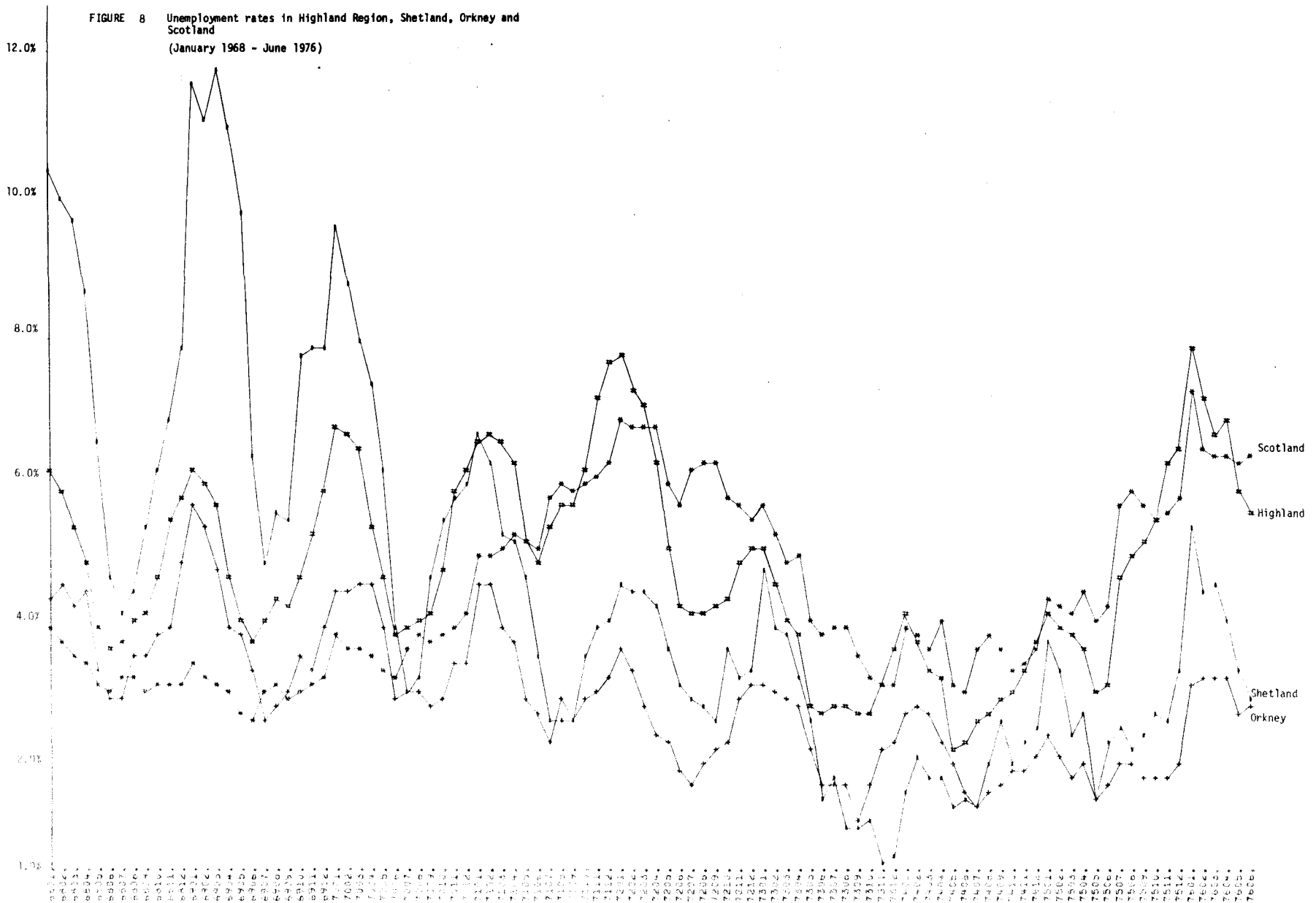


FIGURE 9 Unemployment rates in Grampian, Tayside, Fife and Scotland
(January 1968 - June 1976)

