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A STUDY OF THE IMPACT OF THE UNIVERSITY OF STIRLING ON THE LOCAL ECONOMY

by

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UNIVERSITY OF STIRLING 1971.

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STATISTICAL APPENDICES

CHAPTER 1

Introduction

The effect on the local economy of the establishment of a new University at Stirling will be equivalent to the introduction of a major new industry to the region. Given the nature of the employment offered by the new University, it is likely that there will occur a significant wave of immigration to the area. Since the growth and development of the University will have considerable repercussions on the local employment situation and on population, it is therefore necessary to provide, for practical planning purposes, a series of detailed estimates of these repercussions. With the University taking the nature of a catalyst in this situation, the main objective of the thesis is to analyse and attempt to quantify the economic effects of its development on the local economy. Equally, however, during the period of University expansion, there will be further growth from the continuing development of the local economy in its own right; the second main objective of the thesis must therefore be to study the various internal aspects of the local economy and provide from this further estimates of its growth or decline during the period. It is only by amalgamating the forecasts of both the internal and the University sources of development over the period, that final estimates can be made of the overall situation in the local economy. The provisions of these estimates should be of some interest and assistance to Local Authorities in their planning decisions for future provision of housing, schools, hospitals, roadworks etc, as well as their allocation of space for private industrial development in the area.

The Study Area chosen as the economic base for the analysis of both internal/...

internal growth and University impact consists of the whole of the County of Clackmannan, of the burghs of Stirling and Bridge of Allan and the landward district of Central No. 1 D.C.[1] in the County of Stirling, and of the small burghs of Doune and Dunblane in the County of Perth; this area represented a population base of about 95,600 and provided, within its boundaries, employment for about 37,500 persons, at the commencement of work on the new University. The delineation of the area was based partly on the University Development Plan estimates of the "journey to work" pattern[2] and partly on the pattern of residence of students and staff up to the academic year 1970/71. While some staff and students commute from outside the boundaries of the Study Area, these, as yet, do not represent a significant proportion of the total; where commuting of this nature is, however, likely to have some effect on the estimates made of University impact or internal growth, adjustments have been made for this. On the other hand, no attempt has been made to assess the effect of Study Area development forces on surrounding areas such as Falkirk, Denny or Callander, on the grounds that such an influence is unlikely to be of any real economic significance to them.

The dates chosen as focal points for the analysis, namely 1966, 1976 and 1981 are all related to the development of the University. The first year, 1966, represents the final year before the commencement of any type of work on the University, although the decision to site this at Stirling had been announced in July 1964; effectively, it was the last year in which there were no direct influences on the local economy which could be attributed to the University. The second year, 1976, represents the end of the first/...

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1. The landward district of Central No. 1 D.C. covers, broadly the area from Cowie and Plean in the East to Cambusbarron and Gargunnock in the West.
2. Interim Development Plan, 1966, paragraph 10.13 and figure 10.4.

of the first main development phase to an equilibrium position, in this case the steady-state size of about 3,000 undergraduate students; since further growth is anticipated, this year also provides a point in the course of the development of the University at which the economic effects of the expansion can be studied. The third year, 1981, represents the achievement of the larger equilibrium or steady-state size of about 6,000 undergraduate students; given the Robbins' forecast of increased demand for University places,[3] it was felt possible that the University might need to expand to this size by the early 1980's.

The structure of the thesis is governed by its two main objectives. Part I of the thesis, covering Chapters 1 to 4, inclusive, analyses the various internal aspects of the economy of the Study Area and, on the basis of this, provides projections for population and employment stemming from internal, as opposed to University, forces. Part II, on the other hand, analyses the growth forces of the development of the University and estimates its possible effects on local income, employment and population. In addition, it amalgamates the two sets of estimates, for internal and University growth, and comments on the implications of these for the Study Area.

To provide the data and knowledge of the population and employment situation in the Study Area from which the projections to 1976 and 1981 can be made, the current situation and recent trends in these aspects of the local economy must be analysed. In Chapter 2, the population characteristics of the Study Area for the period preceding 1966 are examined, as these are reflected in the total size of the population, its age and sex structure, geographical distribution, rate of increase, and tendencies towards migration. In Chapter 3, the industrial and employ-

ment structure/...

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3. Report on Higher Education, 1963, CMND 2154, Appendix 1.

structure of the Study Area is examined, with an analysis made of the effects of changes in the employment pattern on the balance of male and female employment and on the type and severity of unemployment experienced over the period in the local labour market. Finally in Part I, Chapter 4 contains the development of the projection models for internal growth in population and employment; from the data provided by the previous chapters and other relevant sources, the models are used to project population and employment for the Study Area to 1976 and 1981.

The development of the University will affect many aspects of life in the Study Area but only the main economic aspects of its impact on income, employment and population will be examined; while other sociological, political and cultural consequences are undoubtedly important, they fall outside the scope of this research. In Part II of the thesis, firstly the existing estimates[4] which have been made of the effects of the University on the local area are gathered together and summarised. Secondly, an alternative series of estimates are provided, based on the economic analysis of the income generated directly and indirectly by the University, its staff and students. Thirdly, the estimates for internal growth in the Study Area, as contained in Chapter 4, are amalgamated to the estimates of employment and population impact from the University, to provide overall projected figures for these for 1976 and 1981. Chapter 5, therefore, summarises the existing estimates of population and employment impact. In Chapter 6, the current literature on the regional income multiplier is examined and, from this, a model developed to analyse the income impact of the University on the Study Area's economy. In Chapter 7, the various terms in the model are quantified and the model used to estimate the income generated by the University for 1976 and 1981. Using/...

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4. These estimates were based largely on physical planning considerations.

Using this data and a modified employment multiplier model, further estimates are made of the indirect employment generated by the University in the supporting local service industries; having then estimated total employment attributable to the University, these figures are then amalgamated with the estimates for internal growth and the resulting overall employment pattern discussed. Finally, in Chapter 8, the estimated numbers of students, staff and indirect employees are analysed and the immigrant component of these established; further calculations are then made of the adult and child dependents of these immigrants to provide estimated figures for the additional population stemming from University development by 1976 and 1981. As with employment, the University estimates for population are amalgamated to the internal projections to provide figures of overall total population and its possible age and sex structure for these years.

Throughout, the conclusions are summarised at the end of each chapter with, in Chapter 9, the main conclusions gathered together so that their implications for planning in the Study Area can be considered. Then, having analysed both internal and University growth forces and the possible resulting situation in population and employment, the chapter contains a discussion of the use of the approach developed in this thesis for similar studies elsewhere, drawing attention to some of the problems which will be encountered in its use.

The theoretical contribution of the thesis lies in Chapter 6, where an attempt is made to develop the conventional regional income multiplier model by a reformulation of the multiplicand and a restatement of some of the functional relationships, to bring into the model some of the main suggestions made by other writers on the subject. Secondly, it is argued that, for practical purposes, the model should be developed for and applied to an economic base which is not the conventional standard region/...

region, but the relevant sub-region of this.

The factual contribution of the thesis has two aspects. Firstly, it gathers and publishes for the first time a great deal of local statistical information on past and current population, industrial and employment patterns. Secondly, it provides an alternative and detailed set of estimates for the impact of the University on the local economy and, by amalgamating these with projected figures for internal growth, allows some statistical analysis of the possible overall situation in the future in the Study Area.

CHAPTER 2

Population

This chapter examines the various trends in the population of the Study Area over the period 1951-66. This latter year represents not only a convenient Census date, but was also the year in which the opening of the University in 1967 was announced; effectively it was the last year in which no influence could be attributed to the University. The period 1951-66 has been chosen, partly because it is of sufficient duration to allow analysis of the main trends and partly because it allows a direct comparison between the full Census returns of 1951 and 1961, and the Sample Census of 1966.

Structurally, the chapter falls into two sections. Firstly, there is an examination of the size of the population of the Study Area, its geographical distribution within the area, its patterns of growth and decline, its age structure and sex balance. Secondly, a more analytical attempt is made to explain the changes in the overall size and age structure of the population by an examination of the migration flows which have taken place over the period, and examine their effect on the age structure of the population.

The Population of the Study Area

Taking the Census figures for 1951 and 1961 and the figures of the Registrar General for Scotland for 1966[1] it was estimated that the total population of the Study Area rose from 88,267 persons in 1951 to 92,800 persons/...

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1. The Annual Report for 1966 has been adjusted by the Registrar to bring the estimates into line with the Sample Census figures for that year.

persons in 1961 and 95,577 persons in June 1966; this represents an increase of 8.2% over the period as against the 1.9% increase in the total population of Scotland over the same period. Breaking these figures down into intercensal changes, the Study Area population increased by 5.1% or by 4,533 persons between 1951-61, against the Scottish increase of 1.6%, and by 3.0% or 2,777 over the period 1961-66 as against the Scottish increase of 0.2%. This would seem to indicate that the Study Area's population has risen consistently at a much higher rate than for Scotland as a whole, a trend which is confirmed from an examination of inter-war year Census returns.[2] Secondly, the figures suggest that the rate of population growth in the Study Area accelerated slightly over the first six years of the 1960's, in comparison to Scotland where it slowed down markedly.

The geographical distribution of the population within the boundaries of the Study Area is shown in table 2.1. The two main urban centres of Stirling and Alloa accounted for 40,672, or 46.1% of the total population at the beginning of the period and 42,061 persons, or 44.0% of the total population at the end of the period. The next two largest concentrations of population were the rural Districts of County of Allca D.C. and Central No. 1 D.C., which between them accounted for a further 27,937 persons, or 31.7% of the total population in 1951 and 32,000 persons, or 33.9% of the total population in 1966. The remaining 20% of the population of the Study Area was distributed over the small burghs of Alva, Dollar, Tillicoultry, Doune, Dunblane and Bridge of Allan, and the small rural Hillfoots D.C.[3]

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2. From 1931 to the present there has been an increase of 22.9% as against 7.2% for Scotland; for the Study Area, over the period, the rate of population growth has been greater than for the East Central region as a whole.

3. The populations for Dollar and Bridge of Allan have been stated throughout as net of the resident students of Dollar Academy and the Beacon school for girls. From Census figures there were 226 of these at Dollar and 31 at Bridge of Allan in 1966; the 1951 Census was during vacation when there were no students.

This distribution indicates a fairly rural type of area, which is confirmed if the various Census returns are used to calculate population density per acre. The figures of about 12 persons per acre for Alloa and about 10 persons per acre for Stirling are completely offset by the large rural Districts of County, where the most heavily populated, Alloa D.C., has only 1.1 persons per acre, Central No. 1, 0.4 per acre and the Hillfoots 0.2 per acre. Overall, the population density for the Study Area over the period has been steady at 1.1 persons per acre.

Over the period almost all parts of the Study Area have increased in terms of population. The largest single increase was of 3,823 persons for Alloa D.C. This was almost entirely caused over the early 1950's by the influx of miners from the North Lanarkshire coal fields to the mines of the new Alloa area.[4] This same influx can be traced in the population increases for Stirling, Alloa and Tillicoultry. While the main population increases over the period 1951-61 can be explained in terms of this single immigration source, the population increases over the period 1961-66 were of a rather different nature. During this later period, immigration appears to have been associated with a wave of housing development, mainly for owner-occupiers, this being concentrated around Stirling, Alloa, Dollar, Tillicoultry, Bridge of Allan and Dunblane. This particular phase of development of the area appears to have taken the nature of a commuter belt residential zone for Glasgow, Edinburgh, Falkirk and Grangemouth.[5] However, taking the period as a whole, the various changes in population over the period have had little more than a marginal effect on its geographical distribution within the boundaries of the Study Area.

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4. 9 new mines were opened here from 1951 to 1956; however, 4 old mines closed over the same period, followed by 6 more in the early 1960's. By 1963, not a single pit in Clackmannan County was producing coal; even Glenochil, the major new colliery had been closed - Third Statistical Account of Scotland, Stirling and Clackmannan, pp 433-50.

5. Based on information given by builders to the planning officers of the various burghs in the area.

The various aspects of the age structure of the Study Area are covered in tables 2.2 to 2.5. The initial analysis takes the form of comparison in broad summary age groups with Scotland, for 1951 and 1961.[6] The figures indicate that there was a broad similarity in age structure between the Study Area and Scotland; for both Census years, the former had a slightly larger proportion of its population in the 0-14 year group and slightly less in the 15-64 and "65 and over" groups. Again, there was a broad similarity in intercensal changes over the period. Both the Study Area and Scotland experienced an increase in the relative size of the dependent groups of 0-14 and "65 and over" at the expense of the working population group of 15-64.

However, this form of summary table does not provide any clear idea of whether the population of the Study Area is relatively younger than the Scottish pattern or not. This can be checked quickly by the calculation of an age index[7] for the Study Area. In table 2.3 the age indices for the Study Area and Scotland are given for the three Census returns and, for all of these, the Study Area has a lower index than the Scottish one. Further, the index figures over the period indicate that the Study Area was ageing less rapidly over the period, although the final figures for 1966 must be treated with some reservation in view of the sample nature of the Census of that year.

Figure 2.4 provides a more detailed comparison of the two age structures for 1961.[6] This confirms the earlier measures that the population of the Study Area was relatively younger than the national pattern; it shows that the Study Area had relatively more of its population in most of the five year/...

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6. The 1966 Sample Census data has not been published for much of the Study Area; the main population centre data which has been published and the unpublished data available for inspection at the Census office is not given in sufficient detail to allow its use in this section.

7. The age index is the percentage of persons in the population aged 45 and over.

of the five year age groups up to 44 years of age.

Within the Study Area, as can be expected, there were considerable variations in the age structure of the various burghs and districts of county. The age index varied from declining areas, such as Doune (47.6%), or other retiral catchment areas such as Bridge of Allan (43.4%) and Dollar (39.5%), to, at the other extreme, the rural areas such as Alloa D.C.[8] (27.2%) and Central No. 1 D.C. (28.3%). Again, using the age index, the effects of the 1961-66 commuter influx can be traced clearly in places like Dunblane (47.4% to 34.6% over the period), Tillicoultry (33.7% to 27.4%) and, to a lesser extent, Dollar (39.5% to 37.0%).

Finally, in the examination of the age structure of the Study Area and its trends over recent years, in table 2.5 the intercensal changes from 1951-61[6] are examined by five year age group and sex. This shows that there was an increase of 2,512 males overall, due mainly to increases in the age ranges 5-19 and 45-64, with increases of 1,770 and 1,584 respectively. Again, there was an overall increase of 2,053 females over the period, concentrated mainly in the same age ranges, with 1,245 for the 5-19 and 1,354 for the 45-64 year old age range. The figures show that this was offset by a significant net loss of population in the age range 20-44 of 830 males and 1,152 females; this would appear to indicate an outward migration flow over these age groups, which is typical of the Scottish pattern.

In both Census years, for all five year age groups from 20 years of age onwards, there were more females than males. For the age range above 60 years/...

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8. This figure, to some extent, has been helped by the inflow from North Lanarkshire; as can be seen more clearly from table 2.5, these appear to have been rather older than is normally the case for migrants and have brought in completed families, which has tended to be reflected in the index.

60 years of age, this is consistent with the effect of heavier male mortality rates over this range, particularly in an area where there appeared to be a steady stream of immigrants for retiral to the area. Over the 20-59 age range, this was probably due not so much to differing mortality rates as the wide nature of female employment in the Study Area[9] in both manufacturing and service industries.

Migration Patterns in the Study Area

The earlier section of the chapter showed that the population of the Study Area increased steadily over both intercensal periods at a rate significantly greater than for Scotland as a whole and that, indeed, there was some evidence that the rate of population increase had risen over the 1961-66 period. This difference in the behaviour of population growth between the Study Area and Scotland could have been caused by differences in birth and death rates or by differences in migration patterns. This section of the chapter examines natural increase and migration behaviour in more detail.

Comparison of birth and death rates[10] for any given year is not satisfactory, particularly where one of the areas is relatively small, like the Study Area. The approach taken here has been to average the rates over the two intercensal periods. The average birth rate for the Study Area over 1951-61 was 18.8 as against the Scottish average rate of 18.4, but, for 1961-66, the Scottish rate of 19.7 was higher than the Study Area rate of 19.3. On the other hand, the average death rate for both periods was lower in the Study Area, 11.3 as against the Scottish rate of 11.9 for 1951-61 and 11.4 as against 12.2 for 1961-66. Given that there/...

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9. See the analysis of employment in Chapter 3.

10. These rates are per 1,000 of population, corrected for usual residence Annual Reports of the Registrar General for Scotland, years 1951-7, tables 5 and 6; 1958 onwards, table 7.

there was no significant difference in birth rates and only a slightly lower death rate in the Study Area, there has been nothing in the rate of natural increase to provide an explanation for the differences in the rate of population growth.

While there was little difference between the rates of the Study Area as a whole and Scotland, there were considerable, if predictable, differences between sections of the Study Area and also between the two time periods in some sections. The older, declining or retiral type of burgh, such as Doune, Dunblane, Dollar and Bridge of Allan, all showed much lower birth rates than the Study Area average, being in the 13.0 to 17.0 range. However, the effects of the population influx of 1961-66 showed up clearly with, in particular, the intercensal average birth rate rising from 13.1 to 25.0 in Dunblane and 15.4 to 20.4 in Bridge of Allan. Death rates, on the other hand, varied rather less both between sections and over time.

To revert to the differing rates of population growth, the explanation for these was obviously to be found in differing patterns of migration. The method used to estimate the direction and volume of the net migration flows was the conventional one of contrasting the natural increase (excess of births over deaths for the period) to the actual increase (the intercensal change).[11] From this, it was estimated[12] that the Study Area suffered a net migration loss of about 2,700 persons, or 3.0% of its 1951 population over the period 1951-61 and about 900 persons, or 1.0% of its 1961 population over the period 1961-66. In comparison, Scotland had a net migration loss of 5.0% of its population for 1951-61 and 3.6% for 1961-66. These figures confirm that the different rates of population/...

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11. See Statistical Appendix 2.1 for discussion of the method, the statistics used and the detailed estimates for the Study Area.

12. See table 2.6.

of population growth were attributable to the patterns of emigration. Firstly, the Study Area suffered a considerably smaller rate of net migration loss in both intercensal periods and, secondly, the rate of migration loss for 1961-66 declined in the Study Area whereas it increased for Scotland as a whole, so that the rates of population increase for this period were 3.0% and 0.2% respectively.

A more detailed examination of the migration patterns for the component parts of the Study Area[13] shows that the lower net loss figure for the Study Area over 1951-61 was due largely to the influx of miners to Alloa D.C.; for the 1961-66 period, the lower net loss was the result of a wave of settlement around Tillicoultry, Dollar, Dunblane, and Bridge of Allan. For both periods, the urban centres of Alloa and Stirling suffered the heavier type of net loss of the Scottish pattern, losing 2,000 persons in the earlier period and 1,200 persons for 1961-66,[14] despite the residential developments within their boundaries.

Having estimated the direction and size of the net migration flows, the final step is to analyse the effect of this on the age structure of the population of the Study Area. The method used was again a fairly simple one,[15] and similar to the approach used earlier to estimate the net flow. Taking, at the beginning of a period, the age structure of the population from the Census report, births were added and deaths deducted on an annual basis, with the survivors aged over the period. This had the effect of adding/...

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13. See Statistical Appendix 2.1, tables (a) and (b) and also table 2.1 to this chapter.

14. The heaviest migration loss in both periods was in the rural Central No. 1 D.C., with 10% or 1,600 persons for the 1951-61 and 6% or 1,000 persons for 1961-66.

15. The model is based on one developed by B M Swift for the University of Glasgow study of the Lothians. See Statistical Appendix 2.2 for discussion of the model, the statistics used and the detailed estimates for the Study Area.

adding the natural increase over the period, by age group, to the base population to provide an estimated population which would have resulted if no migration of any kind had taken place. This estimated population was then compared to the actual population, as given by the Census report for the end of the period and net migration loss or gain calculated for each age group.

The calculations made[16] indicate that, over the period 1951-61, there was a heavy net loss of population over the age range 15-44 of about 3,000 persons, mainly concentrated on the 15-34 section of the range; this would be a fairly typical age pattern for migrants and the loss of their child dependents would provide some explanation for the net loss of about 700 in the 5-9 age group. Heavy losses in these age groups were experienced by all parts of the Study Area. To offset the losses, there was a smaller net gain of about 350[17] persons in the age range 45-64: geographically, this inflow was concentrated on the areas receiving the inflow of miners, who seem to have been spread over the range 35-54; the rest of the net inflow was spread over the "retirement" areas. The main compensating net inflow for the period was in the 0-14 age range, the largest part of which was probably the child dependents brought into the area by the older immigration inflow. The estimated net loss of population for the "65 and over" group was probably due in part to the assumptions made[18] about the age distribution of mortality rates, as well as the continuation of the net loss trend observed in rural districts for the 45-64 group.[17]

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16. See tables 2.6 and 2.7 with Statistical Appendix 2.2 tables (a) and (b).

17. In fact, the net gain was rather greater than this, if computed from the smaller burghs and Alloa D.C.; it was reduced by very heavy outflows from the rural D.C.'s, particularly Central No. 1, which might reflect the pattern of redundancies in the agricultural run-down over this period (based on conversation with D.E.P. officials).

18. See Statistical Appendix 2.2.

The estimates of the effect of migration for the 1961-66 period are further complicated by the fact that the 1966 Census was based on a 10% sample, which created difficulties in estimating the appropriate population parameters from which the migration flows could be deduced.[18] However, it would seem that, over the period, there was a net loss through emigration of over 1,000 persons[19] in the age range 15-44, this loss being concentrated on Alloa D.C., Stirling, and Central No. 1 D.C.[20] There is some evidence that the loss which would normally be expected in this age range was augmented by the series of mining closures in the area.[21] There was also a loss of about 400 persons in the "45 and over" age range, but this is not significant statistically. There was no real gain or loss in the 0-14 age group. Again the more detailed analysis[19] supports earlier discussion by showing that the gains over the period were in Dollar, Dunblane and Bridge of Allan mainly; this time, however, they were clearly in the "under 45" groups, indicating a commuter type of residential development rather than immigration to retirement, although this latter source of inflow was still in evidence.

Overall, the estimates of the effect of migration on the age structure of the Study Area provide some evidence that the migration pattern in both periods has been one of a two way flow. To offset the normal Scottish pattern of loss in the "under 40" range, there has been an immigration inflow over the period. While there is no clear-cut method of estimating the gross flows which have occurred, it would seem that the inflow experienced in the Study Area was of persons in relatively older/...

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19. See table 2.8.

20. The net outflows for these districts all lie outside the range of standard error at a 95% level of confidence.

21. D.E.P. records indicate heavy unemployment in mining, which were relieved more by "considerably emigration" to the Yorkshire and other coalfields than re-employment in the area or in its surrounding coalfields. This would affect the migration patterns for Alloa D.C., Stirling and Alloa.

older age groups than those hit by emigration, and their child dependents. This was particularly true of the 1951-61 period. Secondly, the falling rate of net loss of population for 1961-66 would seem to have been caused by an increased inflow to the smaller residential burghs; the model's estimates indicate that this inflow was, on average 10-15 years younger than the inflow recorded for the previous period.

In conclusion, the various aspects of the population of the Study Area which have been analysed in this chapter have shown that the rate of population increase in the Study Area has consistently exceeded the rate for Scotland as a whole. Overall, the population of the Study Area was marginally younger than the Scottish pattern, although this appears to have had little effect on relative birth rates; while the death rate in the Study Area was slightly lower, this could reflect, in addition to the younger nature of the population, the predominately rural nature of the area. Despite the higher rate of population increase, there was a heavy loss over the period of younger persons from the Study Area. Finally, to offset emigration losses from the Study Area, there has been, over the period, a significant inflow of older persons, recently augmented by the considerable house construction development in the area.

Table 2.1

Distribution of Population within the Study Area, 1951 and 1966

Clackmannan	1951 Persons	%	1966 Persons	%	Change 1951-66 Persons
Alloa	13,521	15.3	14,046	14.7	+ 525
Alva	4,106	4.6	3,996	4.2	- 110
Dollar	1,389	1.6	1,943	2.0	+ 554
Tillicoultry	3,876	4.4	4,082	4.3	+ 206
Alloa D.C.	11,377	12.9	15,200	15.9	+3,823
Hillfoots D.C.	3,263	3.7	3,050	3.2	- 213
Perth					
Doune	834	0.9	776	0.8	- 58
Dunblane	3,017	3.4	3,500	3.7	+ 483
Stirling					
Stirling	27,151	30.8	28,015	29.3	+ 864
Bridge of Allan	3,173	3.6	3,769	3.9	+ 596
Central No. 1 D.C.	16,560	18.8	17,200	18.0	+ 640
Study Area	88,267	100.0	95,577	100.0	+7,310

Source: Census, Scotland 1951 and Annual Report of the Registrar General for Scotland, 1966.

Table 2.2

Age Structure of Population - by summary age groups

	Study Area				Scotland	
	1951 Persons	%	1961 Persons	%	% 1951	% 1961
0 - 14	22,733	25.8	25,153	27.1	24.6	25.9
15 - 64	57,014	64.6	58,292	62.8	65.4	63.5
65 and over	8,520	9.7	9,355	10.1	9.9	10.6
	88,267		92,800			

Table 2.3

Age Index of Population, Study Area and Scotland

	Study Area	Scotland
1951	31.3	32.4
1961	33.5	34.9
1966 (sample)	33.1	35.2

FIGURE 2.10

POPULATION AGE STRUCTURE, SCOTLAND AND STUDY AREA, 1961

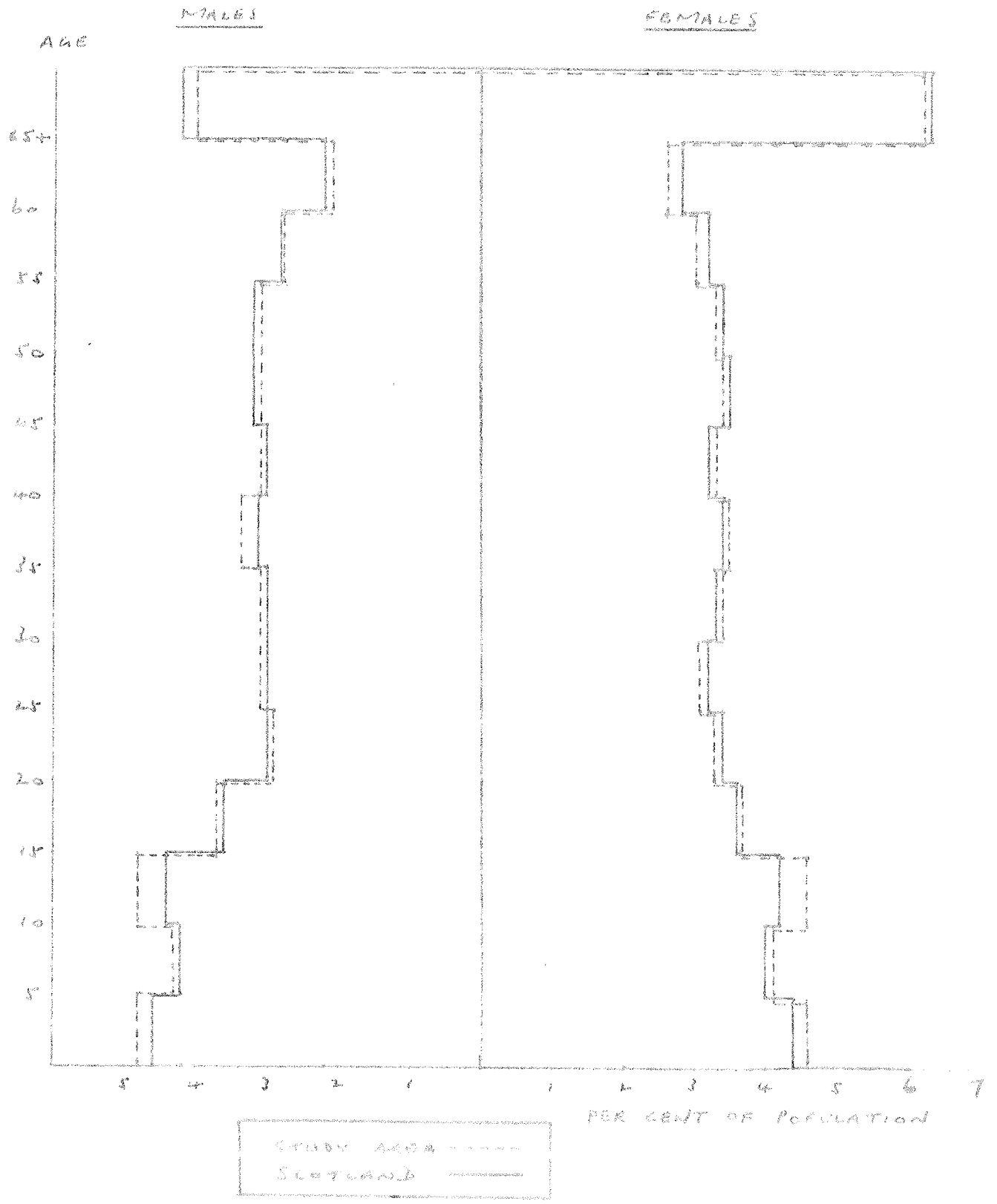

Table 2.4

Population by Age Group, Study Area and Scotland

	1951		1961	
	Study Area	Scotland	Study Area	Scotland
0 - 4	10.0	9.2	9.3	9.0
5 - 9	8.1	7.8	8.4	8.2
10 - 4	7.7	7.6	9.3	8.6
15 - 9	7.0	7.1	7.3	7.2
20 - 4	7.2	7.1	6.2	6.5
25 - 9	7.6	7.5	6.2	6.3
30 - 4	6.9	6.8	6.5	6.5
35 - 9	7.2	7.2	6.8	6.7
40 - 4	7.2	7.3	6.4	6.2
45 - 9	6.7	6.9	6.5	6.7
50 - 4	5.8	6.0	6.4	6.6
55 - 9	4.9	5.1	5.8	6.0
60 - 4	4.2	4.4	4.7	5.0
65 - 9	3.6	3.8	3.7	3.9
70 - 4	2.8	3.0	2.8	3.0
75 and over	3.1	3.2	3.7	3.6
	100.0	100.0	100.0	100.0

Source: Census reports 1951 and 1961

Table 2.5

Population by Age Groups, 1951 and 1961

	Males			Females		
Age Groups	1951	1961	Inter-censal change	1951	1961	Inter-censal change
0 - 4	4,536	4,491	- 45	4,273	4,311	+ 38
5 - 9	3,629	3,958	+ 329	3,532	3,757	+ 225
10 - 4	3,406	4,418	+1,012	3,357	4,218	+ 861
15 - 9	2,949	3,378	+ 429	3,196	3,355	+ 159
20 - 4	2,903	2,692	- 211	3,422	3,062	- 360
25 - 9	3,226	2,872	- 354	3,486	2,903	- 583
30 - 4	2,968	2,886	- 82	3,099	3,146	+ 47
35 - 9	3,033	3,102	+ 69	3,295	3,241	- 54
40 - 4	3,091	2,839	- 252	3,255	3,053	- 202
45 - 9	2,874	2,905	+ 31	3,075	3,149	+ 74
50 - 4	2,377	2,881	+ 504	2,760	3,098	+ 338
55 - 9	1,885	2,609	+ 724	2,400	2,795	+ 395
60 - 4	1,616	1,924	+ 308	2,104	2,402	+ 298
65 - 9	1,425	1,378	- 47	1,772	2,005	+ 233
70 - 4	1,058	1,036	- 22	1,487	1,565	+ 78
75 and over	1,157	1,260	+ 103	1,621	2,111	+ 490
Total	42,133	44,629	+2,496	46,134	48,171	+2,037

Source: Census 1951 Vol. 1 parts 13, 26, 31, Table 15
Census 1961 Vol. 1 parts 13, 26, 31, Table 6.