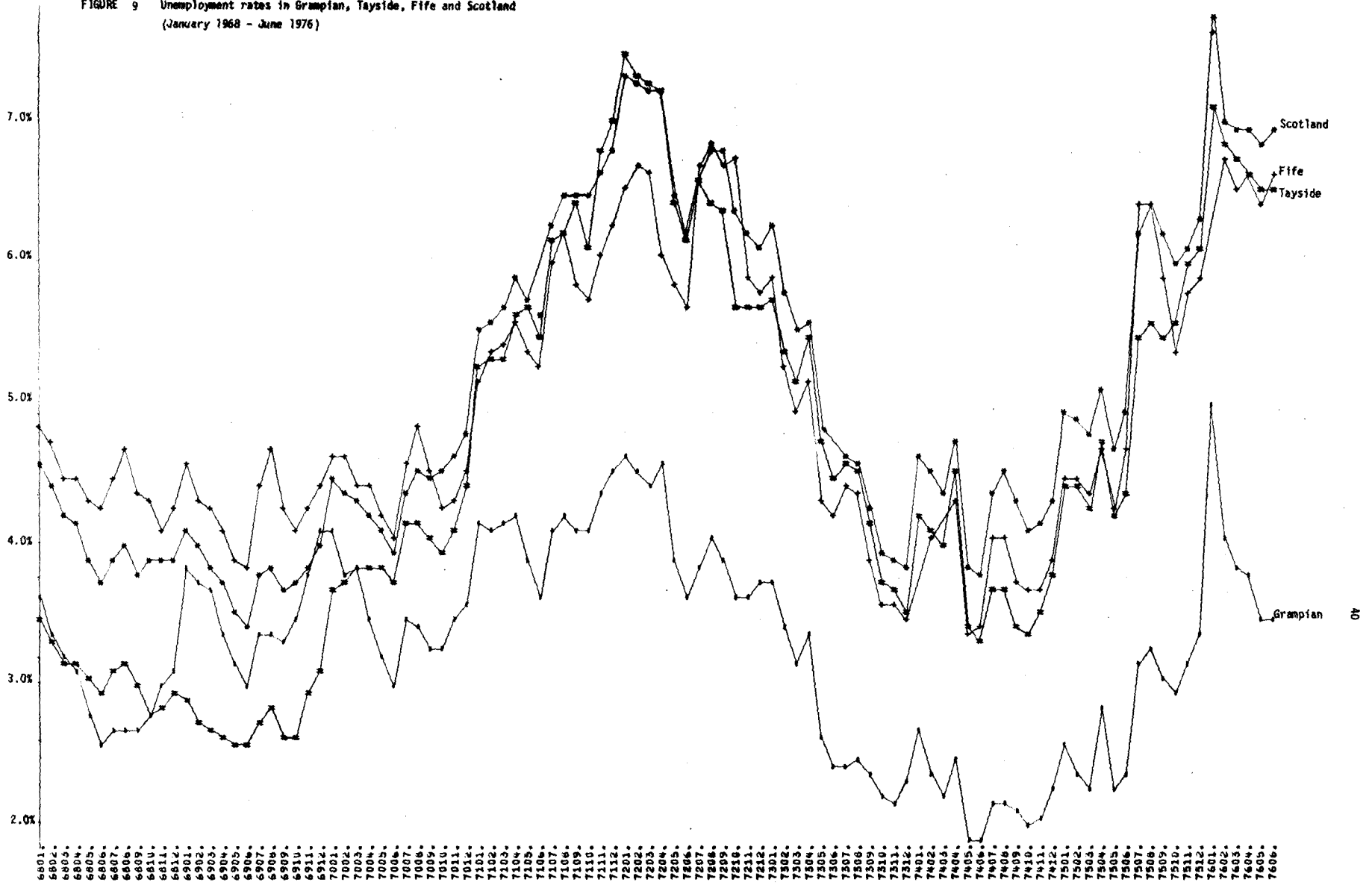


FIGURE 10 Unemployment rates in Western Isles and Scotland
(January 1968 - June 1976)