Table 2.6

Estimates of Migration (1951-1966)

	Study Area		Scotland	
	1951-61	1961-66	1951-61	1961-66
Census population	88,267	92,830	5,096,415	5,178,490
Births over period	17,405	9,462	953,652	513,209
Deaths " "	10,192	5,396	618,399	316,545
Natural increase "	7,213	4,066	335,253	196,664
Actual " "	4,533	3,180	82,075	12,310
Migration "	- 2,680	- 890	- 253,178	- 184,354
as % base population	-3.0%	-1.0%	-5.0%	-3.6%

Source: Statistical Appendix 2.1, tables (a) and (b)

Table 2.7

Estimates of Effect of Migration on Study Area Age Structure 1951-61

	Population 1961	Gain/Loss	As % of Population
0 - 4	8,802	+1,169	+13%
5 - 9	7,797	- 687	- 9%
10 - 4	8,554	+ 263	+ 3%
15 - 24	12,487	-1,483	-12%
25 - 34	11,807	-1,049	- 9%
35 - 44	12,235	- 401	- 3%
45 - 54	12,033	+ 339	+ 3%
55 - 64	9,730	+ 17	0
65 - 74	5,984	- 530	- 9%
75 and over	3,371	- 148	- 4%
Total	92,800	-2,510	- 3%

Table 2.8

Estimates of Effect of Migration on Study Area Age Structure 1961-66

	Population 1966	Gain/Loss	As % of Population
0 - 14	26,250	- 40	0
15 - 44	37,980	-1,210	-3
45 and over	31,780	- 380	-1
Total	96,010	-1,630	-2

CHAPTER 3

Industrial Structure and Employment

This chapter analyses the pattern of industrial structure and employment in the Study Area[1] over the period 1961-66.[2] The statistics used are almost entirely employment figures, these being the most detailed, regular and reliable statistics at a sub-regional level. While this approach is not completely satisfactory,[3] its use is permissable on the grounds that the main importance of industries to a sub-region is their employment contribution and the income received from this, rather than the pattern of their physical output. In any case, there is the advantage that this approach allows the discussion of industrial structure and employment opportunities simultaneously.

The chapter analyses, firstly, the pattern of industrial structure in the Study Area at 1966, for the most part in terms of employment, but latterly in terms of earnings to provide some comparison of the relative importance of the various industries. Secondly, it examines the trends of growth and decline which were experienced over the period, comparing local to national experience here and assessing the effect of these changes on male and female employment. Finally, an analysis is made of the state of the local labour market as measured through unemployment patterns and activity rates.

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1. The local D.E.P. areas of Stirling and Alloa do not coincide with the local authority boundaries of the Study Area as defined from the Census reports. For the resultant adjustments to employment figures, see Statistical Appendix 3.1.
2. Comparison over a longer period, such as 1951-66, is made difficult by the periodic redefinitions of S.I.C. Orders by the D.E.P. The 1961-66 period was chosen to retain a Census year base and still avoid the 1959 redefinition of Orders.
3. The main weakness is not so much concerned with analysis of structure at a given moment of time (although capital-intensive industries would be understated) as the assessment of change over a period, when technological changes obscure growth and decline estimates based on employment figures - see later discussion.

The Pattern of Industry

This is analysed, in the first place, in the form of the main summary industrial groups of Primary, Manufacturing and Services sectors[4] for the Study Area and Scotland. In 1961, the employment structure of the Study Area relied more heavily on the Primary sector than did the Scottish one (15.6% as opposed to 8.7% of total employment). Since there was no great difference in the relative importance of the Manufacturing sectors, (45.5% of total employment in the Study Area as against 44.6% for Scotland), the imbalance of the Primary sector was reflected in the Study Area's much smaller Services sector, (38.8% as opposed to 46.6% for Scotland as a whole).

By 1966 the changes in employment structure were fairly marked, despite the small overall increase in the labour force of about 400 persons. There had been a run down of about 2,000 persons in the Primary sector, reducing it from 15.6% to 10.3% of total employment, bringing it nearer the Scottish figure of 6.2%. Partly as a result of this transfer of labour, there was a gain of over 800 persons in Manufacturing which, by 1966, accounted for 47.3% of total employment in the Study Area. At the same time there was an increase of about 1,500 persons in the Services sector, raising this to 42.4% of total employment, but still well below the Scottish figure of 48.6%

When the industrial structures are compared in the fuller detail of S.I.C. Orders,[5] again there were a number of differences in the relative patterns of employment. Given that the Study Area is relatively small, it is inevitable that such differences will occur, since some industries, e.g. Metal Manufacture/...

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4. See table 3.1 for the figures. Primary industries cover Orders I and II, Manufacturing Orders III to XVIII inclusive and Services, Orders XIX to XXIV, again inclusive.

5. See table 3.2.

e.g. Metal Manufacture (Order V), or Shipbuilding and Marine Engineering (Order VII), will be virtually missing, whereas others, such as Mining (Order II) and Textiles (Order X), being regional specialisms, will play a rather more important part in the pattern of employment.

The six largest industrial orders in the Study Area at June 1966 were Textiles, Professional Services, Miscellaneous Services, Distributive Trades, Mining and Construction, which between them accounted for about 60% of total employment in the area as opposed to about 50% in the Scottish pattern. While these were also the six largest in 1961, there had been in some cases considerable changes in their ranking position over the period. Mining was the largest single order in 1961 with about 14% of total employed (about 5,100 persons) in comparison to its position of 5th largest in 1966, with about 9% of the labour force (under 3,400 persons). On the other hand Professional Services, the 5th largest in 1961, (8% of total, about 3,000 persons), rose to 2nd largest by 1966 (11% or about 4,100 persons). There was little change in the ranking position of the others. Textiles, despite a marginal decline from about 4,300 to 4,200 in persons employed, became the largest order with 11% of total employment. Distributive Trades and Miscellaneous Services, each with about 3,700 employees, or 10% of the labour force remained in the same ranking but increased their absolute size marginally. Construction, in both years the smallest of the six, increased from about 2,900 or 8% of total employment to about 3,400 or 9%.

In terms of location factors[6] in these major industries, Mining (3.30), Textiles/...

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6. Location factors are a more convenient method of comparing the relative importance of industries between areas; the L.F. for the Study Area in any industry is the percentage employed in that industry in the Study Area divided by the percentage employed in the same industry in Scotland. Where the L.F. value is greater than unity, it is a more important source of employment in the Study Area than in Scotland, i.e. it is a regional specialism, and conversely. Its main advantage is that it not only indicates specialisms, but gives a measure of the degree of specialism.

Textiles (2.43) and Miscellaneous Services (1.15) were regional specialisms While Construction (0.98) and Professional Services (0.91) were about the same relative size, Distributive Trades (0.73) was a rather less important source of employment in the Study Area than in the Scottish pattern.

Looking in more detail at these main industries in the Study Area, the largest, Textiles, was mainly concerned with the manufacture of woollens and worsteds (M.L.H. 414) and hosiery and knitted goods (M.L.H. 417), which between them accounted for over 90% of employment in the industry, the remainder being in textile finishing; given the nature of the industry, about 75% of the labour force were female. Employment in Professional Services was mainly in educational services (M.L.H. 872) and medical and dental services (M.L.H. 874), which again provided over 90% of employment and were also female predominant (about 80% female). In Miscellaneous Services, about 40% of the total were employed in hotels and catering (M.L.H. 884), 25% in car sales, garages and filling stations (M.L.H. 887) and 10% in private domestic service (M.L.H. 891); overall, the female proportion was again predominant at about 60%. Distributive Trades, predictably, had about 90% of its labour force in retail distribution (M.L.H. 820), with the remainder scattered over wholesale distribution, coal, builders' and agricultural merchants; again, under the influence of retail distribution, about 60% was female employment. Mining, on the other hand, was almost exclusively male employment and almost entirely (about 95%) concerned with coal mining (M.L.H. 101). Finally, Construction was again almost exclusively male employment and was concerned mainly with housebuilding; while civil engineering had provided several large labour intensive projects in the past, at that time there was a lull in this type of work.

Analysis of local industrial structure has so far been confined to employment figures. While the importance of the various industries to the Study Area/...

the Study Area must be judged primarily from their employment contribution it is useful to convert this to income received from these industries (in wages, salaries and self-employed earnings in the context of this discussion). Since earnings vary between industries reflecting complex factors such as product concentration, market conditions, bargaining structures, company efficiency and policy and since there is a considerabl differential between male and female earnings, it is possible that taken from this slightly[7] different base, some changes may take place in the relative importance of industries.

The estimates made[8] indicate that there was little difference in the identification of the major industries, whether approached from employment or income criterion. From income identification the ten largest industries in the Study Area employed about 78% of the labour force as against the 79% indicated by the employment analysis.[9] The only difference in the composition of the group was that the income ranking excluded Public Administration for Engineering, whereas the employment ranking did the obverse; in both rankings the industries were marginal to the group.

Still in general terms, the ten main industries, by either criterion, employed about 80% of the Study Area labour force and accounted for about 80% of the total income from the Study Area workplaces.[10]

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7. In view of the method of calculation (see Statistical Appendix 3.2) the employment structure remains the prime influence on income.
8. See table 3.3 for comparison of income and employment rankings.
9. The employment figures given differ from those in previous tables due to the inclusion of estimated figures for self-employed in the various industries - see Statistical Appendix 3.2.
10. This must not be confused with the total income of the Study Area; firstly, the estimates only cover income from employment and self-employment and, secondly, no allowance has been made in them for income earned in employment outside the Study Area.

Within the table, the criterion used had a considerable effect on the ranking of the industries, particularly for the six largest. Textiles and Distribution (equal second in employment terms[9]) dropped to 6th and 4th largest in income terms, reflecting partly the lower earnings levels of these industries and partly the employment bias towards lower paid females in this type of work. On the other hand, Construction and Mining 5th and 6th in employment terms, rose to 2nd and 3rd respectively in income rankings, due to higher earnings levels and male predominance in employment. The other changes in ranked position in the main industries tended to be of less importance and might well stem from the assumptions or the figures underlying the calculations.

Trends of Growth and Decline, 1961-66

This section analyses the changes which have taken place in the industrial structure of the Study Area over the period, with expansion and contraction measured in terms of numbers employed.[11] While, overall, there was only an increase of about 400 persons in the total labour force, individual industries experienced considerable changes over the period.[12] The main employment increases were in Professional and Scientific Services (about 1,100), Miscellaneous Services (about 600), Construction (about 450), Gas, Electricity and Water (about 400), Bricks, Potteries and Glass (about 300) and Insurance, Banking and Finance (about 250). On the other hand, the industries suffering the main contraction in employment were Mining (about 1,750), Public Administration and Defence (about 550), Food, Drink and Tobacco (about 250), Agriculture (about 150) and Textiles (about 150).

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11. Employment figures cannot give a complete measure of growth or decli since they do not show changes in the technical relationships betwee inputs and outputs, e.g. for Scotland over the period, in Chemicals, employment fell by 9% but the index of production rose by 18%. However, for a small area, the importance of growth/decline is in the repercussions felt on employment.

12. See table 3.2

Growth or decline in any industry will reflect the influence of both the national trend over the period and purely local experience. It is possible to make at least a rough estimate of the extent to which the changes recorded reflect these two components. To do so, the Scottish pattern of change over the period was applied to the industrial structure of the Study Area at the beginning of the period; this provided estimates of numbers employed by industry for the end of the period if the Study Area had conformed to the Scottish experience. When these estimates were compared to actual numbers employed at the end of the period, local residuals emerged, i.e. changes which could not be explained in terms of purely national experience.[13]

The estimates made show major local residuals of above national trend growth for the following industries.[14] Professional and Scientific Services had a residual of over 550 persons for the period, resulting from an increase of 38% in employment as against the Scottish figure of 19%. Growth in this industry was shared evenly between educational and medical services and was the result of substantial development of capacity in these parts of the public sector over the period, due in part to a coincidence in the timing of expenditure plans[15] as well as the growing needs of the area for these services over the 1960's. The second largest residual was recorded for Bricks, Potteries and Glass; while the main employment section here was concerned with the manufacture of glass containers for the Scottish market, the growth over the period was in the manufacture of abrasives and building materials to service local and Central/...

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13. The method has two obvious weaknesses; firstly, it assumes that there is an identical pattern of employment between the Study Area and Scotland, i.e. L.F. = 1 in all industries, and secondly it assumes an identical pattern of M.L.H. industry groups within each S.I.C. Order.

14. See table 3.4.

15. Based on information given by the County planners. However, growth in this sector has been a little exaggerated by a local reclassification of industry - see later comments.

Central belt construction work. The third main residual was of about 300 persons over the national trend in Gas, Electricity and Water; this reflected the expansion of electricity generation capacity at the Kincardine Power Station. The fourth largest residual was for Miscellaneous Services, which had a gain of about 250 persons over the trend; expansion here was almost entirely in the hotels and catering section, partly as a result of growth in the through tourist trade and partly as a result of the residential developments in the area. The final main residual was for Insurance, Banking and Finance, which increased employment by over 50% for the period; this was largely attributable to the siting of the headquarters of a large Scottish insurance concern at Stirling during the period. In all these cases, obviously, the location factor value for the industry increased over the period.

Almost all of the negative residuals, i.e. where growth was less than the national trend, were relatively insignificant. The largest residual here was for Public Administration and Defence, which had a short-fall of about 750 persons from the national trend. While to some extent this was caused by a reduction of manpower in local defence establishments, a part of the "loss" was the result of local adjustments in industrial classification during the period, which transferred persons from this group to, mainly, Professional and Scientific Services.[16] To some extent, the same explanation applies to the only other main negative residual, for Food, Drink and Tobacco; part at least of the absolute decline in persons employed over the period was caused by another reclassification from this Order to Distributive Trades.[17]

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16. It has been impossible to get further details on the numbers or type of labour involved.

17. The transfer was from M.L.H. 231 to 810, mainly warehousing of malted whisky - again no details of numbers involved available.

However, this type of approach can tend to apply a national trend explanation to changes caused by local experiences in an industry. In mining there was a considerable run-down in manpower over the period of about 34%, which was reflected exactly in the Study Area, despite the fact that the latter had been designated as one of the few growth areas in Scotland for this industry. To some extent, the run-down in the Study Area was a true reflection of the national trend of closure of older, less efficient collieries. Despite these closures, in 1960 there were 13 active collieries in the Study Area, most of them recently opened, employing 4,800 men and producing between them 2 million tons per annum. Yet by 1963 only three of the smaller mines were producing coal[18] and employing only 1,500 men; since then, the balance of the labour force in the industry have been taken daily to coalfields outside the area, in Fife and West Lothian. The massive decline in employment in the industry, which would have caused grave repercussions on an area with a less well diversified industrial structure, did involve a considerable flow of emigration to the English coalfields during the period. This decline in employment was not so much a national trend effect as the result of an overoptimistic assessment of the quantity and quality of deposits, a series of mistakes which culminated in the closure of the new, large Glenochil Mine and the subsequent Public Inquiry.

A further analysis of industrial expansion over the period can be made by regrouping the various industries into two categories, one for regional specialisms, i.e. where location factors exceeded unity, and one for industries which were relatively less important to the Study Area i.e. where the location factors were less than unity. This allows a grouping of the residuals[19]/...

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18. Coal production was entirely for Kincardine Power Station in the surviving collieries. All information here was given by N.C.B. planners.

19. See table 3.5.

of the residuals to show that the section composed of regional specialisms expanded at slightly less than the national pattern had forecast, whereas the industries which were not important traditionally to the area had a significantly larger growth in employment than would have been expected from the national average.[20] Secondly, the above trend growth was concentrated in S.I.C. Orders XX to XXII; while some of this might represent a "once and for all" effect, as in the case of Insurance, the other two sectors, Distribution and Professional services should continue to benefit from both internal and University inspired growth. The effects of the changes recorded for 1961-66 were to broaden the industrial base of the Study Area and, by doing so in the non-Manufacturing sector, bring the Services sector to nearer the Scottish pattern.

Finally, changes in industrial structure, particularly where they involved a marked growth in the Services sector relative to Manufacturing, were unlikely to affect male and female job opportunities equally. The 1.2% increase in total employment over the period was compounded of a 5% decline in males employed and a 12% increase in females employed. As a result of this, the proportion of males in the Study Area labour force fell from 63% in 1961 to 59% in 1966, with a corresponding rise in the female proportion from 37% to 41%. Growth of employment over the period was mainly in female employment, partly due to the heavy run-down in male predominant mining, but also partly due to the nature of the growth. S.I.C. Orders XX to XXIII offered new employment to 1,900 females; female employment in Distribution increased by about 300, in Insurance by about 200, in Professional and Scientific services by about 850 and in Miscellaneous services by about 550. Over the period, in no less than 14 Orders, the proportion of females employed relatively to males rose.

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20. The reclassification from Order XXIV may well have caused the negative residual in section (a) of the table and inflated the positive residual in section (b).

The State of the Labour Market in the Study Area

To some extent, the previous section of the chapter examined the effect of changes in the industrial structure over the period on employment in the Study Area. This section continues the analysis of the repercussions of these changes, as measured in the unemployment statistics of the period. This approach also allows an examination of the state of the local labcur market by showing whether the previously observed trends resulted in any significant surplus or deficit of labour.

Over the period, the rate of unemployment in the Study Area varied between 1.6% and 3.7%, with an average rate of 2.3%; this compared to the Scottish range of 2.5% to 5.4% and average of 3.6%.[21] At all times the rate of unemployment in the Study Area lay well below the Scottish figures, being typically about 2/3 of the national rate. In both cases, the pattern of unemployment showed a steady rise from the beginning of the period to a peak in the first quarter of 1963, then declined to 1966, with minor peaks in the third quarter of 1964 and 1965 and a rising trend towards the end of 1966. The behaviour of the rates would seem to indicate that the level of about 2% was the equilibrium rate; disturbances from this were quickly followed by adjustments back towards this level. As such, the Study Area was obviously one of the more prosperous regions in Scotland, although the improvements in the industrial structure of the latter helped to narrow the gap a little over the period.

The number of unemployed persons in the Study Area varied from about 700 in early 1966 to under 1,700 at the 1963 peak; between 3/5 and 4/5 of the total were males.[22] The peak of male unemployment of about 1,300 in 1963/...

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21. See figure 3.6.
22. See figure 3.7.

in 1963 was caused by a combination of mining closures culminating with Glenochil, the effect of a severe winter on the construction industry and extensive short-time working in the paper industry.[23] The recovery reflected more normal conditions in construction and paper and the emigration of many of the younger miners from the area.[24] The only other notable peak in male unemployment, in late 1965, while it coincided with the mild Scottish downturn, was exaggerated by an industrial dispute and strike of mining maintenance workers, with the lay-off of the other workers under safety legislation. Finally, the rising trend to the end of 1966 reflected partly the national slowdown, but also was inflated by the effects of another severe winter on construction.

On the other hand, the volatility of female unemployment over the period can be traced almost entirely to the Textile industry. All that can be added here is that the peaks in 1963, 1964 and 1966 all reflected short-time working rather than full unemployment, although the latter peak did contain some genuine unemployment following closures of some smaller textile firms in the area.

The implication of these figures is that the peaks of male or female unemployment did not indicate any real or lasting surplus of labour supply over labour demand. They were either caused by short-time working or unique local disturbances. While the national cycle undoubtedly exerted some pressure on the local labour market, this constituted only a minor element in unemployment. Relative to the Scottish pattern, the unemployment figures indicate that the Study Area had little to offer in the way of/...

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23. Short-time working, where it involves any days of no employment during a working week is designated "temporarily stopped" by the D.E.P. and included in the unemployment statistics, although it is not unemployment in the normal sense of the word.

24. The minutes of the D.E.P. quarterly meeting for October 1963 indicate that 75% of the unemployed males were unskilled and typically the older men left after emigration.

the way of labour reserves by 1966.[25]

This observation is confirmed by an analysis of the duration of unemployment.[26] For males, apart from the initial year of the period, the largest proportion of unemployment was relatively short-term in nature;[27] this was particularly noticeable during the recovery phase from 1963. The analysis suggests that over half the male unemployed have been quickly reabsorbed in the Study Area or surrounding districts. Long-term unemployed were typically about 1/3 of the total, with a hard core element of about 150 persons. Medium-term unemployment, very much the cyclical buffer, was virtually eliminated from 1964 onwards.

The pattern of female unemployment was broadly similar with, as one would expect, the long-term element of less importance than for males. With the medium-term component squeezed even more drastically than for males, by far the largest component of female unemployment has been of a short-term nature. However, for females, there is the complication of the fringe element of part-time workers, many of whom do not register as unemployed when laid off (since in most cases they do not qualify for benefit). D.E.P. officials feel that these do not conflict with the general pattern, in as much as any person wanting regular part-time employment is unlikely to suffer prolonged periods of inactivity.

In spite of/...

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25. Current recruitment experience of the University confirms this; while the unskilled posts have drawn large numbers of applications from typically older local people, clerical and secretarial posts have been filled, if local, by transfers from other firms in the area (which have found difficulties in replacing). Few local applications have been received for the technical and scientific posts

26. See table 3.8. Columns (a) and (c) have been obtained from local duration of unemployment returns and column (b) estimated as the balance from the Unemployment by S.I.C. return.

27. It must be remembered that the return does not state the actual duration of unemployment. It merely shows that, at end June each year, this was the analysis of the unemployed on the register. Since there is no sign of any cumulative build-up in the other columns, it suggests a quick turnover.

In spite of the part-time complication, there is every indication that the female labour force was already under considerable demand pressure from expansion in employment over the period. As a final check on this, since the female labour market only covers females registered as prepared to work, an estimate has been made of the Female Activity Rate[28] for the area. While the Scottish female activity rate for 1966 was 40.3%,[29] the Study Area rate was 41-44%. Almost certainly, a significantly higher proportion of the female population in the Study Area were economically active than was the case for Scotland as a whole; indeed, the rates indicate comparability with Glasgow and West Central and Tayside[30] which had the highest activity rates in Scotland for that year. At first sight, this confirms that there was little in the way of female labour reserves in the area, making a constraint for future internal and University growth. However, while there is a constraint, it is not likely to be a fixed one; it is expected that the national level of female activity rate will rise in the future, which will be reflected in the Study Area, as the non-operative type of work expands. This will be augmented by the inflow of immigrants to the area as the University expansion takes place which, in turn, will increase the local female population and therefore labour force.

In conclusion, the chapter has indicated that, over the period 1961-66 there took place a considerable swing towards employment in the Services sector, which had some effect on the relative importance of the various industries - more in terms of employment than income, owing to the male/female proportions of the industries affected. The type of growth in non-traditional industries caused a decline in the number of male jobs and an expansion/...

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28. The Activity Rate is the economically active female labour force expressed as a percentage of female population 15 and over.
29. Digest of Scottish Statistics, No. 30, October 1967, table 42.
30. See The Intermediate Areas, 1969, CMND 3998, Appendix C, p 214.

and an expansion in females employed. These changes appear to have had little effect on male unemployment locally, as a result of emigration and a switch to commuting to outside the area. On the other hand, the growth in female employment placed considerable pressure on labour reserves, although, in female employment, reserves are normally greater than indicated by employment figures. Nevertheless, the indications were that any further expansion in the area would place real pressure on local recruitment, wages and conditions of work.

Table 3.1

Distribution of Insured Workers in Employment

	Study Area				Scotland	
	1961		1966		1961	1966
	No.	%	No.	%	%	%
Primary (1 and 2)	5,791	15.6	3,878	10.3	8.7	6.2
Manufacturing (3 - 18)	16,874	45.5	17,718	47.3	44.6	45.2
Service (19 - 24)	14,396	38.8	15,902	42.4	46.6	48.6
Total	37,061		37,498			

Source: local D.E.P. statistics on Employment
Scottish Digest of Statistics

Table 3.2

Distribution of Employment

	1961				1966				
	Study Area		Scotland	Location Factor	Study Area		Scotland	Location Factor	Study Area Change 1961-66
S.I.C. Order	No.	%	%		No.	%	%		No.
1. Agriculture	678	1.8	4.5	0.40	528	1.4	3.5	0.40	- 150
2. Mining	5,113	13.8	4.2	3.29	3,350	8.9	2.7	3.30	-1,763
3. Food, Drink & Tobacco	2,339	6.3	4.6	1.37	3,075	5.5	4.6	1.20	- 264
4. Chemicals	41	0.1	1.7	0.06	17	0.0	1.6	0.00	- 24
5. Metal Manufacturing	13	0.0	2.7	0.00	47	0.1	2.4	0.04	+ 34
6. Engineering & Electrical	1,447	3.9	7.8	0.50	1,536	4.1	8.5	0.48	+ 89
7. Shipbuilding	17	0.0	3.0	0.00	17	0.0	2.2	0.00	0
8. Vehicles	89	0.2	1.7	0.11	14	0.0	2.0	0.00	- 75
9. Metal goods	1,109	3.0	1.3	2.31	1,246	3.3	1.3	2.54	+ 137
10. Textiles	4,336	11.7	4.9	2.39	4,197	11.2	4.6	2.43	- 139
11. Leather	81	0.2	0.2	1.00	7	0.0	0.2	0.00	- 74
12. Clothing and Footwear	55	0.1	1.4	0.07	54	0.1	1.5	0.07	- 1
13. Bricks etc.	1,364	3.7	1.0	3.70	1,667	4.4	1.1	4.00	+ 303
14. Timber etc.	396	1.1	1.1	1.00	379	1.0	1.1	0.91	+ 17
15. Paper and Printing	1,603	4.3	2.7	1.59	1,637	4.4	2.7	1.63	+ 34
16. Other manufacturing	235	0.6	0.9	0.67	236	0.6	0.8	0.75	+ 1
17. Construction	2,897	7.8	8.0	0.98	3,345	8.9	9.1	0.98	+ 448
18. Gas, Electricity	852	2.3	1.4	1.64	1,244	3.3	1.6	2.06	+ 392
19. Transport	1,734	4.7	8.4	0.56	1,677	4.5	7.3	0.62	+ 57
20. Distribution	3,513	9.5	13.3	0.71	3,657	9.8	13.4	0.73	+ 144
21. Insurance	509	1.4	1.9	0.74	767	2.0	2.1	0.95	+ 258
22. Professional Services	2,975	8.0	10.3	0.78	4,099	10.9	12.0	0.91	+1,124
23. Miscellaneous Services	3,102	8.4	7.7	1.09	3,689	9.8	8.5	1.15	+ 587
24. Public Administration	2,563	6.9	5.0	1.38	2,013	5.4	5.3	1.02	- 550
	37,061				37,498				+ 437

Source: See table 3.1 above

Table 3.3

The Ten Most Important Industries in the Study Area (1966)

(a) Income			£'000 p.a.	% of total wages & salaries	% of total employment
1.	(XXII)	Professional & Scientific	4,373	13.4	11.0
2.	(XVII)	Construction	3,558	10.9	8.9
3.	(II)	Mining & quarrying	3,153	9.7	8.5
4.	(XX)	Distribution	2,854	8.8	10.6
5.	(XXIII)	Miscellaneous	2,546	7.8	10.2
6.	(X)	Textiles	2,482	7.6	10.6
7.	(III)	Food, Drink etc.	1,736	5.3	5.4
8.	(XIX)	Transport	1,626	5.0	4.4
9.	(VI)	Engineering	1,616	5.0	4.1
10.	(XIII)	Bricks etc.	1,563	4.8	4.2
			25,507	78.3	77.9

(b) Employment (including self-employment)			Persons	% of total for S.A.	Ranking on income table
1.	(XXII)	Professional & Scientific	4,333	11.0	1
2.	(X)	Textiles	4,200	10.6	6
2.	(XX)	Distribution	4,197	10.6	4
4.	(XXIII)	Miscellaneous	4,025	10.2	5
5.	(XVII)	Construction	3,515	8.9	2
6.	(II)	Mining & quarrying	3,350	8.5	3
7.	(III)	Food, Drink etc.	2,129	5.4	7
8.	(XXIV)	Public Admin.	2,013	5.1	11
9.	(XIX)	Transport	1,748	4.4	8
10.	(XIII)	Bricks etc.	1,667	4.2	10
			31,177	78.9	

Source: See Statistical Appendix 3.2

Table 3.4

Employment Changes in Study Area 1961-66 - estimates of breakdown into national and local components

	Study Area 1961 (a)	Scotland % Δ 1961-66 (b)	Study Area adjusted by Scottish Rate (c)	Actual S.A. figures 1966 (d)	Residual Study Area (d-c) (e)	L.F. of Study Area 1961
1. Agriculture	678	-22.4	526	528	+ 2	0.40
2. Mining & quarrying	5,113	-34.4	3,354	3,350	- 4	3.29
3. Food, Drink & Tobacco	2,339	+ 3.0	2,409	2,075	-334	1.37
4. Chemicals	41	- 8.7	37	17	- 20	0.06
5. Metal Manufacturing	13	- 9.6	12	47	+ 35	0.00
6. Engineering & Electrical	1,447	+10.0	1,592	1,536	- 56	0.50
7. Shipbuilding	17	-24.6	13	17	+ 4	0.00
8. Vehicles	89	+16.6	104	14	- 90	0.11
9. Metal goods	1,109	0.0	1,109	1,246	+137	2.31
10. Textiles	4,336	- 5.4	4,102	4,197	+ 95	2.39
11. Leather	81	- 9.5	73	7	- 66	1.00
12. Clothing & Footwear	55	+ 5.0	58	54	- 4	0.07
13. Bricks etc.	1,364	+ 3.5	1,412	1,667	+255	3.70
14. Timber etc.	396	- 3.3	382	379	- 3	1.00
15. Paper & Printing	1,603	+ 1.6	1,629	1,637	+ 8	1.59
16. Other manufacturing	235	- 1.1	232	236	+ 4	0.67
17. Construction	2,897	+14.6	3,320	3,345	+ 25	0.98
18. Gas, Electricity & Water	852	+13.4	966	1,244	+278	1.64
19. Transport	1,734	-11.1	1,542	1,677	+135	0.56
20. Distribution	3,513	+ 2.0	3,583	3,657	+ 74	0.71
21. Insurance	509	+11.3	567	767	+200	0.74
22. Professional Services	2,975	+18.6	3,528	4,099	+571	0.78
23. Miscellaneous Services	3,102	+11.5	3,459	3,689	+230	1.09
24. Public Administration	2,563	+ 7.6	2,758	2,013	-745	1.38
	37,061		36,767	37,498	+731	

Source: See table 3.1 above.