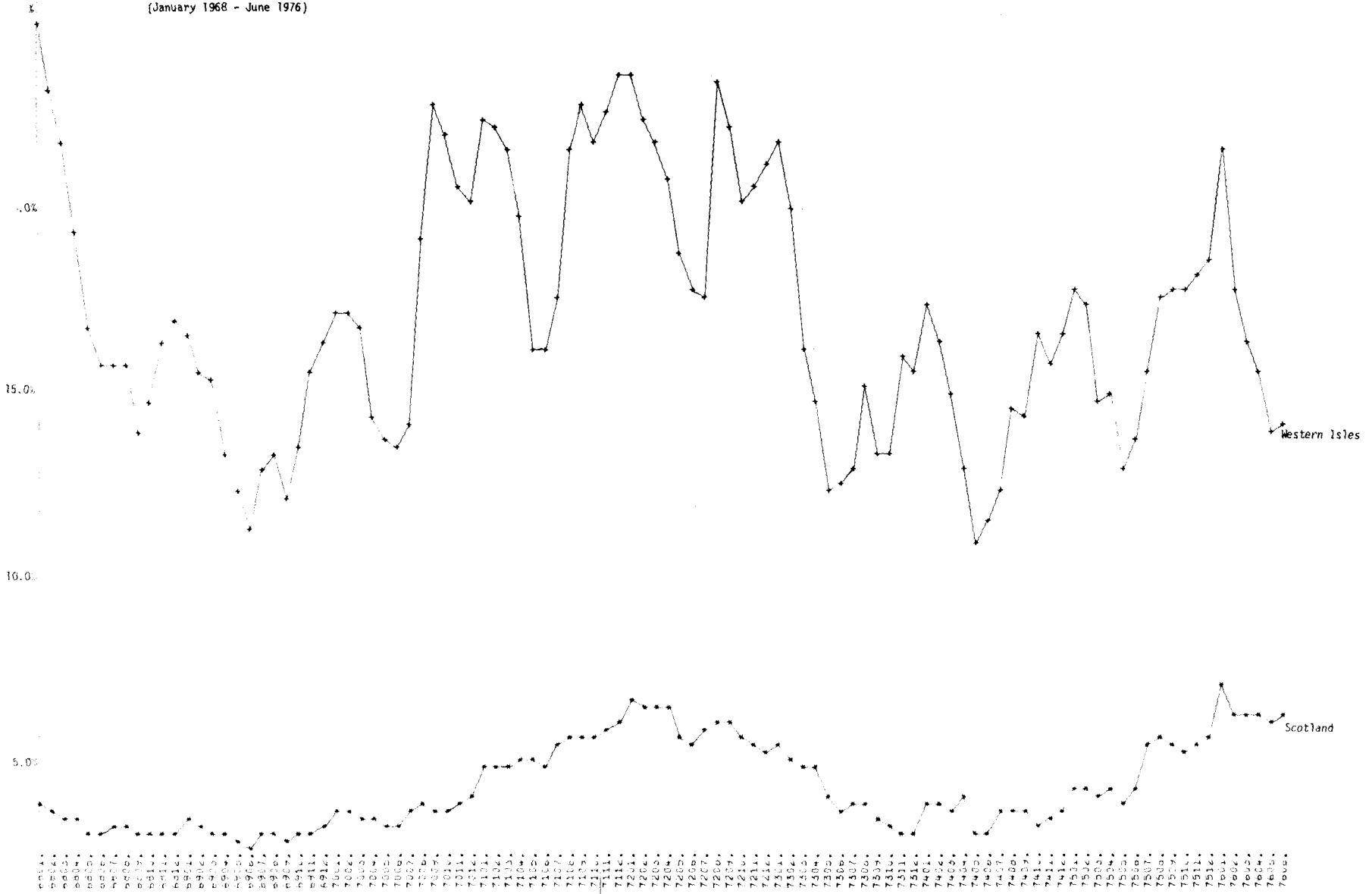


FIGURE 11 Unemployment rates in Dumfries & Galloway, Borders and Scotland
(January 1968 - June 1976)