Table 3.5

Employment Changes in Study Area - 1961-66 - by regional specialisation

(a) S.I.C. with L.F. ≥ 1	1961 L.F.	S.A. persons employed at 1961	Residual from table 3.5		Residual for industries L.F. > 1
Mining & quarrying	3.29	5,113	- 4		
Food, Drink & Tobacco	1.37	2,339	-334		
Metal Manufacturing	2.31	1.109		+137	
Textiles etc.	2.39	4,336		+ 95	
Leather etc.	1.00	81	- 66		
Bricks etc.	3.70	1,364		+255	
Timber etc.	1.00	396	- 3		
Paper & Printing	1.59	1,603		+ 8	
Gas, Electricity & Water	1.64	852		+278	
Miscellaneous Services	1.09	3,102		+230	
Public Administration	1.38	2,563	-745		
		22,858	-1152	+1003	-149

(b) S.I.C. with L.F. < 1					Residual for industries L.F. < 1
Agriculture	0.40	678		+ 2	
Chemicals	0.06	41	- 20		
Metal goods	0.00	13		+ 35	
Engineering & Electrical	0.50	1,447	- 56		
Shipbuilding	0.00	17		+ 4	
Vehicles	0.11	89	- 90		
Clothing & Footwear	0.07	55	- 4		
Other manufacturing	0.67	235		+ 4	
Construction	0.98	2,897		+ 25	
Transport	0.56	1,734		+135	
Distribution	0.71	3,513		+ 74	
Insurance	0.74	509		+200	
Professional Services	0.78	2,975		+571	
		14,203	-170	+1050	+880
					-149
Total Residual for Study Area 1961-66					+731

FIGURE 3.6

PERCENTAGE UNEMPLOYED, SCOTLAND AND STUDY AREA, 1961-66

(SEASONALLY ADJUSTED)

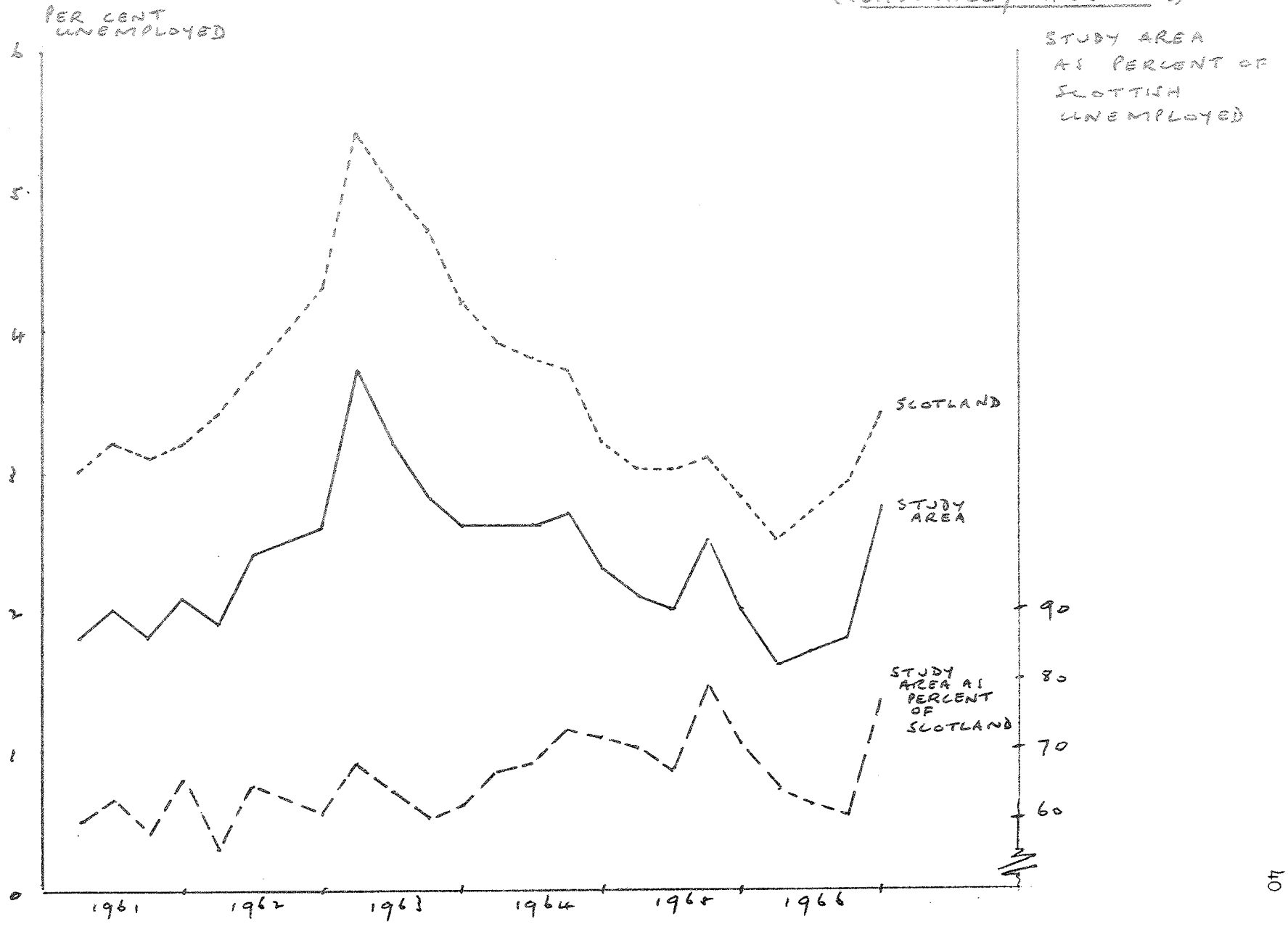

FIGURE 17

PERSONS UNEMPLOYED IN THE STUDY AREA (1961-66)

SEASONALLY ADJUSTED

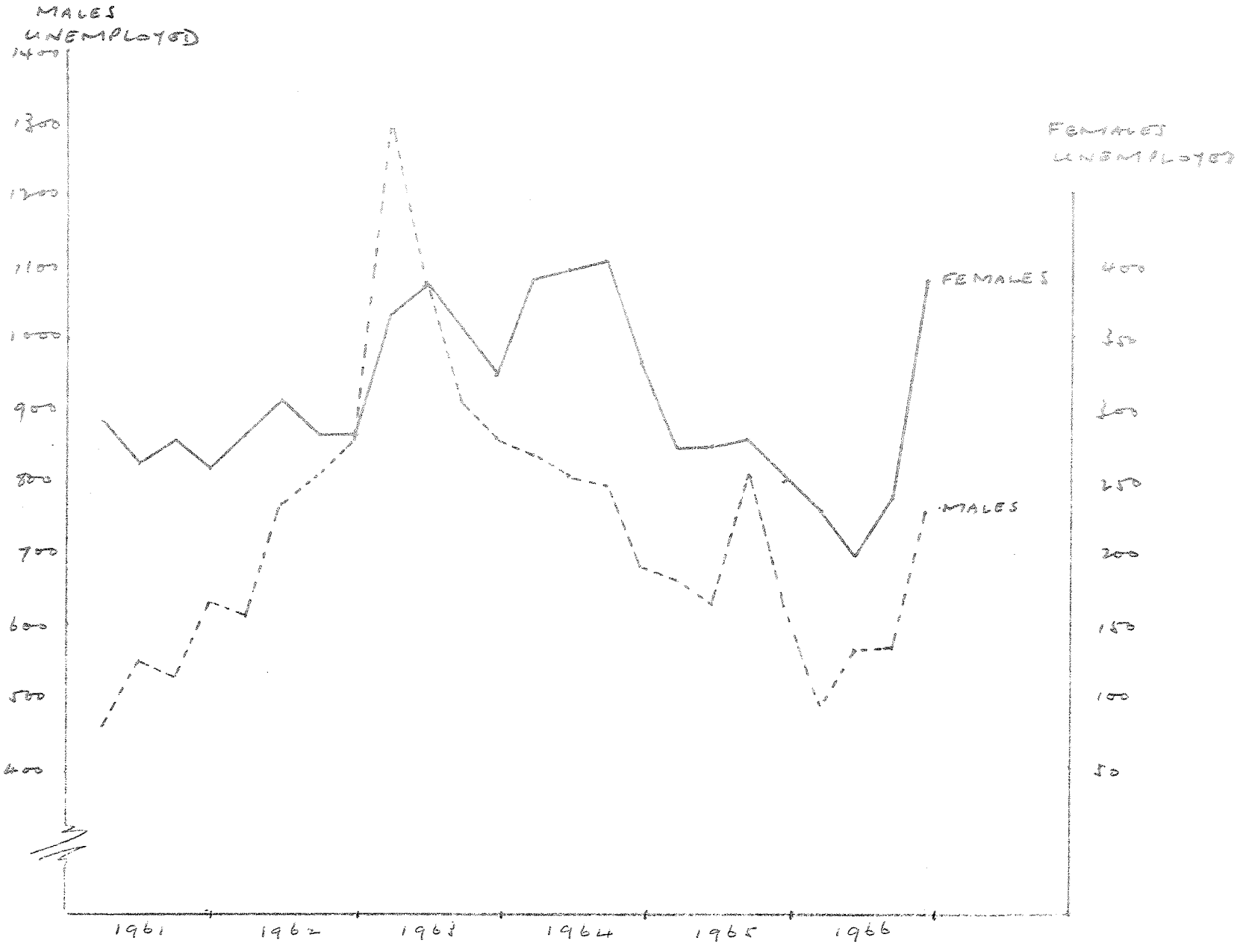

Table 3.8

Duration of Unemployment in the Study Area

Males

	less than 8 weeks (a)	8-26 weeks (b) d-(a+c)	over 26 weeks (c)	total wholly unemployed *(d)	less than 8 weeks as % total	over 26 weeks as % total
1961	149	109	151	409	36.4	36.9
1962	310	128	204	642	48.3	31.8
1963	361	179	287	827	43.6	34.7
1964	351	32	231	614	57.2	37.6
1965	282	40	164	486	58.0	33.7
1966	245	51	145	441	55.6	32.9

* Total net of temporarily stopped

Females

	less than 8 weeks (a)	8-26 weeks (b) d-(a+c)	over 26 weeks (c)	total wholly unemployed *(d)	less than 8 weeks as % total	over 26 weeks as % total
1961	111	88	57	256	43.4	22.3
1962	131	62	45	238	55.0	18.9
1963	185	37	78	300	61.7	26.0
1964	185	62	63	310	59.7	20.3
1965	120	33	46	199	60.3	23.1
1966	110	1	41	152	72.4	27.0

* Total net of temporarily stopped

Source: local D.E.P. statistics

Table 3.9

Female Activity Rate Estimates

	Female Population 15 and over (a)	Economically Active Female Population (b)	Activity Rate ($\frac{b}{a}$ x 100) (c) 95% confidence level
Clackmannan county	16,06	6,81	40% to 45%
Perth county			
Doune	36	13 }	28% to 41%
Dunblane	1,70	58 }	
Stirling county			
Stirling	11,09	4,78	
Bridge of Allan	1,70	62 }	42% to 46%
Central No. 1	5,96	2,79	
	36,87	15,71	41% to 44%

Source: Sample Census 1966 data (Census Office)

CHAPTER 4

Projections of Study Area's Population and Employment

Previous chapters have analysed the population and industrial structure of the Study Area in the years up to 1966. This chapter completes Part I of the thesis by providing a series of estimates of how the area would have continued to develop without the influence of the new University. In Part II, estimates will be made of the additional population and employment from the University's development and will be added to the estimates of this chapter to provide overall projections for the Study Area covering both internal and University inspired growth.

To some extent, the growth from the University does pose a problem for the estimates of internal growth; if the additional employment offered by the University and its secondary growth depletes the labour reserves of the area, then this might well deter other enterprises from expanding here and have serious repercussions on internal growth. However, officials from both the local Planning Departments and the D.E.P. feel that the effect of the University will be to make the local area more prosperous and attractive to further expansion, as was the case in Grangemouth. Certainly, on the basis of experience up to 1970/71, over a period when the influence of the University was fairly minimal, the considerable flow of population into local housing developments and the demand pressures on Planning offices for industrial and further house-building space to be released over the early 1970's, both seem to indicate strong internal development forces outwith and independent from the effects of the University. On these grounds, a separate projection for internal growth of population and employment appears to be justified.

The projections/...

The projections made in the course of the Chapter are to the years which mark the end of the two main growth phases[1] of the University, namely 1976, when the University will reach its first steady-state size of 3,000 undergraduate students, and 1981, the Phase 3 size for 6,000 undergraduates.[2] The chapter firstly projects the population of the Study Area to these years; it discusses the type of model to be used, the information required by it, the migration assumptions on which the projections are based and the results obtained. Secondly, in projecting the employment pattern of the area, the chapter discusses the use of national projections adjusted for local factors, and the results obtained from the model.

The Population Projections

In developing a model for the projections, no attempt was made to adopt any of the more sophisticated component type projection models, for a number of reasons. The two main problems of using such models are that, firstly, much of the data required (e.g. fertility rates, duration of marriage) is not available at sub-regional level, and secondly, again at sub-regional level, some of the variables excluded (e.g. availability and cost of housing) are likely to be of more importance than some of the variables included (e.g. probability of divorce or widowhood and re-marriage fertility rates). Any model must be a simplification of the complex relationships of reality and the simplified type of projection model used here is no less defensible for reason of its simplicity; care has been taken to base it on what are conventionally regarded as the main variables and relationships.

The model[3]/...

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1. See Development Plan Report, 1968, pp 20-21.
2. See Chapter 5 for a fuller discussion of the timing of the growth phases.
3. See Statistical Appendix 4.2 for a full discussion of the model and its various formulae.

The model uses four sources of information. Firstly, the base population, classified by five year age group and sex, was taken from the Census report of 1961,[4] rather than the sample Census of 1966. This base population was then adjusted over the projection period for births, deaths and migration. The data for births[5] was calculated from age specific fertility rates based on the average Scottish figures[6] for the period 1960-67, adjusted to predict total births per annum for the Study Area equal to the annual average for the period. The data for deaths[5] was calculated from age specific mortality rates, based on average Scottish figures,[7] and adjusted to predict annual deaths in the Study Area equal to the annual average for the period. Finally, the migration figures and age structure used were based on the assumptions discussed below.

Since population projections are based on fairly rigorous conditions and formalised relationships, it is normal to make a series of projections, in which some basic condition is allowed to vary and the effect of these variations observed. If the direction and volume of the Study Area's migration flow seemed likely to remain constant for the future, the series of projections could be made incorporating combinations of rising and falling rates for births and deaths, to produce a "band" within which total population might fall in the future. However, while the direction of net migration was a net outflow for the Study Area over the period, the rate of loss fell from an average of 270 persons per annum for 1951-61 to about 180 persons/...

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4. This population was adjusted for resident students in the same way as for Chapter 2. In addition, since it is conventional in population projections to project from and to end-June, the Census figures for April were adjusted for births, deaths and migration as estimated for part of April, May and June.
5. Births, deaths and migration rates are discussed in detail in Statistical Appendix 4.1.
6. Annual Reports of the Registrar General, table 23.
7. Op. cit., table T.37.

to about 180 persons per annum for 1961-66, at a time when the Scottish rate was rising markedly.[8] Indeed, for the later period, many sections of the Study Area showed significant net inflows, with only the urban centres reflecting the Scottish pattern. It is argued here that there are two main reasons why the net migration loss from the Study Area overall might well decline, or be replaced by a net gain over the period of the projection. Firstly, the Registrar General has forecasted[9] that the rate of migration loss from Scotland will fall over the period to a lower level than has been experienced since 1951; if this is reflected in the urban sections of the Study Area, then the continuing expansion from the other sections could well result in a migration flow balance, or even net gain. Secondly, current road developments from the Study Area to the rest of the Central belt and the North, taken with the apparently growing willingness to commute greater distances to Glasgow and Edinburgh, as well as the Falkirk/Grangemouth complex, could result in considerable residential expansion in the area.[10]

On the grounds that possible changes in the direction and volume of the migration flow are likely to be more significant than any changes in birth and death rates over the projection period,[11] the former has been chosen as the condition allowed to vary in the projections made. Three projections have been made on the basis of constant birth and mortality rates over the period to 1981. Projection 1, the lower case, assumes a continuing net loss of 300 persons per annum, i.e. roughly of the same magnitude/...

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8. See Chapter 2, pp and .
9. Annual Report of the Registrar General for Scotland, 1967, comments on table 5, p 88.
10. Evidence given by Bradley Homes Ltd. to the Planning Committee for Stirling County.
11. Confirmation of this can be gained from the sensitivity test on the model's projections, Statistical Appendix 4.3. However, some allowance has been made for the falling birth and death rates over the 1960's by the method used in estimating fertility and mortality rates - see Statistical Appendix 4.1.

magnitude as experienced over the 1950's by the Study Area; it is unlikely that net migration loss in the future will be above this level. Projection 2, on the other hand, assumes that migration flows will balance throughout the period, i.e. zero net migration. Finally, Projection 3 assumes that there will be a net migration gain annually of 300 persons for the duration of the period; within the conditions specified for birth and death rates, it takes the nature of an upper case.

The basic formula used[12] for the projections can be taken most easily from Projection 2, where there is no emigration. Here each five year age group (P_x) is projected over the quinquennium (i.e. from year n+1 to n+6) on the basis of the numbers who survive the period, i.e.

$$ {}^{n+6}P_{x+5} = {}^{n+1}P_x \cdot {}^{5}\Pi_x \qquad (1) $$

where ${}^{5}\Pi_x$ represents the survival factor for that age group over the quinquennium. In Projection 1, where there is a net migration outflow for each year of the period, then for any age group, migrants (M_x) for the period must be deducted from the survivors, i.e.

$$ {}^{n+6}P_{x+5} = {}^{n+1}P_x \cdot {}^{5}\Pi_x - \sum_{r=1}^{5} ({}^{n+r}M_x) \qquad (2) $$

Finally, in the case of Projection 3, where there is a net migration inflow over the period, the migrants to the age group must be added to the survivors,[13] i.e.

$$ {}^{n+6}P_{x+5} = {}^{n+1}P_x \cdot {}^{5}\Pi_x + \sum_{r=1}^{5} ({}^{n+r}M_x) \qquad (3) $$

The projections indicate[14] that, with a net outward flow of about 300 persons per annum, the population of the Study Area would increase from its base/...

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12. See Statistical Appendix 4.2 for the full discussion of the model's system of equations for the various age groups and births.
13. See Statistical Appendix 4.2 for a discussion of the survival of migrants over the period and the justification for assuming zero deaths, as in equation (3) above.
14. See table 4.1 and figure 4.2.

its base of 92,900 in 1961 to about 100,900 by 1976 (an increase of 8.6% or about 8,000 persons) and about 103,300 by 1981 (11.2% or 10,400 persons) For Projection 2, with its zero migration flow, there would be an increase to about 106,400 by 1976 (14.6% or about 13,500 persons), and about 111,00((19.5% or 18,100) by 1981. Finally, for Projection 3, with its net migration inflow of 300 persons per annum, there would be an increase to about 111,800 by 1976 (20.3% or 18,900 persons) and about 118,500 by 1981 (an overall increase of 27.5% or 25,600 persons). These figures indicate a population band of between 101,000 to 112,000 for 1976, and 103,000 to 118,000 for 1981.

Projection 2, with a zero migration flow, effectively estimates the natural increase of the population of the Study Area over the period. Comparison with Projection 1 shows that even a relatively mild migration loss of 300 persons per annum causes a shortfall of 7,700 persons over a twenty-year period - 1,700 more than the loss of the actual migrants, due to the loss of their potential children over the period.[15] On the other hand, comparison of Projections 2 and 3 shows the result of an annual gain of 300 persons, with a surplus of about 7,500 over the natural increase, again 1,500 more than the actual migrants gained. The comparison of Projections 1 and 3 provides a fairly clear indication of the extent to which the more fortunate "migration gain" areas of Scotland experience an explosive rate of population growth relative to the other areas, since they do not only retain their own natural increase but also receive a further transfusion of, typically, a younger and more active population.

The effects/...

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15. Most estimated age structures of migrants indicate that there is a heavy concentration on the 20-39 age range, the key reproductive groups in the community. Therefore loss or gain of migrants involves the secondary loss or gain of both actual and potential child dependents.

The effects of migration patterns can be seen very clearly from an analysis of the relative rates of growth.[16] Not only does Projection 1 have a relatively slower rate of growth than Projection 2, and this in turn relatively slower than Projection 3, but there is a significant cumulative effect. Owing to the drain of net migration loss from reproductive groups, a population will increase at a more and more sluggish rate, relative to its rate of ratural increase; conversely, a population with a net migration gain will tend to grow at an increasing rate. Thus the gap made by different patterns will widen at an increasing rate over time.

If the effects of migration patterns are applied to the age structure of the population,[17] then over the period to 1976 there would be a natural increase of about 3,200 persons in the age group 0-14. On the other hand, the Projection 1 conditions of net migration loss would cause a shortfall of 1,500 from this figure, i.e. a loss of almost half the natural increase. Under the Projection 3 conditions, the natural increase in this age group would be exceeded by a further 1,400. A similar pattern emerges for the other age groups, with the impact of migration declining in the higher age groups, partly since these are not normally affected much by migration and partly because the heavier mortality rates tend to even out any differences which do occur. For the 15-39 age group, there would be a natural increase of about 6,900 persons from the base population, with Projection 1 losing and Projection 3 gaining about 1/3 of this. For the 40-64 age group, the natural increase of Projection 2 shows only 300 persons more than for the base year/...

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16. See figure 4.3; by plotting the population figures on semi-log paper, equal proportionate rates of growth would appear as parallel slopes either along curves over the period, or between curves for any quinquennium. Steeper slopes indicate faster rates of growth and conversely.

17. See tables 4.4 and 4.5. For detailed tables by 5 year age groups and by sex, see Statistical Appendix 4.2 tables (b) and (c).

year, due in part to the movement of depleted (by emigration in earlier years) younger age groups into this section and, in part, the assumption of a zero migration flow here;[18] Projection 1 conditions indicate a loss of about 1,400 persons in this age group from the base year total and Projection 3 a gain of about 2,000. The final age group for "65 and over" in common with the projections of the Registrar General and others, increases markedly both in absolute numbers and in relative size under all projection conditions, to contain about 3,000 persons more than in 1961.

Examination of the projection figures for 1981 offers no contradiction to the findings for 1976. They show that further natural increases of about 1,000 in age group 0-14, 3,000 in age group 15-39, about 600 in age group 65 and over and a loss of about 500 in age group 40-64, have been estimated. Projection 1 conditions cause a more sluggish rise in all groups, increasing over the period 1976-81 by 2,500 persons, or 2.3% compared to the increase overall of 4,600 or 4.3% for Projection 2 and 6,700 or 6% for Projection 3.

The final result, in all cases, is that the assumptions made on the nature of the age structure of the migration flows causes a transition to a relatively younger population than the base year, this bias towards the younger age groups being accelerated towards the end of the period in the zero migration or net migration inflow figures.

The Employment Projections

Forecasting changes in employment, even at national level is a hazardous business, involving as it does such diverse variables as internal and international/...

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18. When, for 1951-66 there had been a steady stream of immigrants for retiral or in the upper section of this age range. One of the effects of eliminating this inflow by assuming a normal migration age structure, has been to accelerate the bias towards a younger population by understating the 40 and over age groups.

international pressures on demand and output, changes in technology and their rate of acceptance over the period, and the effects of population growth and age structure on both demand and supply sides. The difficulties are compounded when forecasts have to be made for a small sub-region such as the Study Area, where the changes in its employment pattern will be influenced by both national and local factors. No area will reflect completely, industry by industry, the pattern of national changes over the period; equally, no area will be totally unaffected by significant changes in the nature and level of the economic activity of the nation. While several approaches are available[19] which allow the combination of national and local influences in the forecast, a fairly simple approach has been adopted for this chapter. This method, developed from a technique used in Chapter 3,[20] projects the employment pattern of the Study Area on the basis of estimated national changes in industrial structure for the period 1961-76, as modified for normal local residuals and adjustments to particular industries.

In estimating the national change in industrial structure over the period, use could be made of either the National Plan[21] or the broadly similar estimates made by Beckerman and Associates in "The British Economy in 1975". Despite the official abandoning of its target, the Plan can still be used[22] as a reasonable guide for future rates of relative growth between industries. Both the Plan and the Beckerman estimates have used, broadly, the same approach for the projection, basing this on estimates of final demand and total output by industry, with allowances for productivity/...

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19. See "Regional and Urban Studies", ed. Orr and Cullingworth, Chapter 9, J T Hughes.
20. See tables 3.4 and 3.5.
21. The National Plan, September 1965, CMND 2764, as updated by "The Task Ahead", HMSO for D.E.A., 1969.
22. For example, in "The Falkirk/Grangemouth Regional Survey and Plan", Chapter 4.

productivity improvements and changes in the composition of the labour force. However, for projecting employment in the Study Area, the Beckerman estimates have been taken, partly because they were more detailed and partly because they cover virtually the same period as the first stage in the employment projections for this chapter.[23]

The explanation for the differences normally experienced between national and local rates of change over a period tends to be found, to a great extent, in the relative composition of the industrial orders. An increase of 12% in national employment in Engineering and Electrical Goods, where the employment bias is towards the "light" engineering and electronics, is unlikely to be reflected in an area where engineering employment is mainly engaged in the manufacture of agricultural machinery. Given these differences in the structure of industry within the S.I.C. Orders, it can be assumed reasonably that a local area will perform consistently better or worse (in terms of growth or decline in employment) than the nation as a whole, over the short and medium term,[24] i.e. there will tend to be a steady plus or minus residual from the national trends of employment change. Estimates have been made[25] of these residuals from employment data for the U.K. and the Study Area for the period 1960-68, and a correction factor, or modification factor[26] calculated for each industry, to adjust the estimated change in employment from national factors to the actual figures recorded for the end of the period.

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23. See table 4.6, column (b) for the Beckerman estimates of change.

24. The sluggish response of changes in regional industrial structures to post-war attempts at diversification indicates how difficult it is to change significantly industrial composition over the short and medium term.

25. See Statistical Appendix 4.4 for statistical sources and the method of estimation of both the residuals and the modification factors.

26. Modification factors show the extent to which the actual change in the Study Area will exceed (M.F. greater than one), or fall short of (M.F. less than one) the national rate of change.

As the first step in projecting employment for the Study Area to 1976, the Beckerman estimated changes for the period were applied to the employment structure of the Study Area at the beginning of the period[25] to provide the national component of estimated employment for 1976. Next, assuming that the modification factors for 1961-76 would be the same as for 1960-68, these estimates were corrected for local influences to provide a preliminary series of estimates of employment by industry for the Study Area for 1976.

At this stage, there were two main sources of error in the projections; firstly, the projected national rate of change could be in error and, secondly, changes could have taken place in the relationship between national and local trends, i.e. in the modification factors. For example, in Mining and Quarrying, there has almost certainly been a change in the value of the modification factor, which, over the 1960-68 period, reflected the series of closures of collieries and N.C.B. workshops. These closures were the last major redundancies[27] in mining locally and, from 1971/72 there will be considerable employment in the newer collieries opened to serve the Longannet Power Station. For this industry in the period to 1976, neither the national trend nor the modification factor will apply; for both 1976 and 1981, it is estimated that employment will remain constant at about 3,250 men from the Study Area. Again, in the case of Food, Drink and Tobacco, the national trend estimate of a 4% decrease in employment over the period compares to a 3% increase in employment nationally to 1968; accordingly the Beckerman figure has been adjusted to a 4% increase over the period. Also in this industry, the modification factor for 1960-68 reflects an inter

S.I.C./...

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27. This section is based on conversations with the Planning Officer and the Industrial Relations Officer for the N.C.B. (North) Area. Some minor redundancies will occur, but these will be more than offset by the expansion planned for Longannet, and Study Area employment in mining stabilised.

S.I.C. Order transfer and has been adjusted to allow for this.[28] Taking account of both adjustments, the preliminary figure for employment in this industry has been amended to 2,090 persons for 1976.

Further adjustments to either national trend or local modification factors have been made[29] to Engineering and Electrical Goods, Bricks, Potteries and Glass, Construction, Insurance, Banking and Finance, Professional and Scientific Services, and Public Administration and Defence. When the final projected figures for persons employed by industry in the Study Area for 1976 are totalled, the total labour force of 39,655 represents an increase over the period of 6%. This compares to the Beckerman estimated increase in the national labour force over the period 1960-68 of 6.7% and the implicit increase in the National Plan, extended for an equivalent period, of over 7%. On past trends, the relationship between local and national increase seems to be just about right; in the past, the Study Area labour force has grown slightly faster than the Scottish one, which, in turn, has performed rather worse than the U.K. labour force, in terms of employment growth.

One difficulty in methodology remains. In estimating the pattern of employment in the Study Area in 1976, some of the original Beckerman estimates of employment have been increased, in view of the apparent divergence of estimated and actual changes in national employment, or, when applied to the Study Area adjusted for further changes in modification factors. While these adjustments seem defensible when taken individually, overall they might give rise to inconsistencies. If more people are employed in a given sector than was originally estimated, then less must be employed elsewhere than estimated to maintain overall balance in the changes/...

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28. See Chapter 3, section on Trends of Growth and Decline

29. See Statistical Appendix 4.5 for a full account of the adjustments made to these industries, and table 4.6, column (f) for the final projected figures of employment.

changes estimated for the labour force. In fact, comparison of the actual and Beckerman estimated changes in employment for the mid-point in the period of the projection, indicates that there has been a fair degree of compensation between industry groups. While some industries have experienced a considerably greater increase than estimated, in others, e.g. mining, shipbuilding, the rate of contraction has been rather greater than anticipated; equally, other industries have expanded less than forecast, or have even declined.[30] Thus, if adjustments were made for actual changes by the mid-point of the period, they would tend to compensate, and at least a rough balance would be maintained.

The projected employment figures for 1976[31] indicate that Mining and Textiles, the two largest industries at the beginning of the period, will decline markedly over the period, both in terms of relative importance and numbers employed. This decline will be more than offset by increases in employment in most of the other industries, particularly, Professional and Scientific Services, Construction and Distributive Trades. The projections indicate a further shift towards the Services sector, relative to Primary and Manufacturing sectors.

Projections for employment in the twelve main industries have been made to 1981, with the remaining industries projected as a single group. The method of projection used, bearing in mind the problem of falling accuracy over a longer period which faces any method, has been to assume that the relative direction and magnitude of employment changes for 1961-76 will continue to be experienced to 1981; figures for that year have been extrapolated by straight line trend from the 1961-76 employment figures/...

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30. These groups are relatively small in the Study Area and have been left unadjusted in the projections.

31. See table 4.7 for comparison of projections in the main industries for 1976 and 1981.

figures. As a result of this they merely show a continuation of the trends in overall structure, as observed for 1976, with a further increase in the relative importance of the Services sector.

The various employment figures for 1976 or 1981 show that, even ignoring the impact of the University and its secondary growth on the local pattern of employment, marked changes in the industrial structure of the Study Area are likely to take place with a continuing decline in the relative position of the traditionally important industries, a continuation of the trends experienced for 1951-66. For the future, as for that earlier period, the most rapidly expanding sectors will be Services industries, a conclusion supported both by national expectations and by the type of population increases projected earlier in the chapter. The extent to which the development of the University will accelerate these trends is examined in Part II.