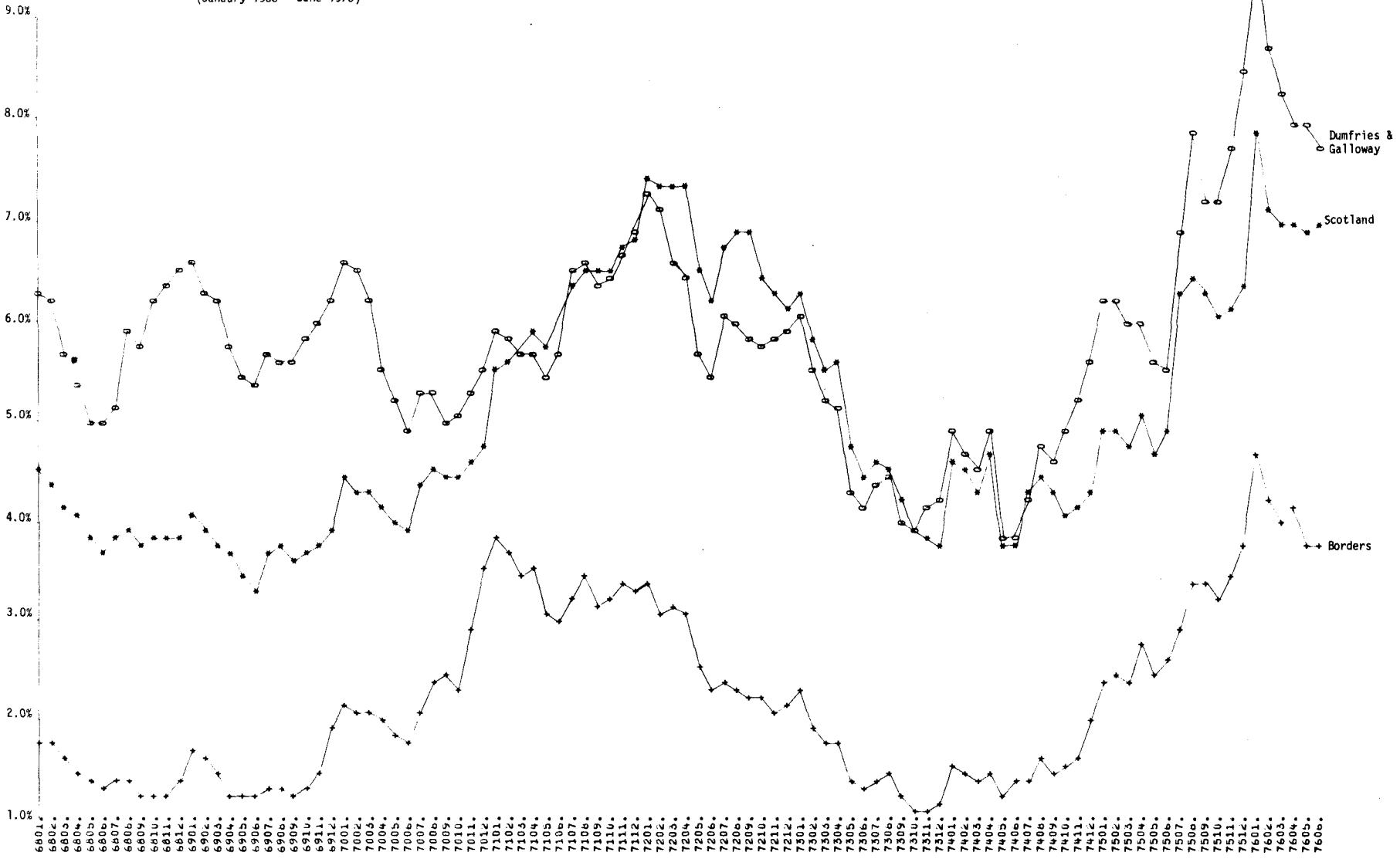
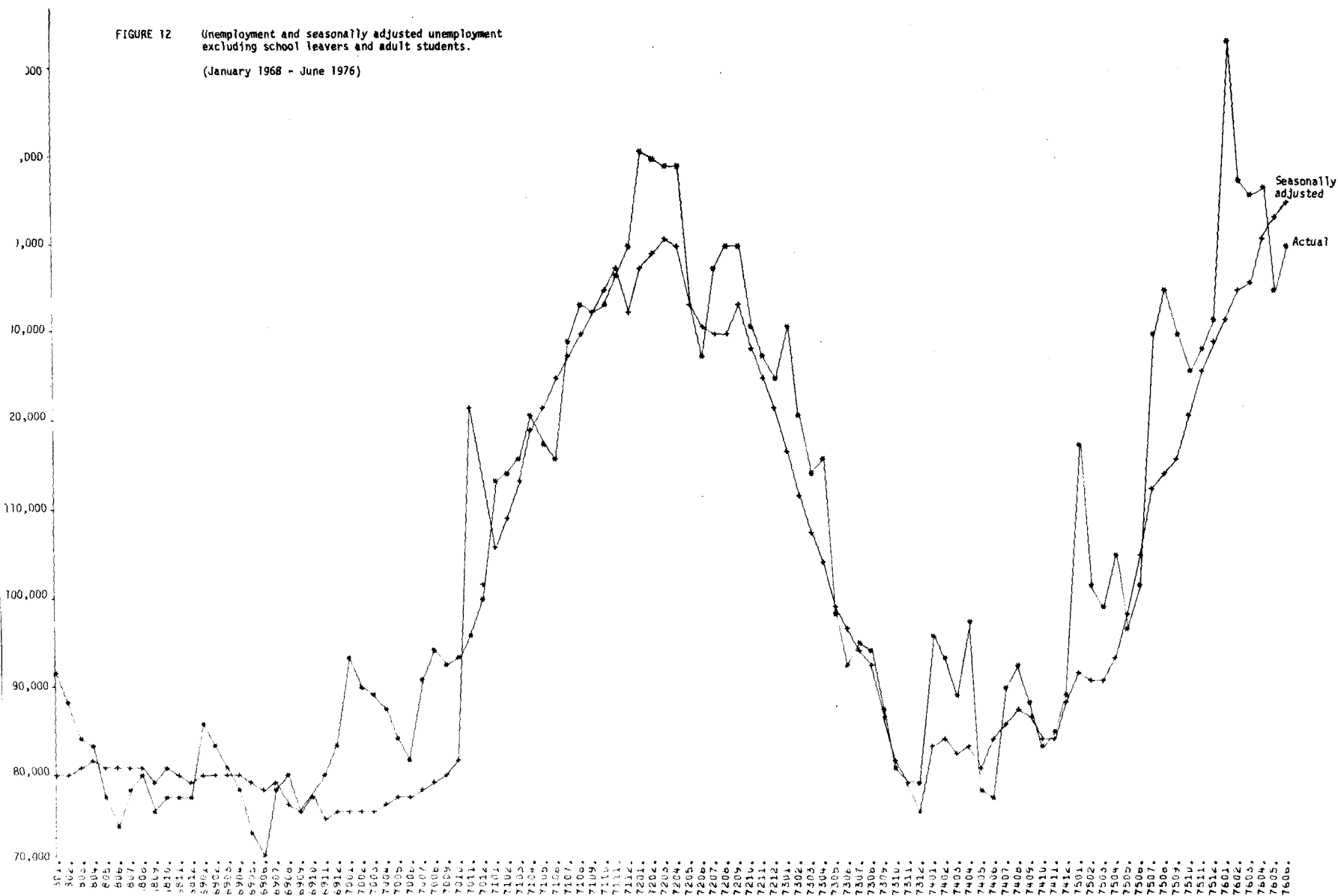


FIGURE 12 Unemployment and seasonally adjusted unemployment excluding school leavers and adult students. (January 1968 - June 1976)



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