Table 4.1

Projected Total Population of the Study Area

	Projection I	Projection II	Projection III
1961	92,905	92,905	92,905
1966	95,755	97,372	98,973
1971	98,467	101,927	105,327
1976	100,911	106,395	111,770
1981	103,330	110,984	118,485

FIGURE 4.2

POPULATION PROJECTIONS FOR THE STUDY AREA TO 1981

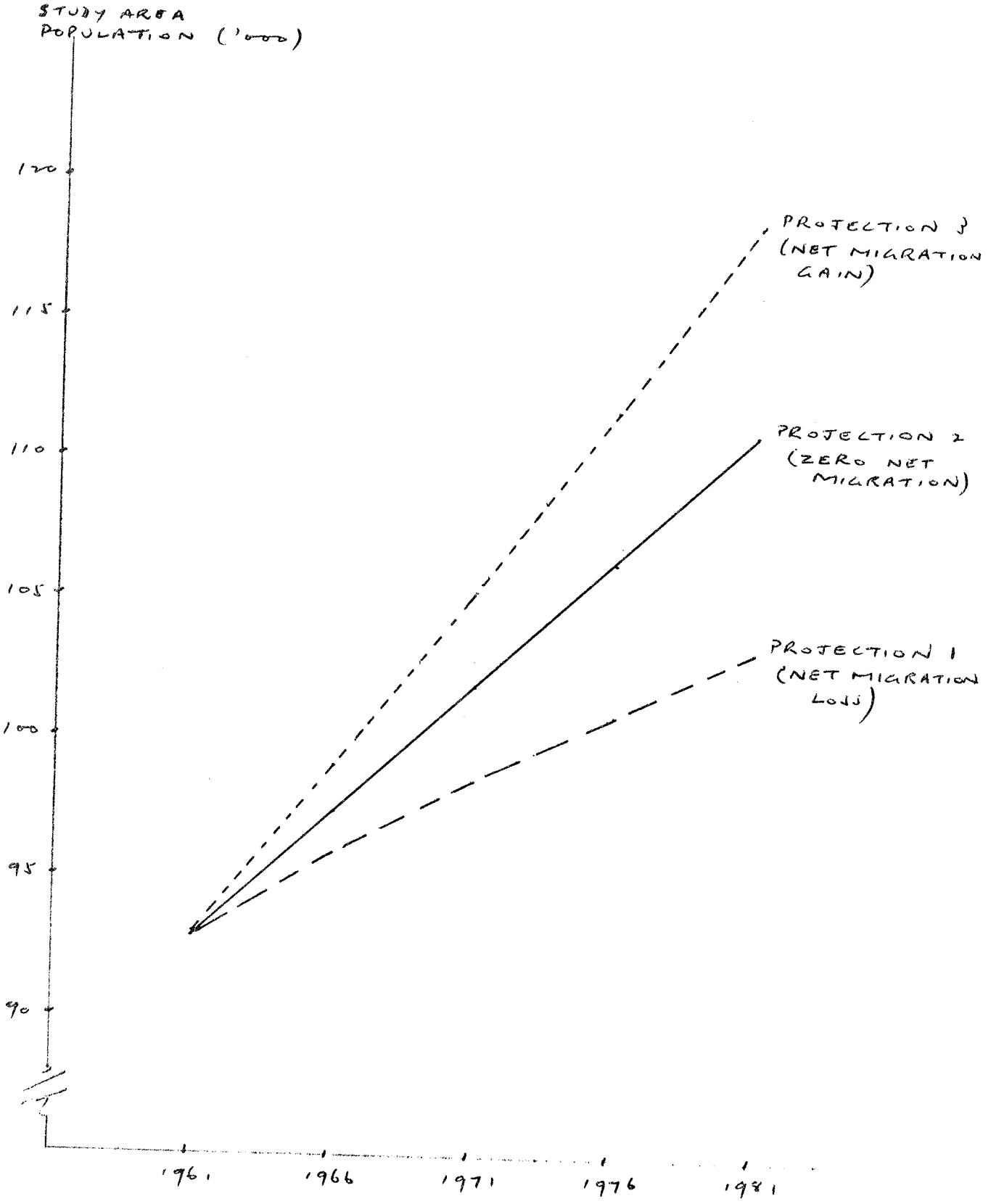

FIGURE 4.3

RATES OF GROWTH OF PROJECTED POPULATIONS TO 1981

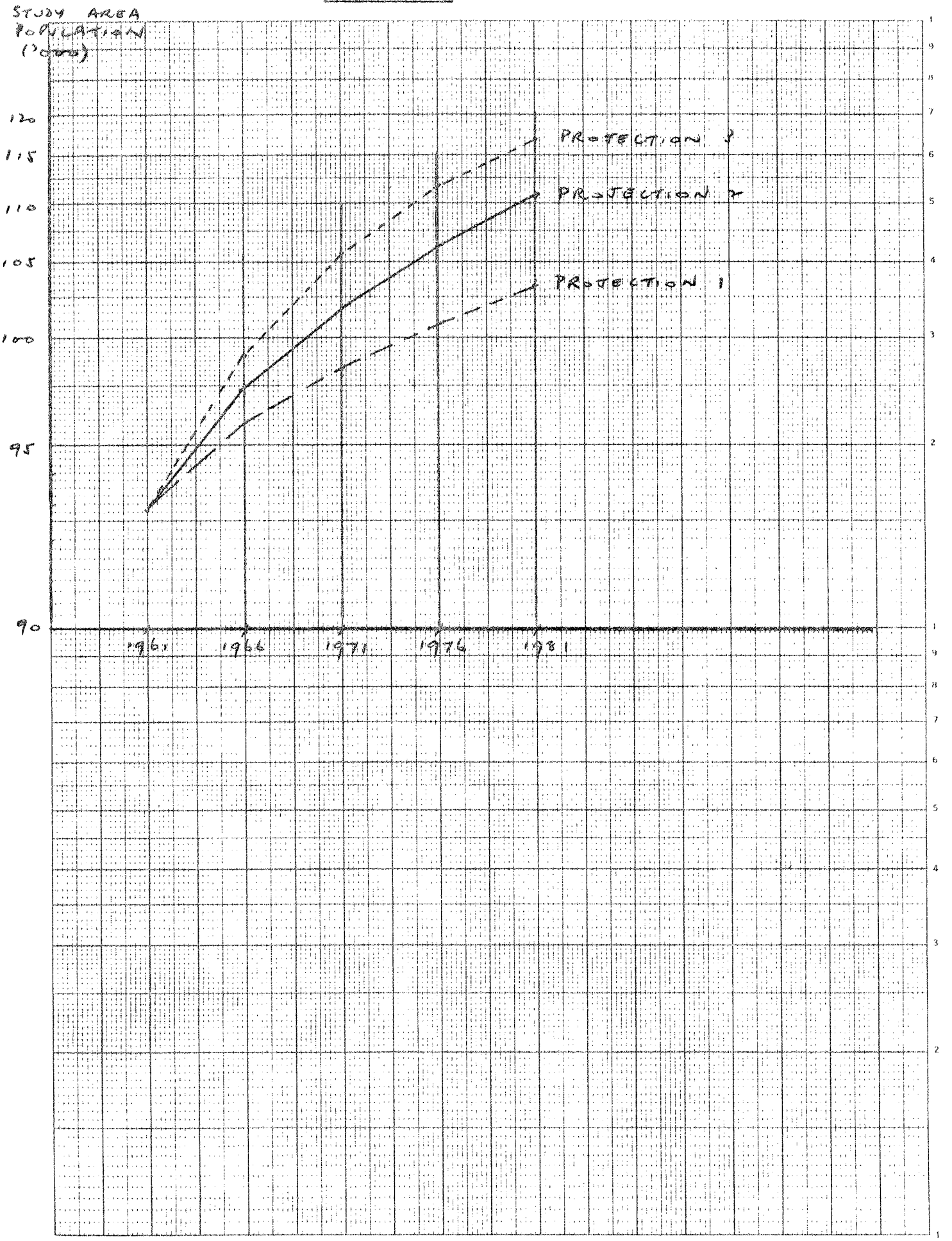

Table 4.4

Age Structure of Projected Population (1976)

	All Persons 1961 and 1976							
	1961		1976					
Age	Persons	%	I	%	II	%	III	%
0 - 14	25,445	27.4	27,152	26.9	28,654	26.9	30,051	26.9
15 - 39	30,614	33.0	35,358	35.0	37,538	35.3	39,722	35.5
40 - 64	27,603	29.7	26,240	26.0	27,934	26.3	29,623	26.5
65 and over	9,243	9.9	12,161	12.1	12,269	11.5	12,374	11.1
	92,905		100,911		106,395		111,770	

Table 4.5

Age Structure of Projected Population (1981)

	1961		1981					
Age	Persons	%	I	%	II	%	III	%
0 - 14	25,445	27.4	27,636	26.7	29,797	26.8	31,825	26.9
15 - 39	30,614	33.0	38,133	36.9	40,877	36.8	43,608	36.8
40 - 64	27,603	29.7	24,859	24.1	27,403	24.7	29,941	25.3
65 and over	9,243	9.9	12,702	12.3	12,907	11.6	13,111	11.1
	92,905		103,330		110,984		118,485	

Table 4.6

Projection of Employment Structure to 1976

S.I.C.	Base population average 1960-62 (a)	Beckerman estimates 1960-75 (b)	National estimates for Study Area (c)	Modification factor (d)	Estimated employment 1976 (e)	Adjusted (f)
1. Agriculture	681	-29.76%	478	1.014	485	485
2. Mining	5,044	-43.32	2,859	0.893	2,553	3,250
3. Food, Drink & Tobacco	2,398	- 3.53	2,313	0.839	1,941	2,090
4. Chemical	17	+25.89	21	0.824	17	17
5. Metal Manufacturing	52	- 4.04	50	0.745	37	37
6. Engineering	1,503	+11.98	1,683	0.941	1,584	1,686
7. Shipbuilding	15	- 3.60	14	0.667	9	9
8. Vehicles	89	+ 4.10	93	0.146	14	14
9. Metal NES	1,070	+ 2.33	1,095	0.972	1,064	1,064
10. Textiles	4,346	-10.60	3,885	1.017	3,951	3,951
11. Leather	32	- 0.59	32	0.167	5	5
12. Clothing	27	- 0.59	27	1.375	37	37
13. Bricks etc	1,340	- 4.08	1,285	1.229	1,579	1,759
14. Timber	420	+ 0.95	424	0.642	272	272
15. Paper	1,569	+10.44	1,733	0.979	1,697	1,697
16. Other Manufacturing	413	+13.73	470	0.774	364	364
17. Construction	2,899	- 2.05	2,840	1.094	3,107	3,663
18. Gas, Electricity etc	880	+41.64	1,246	1.116	1,391	1,391
19. Transport	1,719	- 2.07	1,683	1.002	1,686	1,686
20. Distribution	3,612	+22.41	4,421	0.962	4,253	4,253
21. Insurance	502	+10.27	554	1.266	701	815
22. Professional etc	2,995	+10.27	3,303	1.095	3,617	4,896
23. Miscellaneous Services	3,138	+10.27	3,460	0.999	3,457	3,457
24. Public Administration	2,652	+20.87	3,205	0.829	2,657	2,757
Total	37,413	+ 6.72			36,478	39,655

Table 4.7

Estimates of Employment Structure in the Study Area

S.I.C.	Order	1961	%	1976	%	1981	%
II	Mining	5,044	13.5	3,250	8.2	3,250	7.9
X	Textiles	4,346	11.6	3,950	10.0	3,850	9.4
XX	Distribution	3,612	9.7	4,250	10.7	4,450	10.9
XXIII	Miscellaneous & other	3,138	8.4	3,450	8.7	3,600	8.8
XXII	Professional etc	2,995	8.0	4,900	12.4	5,500	13.4
XVII	Construction	2,899	7.7	3,650	9.2	3,950	9.6
XXIV	Public Administration	2,652	7.1	2,750	6.9	2,800	6.8
III	Food, Drink etc	2,398	6.4	2,100	5.3	2,000	4.9
XIX	Transport	1,719	4.6	1,700	4.3	1,650	4.0
XV	Paper, printing	1,569	4.2	1,700	4.3	1,750	4.3
VI	Engineering etc	1,503	4.0	1,700	4.3	1,750	4.3
XIII	Bricks, glass etc	1,340	3.6	1,750	4.4	1,900	4.6
All other industries		4,198	11.2	4,500	11.3	4,600	11.2
		37,413		39,650		41,050	

CHAPTER 5

The Existing Estimates of the Effect of the University on the Local Area

Whereas Part I of the thesis examined the internal aspects of the population and industrial structure of the Study Area, Part II is concerned with analysing the effect on the local economy of the establishment of the new University. This chapter provides a survey of the estimates of the impact of the University which have been made by other bodies; these estimates can then be compared with the findings of later chapters. Finally, while comments have been made on the effect of the University over a wide range of matters, economic, social and cultural, this and subsequent chapters will be concerned with only the main aspects of impact, namely on population, employment and income; while effect on other fields is also an important consequence of the establishment of a new University, these topics fall outwith the scope of this research.

The main sources of existing estimates are, firstly, the Development Plan Report, 1968,[1] secondly the report to a joint Local Authority Land Use Study Group by a Technical Officers Sub-Committee and, thirdly, the relevant sections of a Traffic Study Report on the Stirling area.[2] The rest of the information on the University tends to be of a fairly superficial nature in the press, with any figures given taken from the above sources.

Population Estimates

Analysis of the effect of the University on local population has been made in three stages/...

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1. Prepared by Robert Matthew, Johnson-Marshall and Partners, the Planning Consultants to the University.
2. Itself part of a larger Transportation Study of East Central Scotland, by Freeman Fox, Wilbur Smith and Associates, March 1969.

in three stages. Firstly, estimates were made of the numbers of students, University employees and the dependents of these. Secondly, estimates were made of the number of jobs which would be created indirectly by the University, with further estimates of dependents for these employees. Finally, this total population was broken into immigrant and resident components.

Growth of student numbers has been limited over the period by the constraint, part financial, part physical, of the University building and construction programme. In view of this, it was estimated that,[3] as the increased space became available, the annual student intake would rise from 150 per annum for Phase 1, to about 850 per annum for Phase 2 and about 1,700 per annum for Phase 3. This would provide a total number of students (including postgraduates) of about 510 by the end of Phase 1 (1969/70), about 3,400 by the end of Phase 2 (1975/76) and about 6,950 by the end of Phase 3 (taken as 1981[4]). This growth in student numbers has been planned against the forecast demand for University places[5] in which, for Scotland alone, demand is expected to rise from below 30,000 per annum in 1966 to over 51,000 per annum by 1980. Phase 1 growth coincides with the plateau in the demand for Scottish places, at about 32,000 per annum. Phases 2 and 3 cover the forecast increase of nearly 20,000 places per annum (or 65%) over only 10 years. The obvious strain that such an increase would place on Scottish Universities was one of the main considerations in the establishment of the new University at Stirling and is probably/...

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3. Development Plan Report, revised figures of Appendix, see table 5.1.
4. Phase 3 size was originally indicated for 1980/81, then left a little more vague as "the early 1980's". While the earlier, more definite date has been retained for projection purposes, it must be remembered that it represents only the long-run equilibrium size of the University, given the requirements of both the Robbins Report and the physical construction problems involved.
5. Report on Higher Education, 1963, CMND 2154, Appendix 1, pp 99-128.

and is probably the source of the planning reference[6] that the University could well be asked to expand to the Phase 3 steady-state by the early 1980's.

The staff figures associated with the various stages of growth have been estimated[3] as 324 for 1969/70, rising to 1,222 by the end of Phase 2 and 2,685 by the end of Phase 3, with academic staff accounting for about half of these. The figures for the various non-academic staff grades have been based on the experience of other Universities; for academic staff, they are based on an assumed staff:student ratio of 1:7.7.[7]

The amalgamated figures for students and staff give a total population of about 4,600 persons for 1976 and about 9,600 for 1981. Further estimates made for 1976 indicate that dependents of students and directly employed staff will amount to a further 2,000 by that year.[8]

So far, it has been estimated that the total population directly associated with the University will amount to about 6,600 persons by 1976, imposing additional demands on housing, schools, hospitals, roads, retailing outlets and other services. To some extent, this increase in demand can be met by additional productivity from the existing labour force in the area but, for the most part, it will involve an increase in the employment in these sectors. Estimates of the magnitude of this secondary growth in employment have been provided for the Local Authorities by the Planning Consultants to the University.[9] By the end of Phase 2/...

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6. Interim Development Plan, paragraph 2.12.
7. See tables and comments on Development Plan Report, p 21.
8. See Report to Land Use Study Group, Appendix A.
9. These figures, given to the Land Use Study Group, were apparently based on estimates from other University or Education sources, primarily on the First Report of the Bristol College of Science and Technology, 1964, on the site at Norwood, Bath. The ratios used were that two students would support one service trade worker and all other University employees one service trade worker each. The dependent ratio was 2.3:1 for service trade workers.

of Phase 2, it was estimated, there would be additional employment in secondary growth industries for about 2,950 persons, linked with a further 6,770 dependents, giving a total population for secondary growth of 9,700. This provided an overall estimate of a population of about 16,500 by 1976. To make further allowance for improvements in productivity in secondary employment and possible over-allowance for services employment, this figure was revised downwards to about 15,000, comprised of 3,500 students and, covering all other employees and dependents, 11,500 others.

The final step was to estimate the number of immigrants to the area from this overall population. It was estimated that, of the original 4,695 total for students and directly employed staff, 3,972 of these would be immigrants[10] and that 1,591 dependents would enter the area with them. This immigrant population of 5,563 would generate secondary employment for about 2,310 persons, on the basis of previous assumptions, who would in turn have about 5,310 dependents.[11] This provided an estimate of an immigrant population of 13,200 persons for 1976. To obtain rough estimates of the possible immigrant population for 1981, the 1976 figures were doubled, i.e. the estimated immigrant population for the later year was given as 26,500 persons.

The other main estimates made[12] were for the combined growth of both the University and a Survey Area[13] population, for the period 1966-86. Estimates made here suggest a much slower rate of population build-up, given that both internal and University growth were included; for the period/...

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10. See table 5.2.

11. There is an implicit assumption here that all secondary employees related to immigrants to the University, would themselves be immigrant to the area.

12. Traffic Study Report, March 1969.

13. The Survey Area for the Report was rather narrower than the Study Area was defined, excluding, mainly, Clackmannan County, Central No. 1 D.C.

period 1966-76, it was estimated that there would be a total increase of 11,000 persons (against the previous estimate of 13,000 immigrants from the University influence alone). For the second projection period, 1976-86, there was estimated a larger increase of 17,800 (against the cruder 13,000 persons from University growth). No details are given as to whether the difference arises from a different phasing of the growth of secondary employment or merely a different rate of internal growth. Taking the entire period 1966-86, the estimated joint increase of 28,700 compares to the previous estimate of 26,500 from University growth alone. Either a much slower rate of internal growth has been taken than seems historically justified, or more likely, a smaller estimate of secondary growth employees and their dependents has been made.[14]

Employment

The effect of the University on employment has not been given anything like the same depth of analysis as its effect on population. At best, it has been recognised that the University will influence the employment position of the Study Area at three levels, namely the employment of construction workers involved in building the University, plus persons employed directly as staff or workers by the University, plus, finally, persons employed in the supporting growth in the Services sector.

No figures have been published for persons employed on the construction work at the University, despite the fact that this source of employment, both in numbers employed and in the duration of the period of activity, is far from insignificant. Figures for direct employment have been taken from the Development Plan for the University.[15] At Phase 2 level, 560 academic/...

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14. No reply was obtained to requests for further details.

15. These figures were summarised in table 5.1; more detailed figures for the various staff grades can be seen in the Appendix of the Development Plan Report.

academic and 620 other staff will be employed, it has been estimated; the Phase 3 numbers are about 1,350 academic and 1,240 other staff. While it was hoped that there would be considerable recruitment from local labour supplies, it was recognised that most of the skilled posts would be filled from immigration; it was expected that reliance on immigration would increase for Phase 3, as local reserves were exhausted.[16] Similarly, the only detailed estimates of the numbers involved in secondary employment were those discussed previously, which were taken from the Land Use Report; here, it was estimated, there would be about 2,300 jobs created by 1976 and between 4,500 and 5,000 jobs by 1981. As regards the nature of secondary employment, all sources[17] content themselves with the opinion that it will be "mainly in the Services sector".[18]

Income

Estimates here are even more general and vague than for the employment section. Mostly they take the form of unquantified, but optimistic comments on the financial stimulus which the local trading community will receive from student and staff income. Indeed, the Traffic Study Report appears to ignore this effect completely.[19] One of the few quantified estimates[20] gives an annual figure of between £1 million and £1.5 millions for student grants by the mid 1970's and a further figure of about £1.5 for staff salaries/...

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16. Land Use Report, Appendix A.
17. Apart from the Land Use Report, see major press articles such as Glasgow Herald 10.2.66, 11.2.66, 2.12.66 and 3.4.69.
18. The Traffic Study Report makes estimates of employment changes over the period, but these have not been accepted by the Local Authorities; part of the problem appears to be the base employment pattern suggested for the region (which has been virtually rejected by the Planning Department and the D.E.P.), and there is also a disagreement of the growth pattern assumed (which gives a Services sector of 74%) of total employment (by the 1980's).
19. Paragraph 5.04 assumes normal East Central Scotland growth of incomes.
20. Glasgow Herald 30.1.68

for staff salaries. A later estimate[21] increases this figure by £1 million representing expenditure annually on University construction work.

The most detailed estimate[22] is that, by the mid 1970's, the University will give direct employment to about 4,600 persons (including students), with additional indirect employment of between 2,000 and 3,000 persons. On the basis of an average annual earnings figure of £1,000 (while students receive less, others earn considerably more), the effect on the University will be to add income to the extent of about £7 millions per annum to the local economy.

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21. Glasgow Herald 20.4.70
22. Times Educational Supplement, 2.9.66

Table 5.1

Summary of University Working Population

	Phase 1	Phase 2	Phase 3
Students (including post-graduates)	510	3,400	6,950
Academic staff and technicians	140	561	1,352
Administrative staff	93	200	429
Work staff and others	76	416	814
Visitors	15	45	90
	834	4,622	9,635

Source: Development Plan Report, 1968

Table 5.2

Estimates of Immigrant Population from Students and Staff for 1976

	Numbers	Immigrants	Percent married	No. married	Family Size	Dependents
Undergraduates	3,000	2,850	10	285	2.0	285
Postgraduates	500	475	25	119	2.5	179
Academic staff	450	436	85	371	3.5	927
Administrative staff	104	10	15	2	3.5	5
Technicians	225	112	50	56	3.5	140
Maintenance	74	22	90	20	3.5	50
Catering	223	22	10	2	3.5	5
Cleaners	74	-				
Visitors	45	45				
	4,695	3,972		855		1,591

Source: Land Use Report, Appendix A, tables 1-3.

CHAPTER 6

Construction of the Regional Multiplier Model

The estimates of the impact of the University on population, employment and income which were given in the previous chapter were all constructed from the viewpoint of physical planning. The purpose of the remainder of the thesis is to provide an alternative set of estimates, based on the macro-economic concept of the income multiplier.

At first sight, the most detailed framework against which the impact of the new University could be measured, would be an Input-Output analysis of the local economy. Ideally, this approach would allow a formal study to be made of the production and distribution characteristics of the individual industries (or, more realistically, the main industries) of the region, as well as their trading inter-relationships between each other and, particularly where the region is as small as the Study Area, with other regions; against the detail of an input-output table, the effects and repercussions of the establishment of a new industry, such as the University, could be traced.[1] However, the construction of such a table, even for a highly simplified matrix of the main industries, would involve an immense expenditure of effort and time, due to the problems of data availability, collection and processing. Even when constructed, the model would be open to criticism on the set of industries chosen, the data used, the accuracy and stability of the coefficients which have been calculated.[2] At least/...

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1. This type of approach was used by Blake and McDowall (Scottish Journal of Political Economy, November 1967) to study the contribution of the University of St. Andrews to the local economy; more recently, the University of Aberdeen are using input-output techniques to study the impact of the aluminium smelter at Invergordon.
2. See Isard, Methods of Regional Analysis, Chapter 8, section C.

At least one writer[3] has been moved to comment that regional input-output models have all the problems of national models, plus some additional ones of their own. The use of the input-output technique for this research was rejected, partly for the problems discussed above, but mainly because it was felt that the objective of this thesis was not to analyse in depth the economic structure of the region, but to assess only the economic effect of a new regional project; this study of change at the margin could be accomplished by the use of an alternative type of model, the regional income multiplier, which has rather less detailed and voluminous data requirements and involves a less rigorous knowledge of inter-industry and inter-regional relationships.[4]

The impact of the University on the population of the Study Area will depend on its impact on employment, both direct[5] and secondary; while direct employment will be governed by teaching and other considerations, the amount of indirect employment generated will depend upon the income received and spent within the Study Area by those directly employed.[6] Effectively, the critical area of impact is the income injected into the local economy by the University, together with its subsequent expenditure. It is in the analysis of this aspect of the growth of the University that the regional income multiplier model can be used; once the impact on income has been quantified, the final estimates for employment and population can follow.

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3. Meyer: Regional Economics, Surveys of Economic Theory II, p 255.
4. In fact, while it is normally, as in Isard and Meyer, presented as an alternative method of analysis to input-output, the regional multiplier approach can be used as a simplified input-output system, by developing the conventional multiplicand; it can be based on selected data, without having to specify even the main inter-sectoral relationships. This is discussed briefly in my article in the Scottish Journal of Political Economy, but is developed more fully by M Greig in his current research thesis.
5. Direct employment excludes construction workers on the University site
6. And, of course, on the L.V.A. component of the University's construction expenditure - see later.

This chapter is therefore concerned with the development of a multiplier model to analyse the income effect of the University. Firstly, it discusses the basic theory of the income multiplier; next, it surveys the series of papers which have appeared recently in British journals on multiplier models, and comments on the results obtained; thirdly, it attempts to bring together the main suggestions made and develop these ideas and relationships into a completed model; and, finally, it selects the multiplier values to be used for the model and provides further estimates of some of the main terms in the model.

The Basic Multiplier Formulation

The basic theory of the income multiplier is simple enough; a money injection into an economic system, whether national or regional, will cause an increase in the level of income in that system by some multiple of the original injection, i.e. where ΔY_r represents the change in the level of the region's income, J the injection and k_r the value of the regional multiplier, then,

$$\Delta Y_r = k_r J \qquad (1)$$

The conventional formulation of the multiplier (k_r) assumes that the level of Investment (I), Government expenditure (G) and regional exports (X) will remain constant and autonomous, then makes allowance for the various leakages during the multiplier process, such as the proportion of the additional income consumed (c), direct taxation and National Insurance contributions (t_d) decline in transfer payments with the rising level of regional income (u), imported consumer goods (m) and indirect taxation (t_i); conventionally, the problem of undistributed profits is ignored in the simple model. These symbols for the various marginal propensities, with the usual relationships, provide the basic formulation towards which all the papers move, despite differences in the approach taken:

$$k_r = \frac{1}{1-c(1-t_d-u)(1-m-t_i)} \qquad (2)$$

Survey of Current Literature

In recent years there has been a considerable wave of interest in formulating and estimating values for regional income multipliers, to allow some evaluation to be made both of the usefulness of this analytical method and, through it, of the consequences of regional stimulation policies. The main contributions on the model have been made by Professor Archibald,[7] Professor Brown and colleagues,[8] Professor Wilson,[9] K Allen,[10] D B Steele[11] and M A Greig.[12] In all cases, these papers set up basic models and, in most, use these to provide estimates of the multiplier effects of various types of projects; having done so, most then suggest ways in which the model might be improved. These suggested modifications fall into two categories, those affecting the basic multiplier formulation and those affecting the formulation of the multiplicand.

Generally speaking, the basic multiplier model set up in most of the papers is either similar to or covers the same types of leakage as the model shown in equation (2). The only basic model to differ substantially[13] from this is the one developed by Greig. This model is particularly interesting, inasmuch as it deals with the impact of a new project on a sub-region, whereas the other models relate to standard planning regions. Secondly, it caters for an inflow of a large body of immigrants to the area to work in the new industry and analyses their effect on indirect employment/...

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7. Regional Multiplier Effects in the U.K., G C Archibald, Oxford Economic Papers, March 1967.
8. The 'Green Paper' on Development Areas, Brown, Lind and Bowers, National Institute Economic Review, May 1967.
9. The Regional Multiplier, a Critique, T Wilson, Oxford Economic Papers, November 1968.
10. Regional and Urban Studies, Ed. Orr and Cullingworth, pp 80-96.
11. Regional Multipliers in Great Britain, O.E.P. July 1969.
12. The Regional Income and Employment Effects of a Paper Mill, Scottish Journal of Political Economy, February 1971.
13. The apparent differences of the Steele model have been caused largely by his amalgamated figure for savings and taxation leakages and the single coefficient value applied to this.

employment generation in both private and public sectors. This regional case study is obviously very similar to the study of the impact of the University.

This immigrant inflow situation has given rise to two main modifications to the conventional model. Firstly, the multiplier process has been separated into a first round of expenditure (of income received from the project), and the other rounds of the multiplier. Since the income received from the project accrues to immigrants to the region, the important factor becomes the overall expenditure pattern of these; for this first round, average rather than marginal propensities are used, with the normal marginal propensities reverted to for all other rounds of the multiplier. The second modification is that an interaction between employment and income multipliers has been identified and is included in the model; the population growth associated with direct and the generated indirect employment increases the demand for public services and, therefore, generates further employment here, the income from which adds to the multiplier effects from the initial injection. Thus, the first round income multiplier (k_a) will have three components, namely income from the wages of direct employees, plus the proportion of this accruing to Local Value Added through expenditure, plus the income of the additional public employees, i.e.

$$k_a = 1 + v + \frac{(E_d + \frac{\Delta V}{\ell})\theta w_p}{E_d w_d} \qquad (3)$$

where v is the proportion of the increase in income which is L.V.A., E_d represents direct employment, ΔV the increase in L.V.A. created by direct employees, ℓ the increase in L.V.A. needed to create an additional job in the service trades, θ the ratio of public service to other employees, and w_d and w_p the average earnings of direct employees and public service employees respectively. For subsequent rounds, the marginal propensities to consume (c*) and tax directly (t*) are used. The autonomous/...

The autonomous item for Government expenditure (G) is split into an exogenous component (G') and an endogenous component (G*), where the latter represents income paid to public service employees and where $G^* = \lambda Y$ (with λ being the income of public sector employees as a percentage of total income). Thus the multiplier for second and subsequent rounds (k_b) becomes:-

$$k_b = \frac{1}{1-\lambda-c^*(1-t^*-u)(1-m)} \qquad (4)$$

and the overall regional multiplier (k_r) can be calculated as:-

$$k_r = 1 + k_b(k_a - 1) \qquad (5)$$

The remaining category of modifications are all concerned with adjustments to the formulation of the multiplicand and can be summarised as:-

a) a modification to include repercussions from inter-regional trade,

b) a modification to take account of leakages from the injection, and

c) a modification to include a feedback effect from induced investment.

The effect of modifying the multiplicand to incorporate repercussions from inter-regional trade has been analysed by Brown and Steele. The multiplied rise in the level of income in region A causes a rise in its level of imports (M_a) through consumption expenditure (C_a); this increase in imports to A becomes, for its non-international component, a rise in the level of exports from other regions in the country (collectively region B), i.e. an injection which raises, through the multiplier, their level of income (Y_b), consumption (C_b) and imports (M_b) in turn.[14] Some of this increase in imports will leak back to region A as an increase in exports, i.e. a further injection causing a further rise in income in A. If $M_b = m_b C_b$ and $C_b = cY_b(1-t_d-u)$, than A's exports will rise by $m_b cY_b(1-t_d-u)$, and the effect of any injection on region A's income being:-

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14. From the Brown model, where Y_b etc. represent changes in the level of income etc., and not the absolute levels.

$$\Delta Y_a = \frac{G_a + m_b c Y_b (1-t_d-u)}{1 - c(1-t_d-u)(1-m_a-t_i)} \qquad (6)$$

The increase in the level of income in region B (Y_b) is generated by the change in the level of A's imports from B in the first place. With similar relationships as before, then, after the multiplier process:-

$$Y_b = \frac{m_a c Y_a (1-t_d-u)}{1 - c(1-t_d-u)(1-m_a-t_i)} \qquad (7)$$

so that this can be substituted for Y_b in equation (6)[15] and the final multiplier for A becomes:-

$$k_a = \frac{G_a\left(1-c(1-t_d-u)(1-m_b-t_i)\right)}{\left(1-c(1-t_d-u)(1-m_a-t_i)\right)\left(1-c(1-t_d-u)(1-m_b-t_i)\right)-\left(m_a(1-t_d-u)\right)\left(m_b(1-t_d-u)\right)} \qquad (8)$$

There is some disagreement as to whether this modification has any significant effect on the multiplier value; Brown argues that it only raises it slightly, from 1.28 to 1.29 for all Development Areas, whereas Steele estimates that it could raise the multiplier value by between 0.06 to 0.16, depending on the region. The clash of opinion seems to be due more to differences in the type of data used and the resultant coefficients, than the formulation of the model.

The second suggested modification to the conventional multiplicand follows from a point raised by Wilson, on the problem of injection leakages.[16] Conventional theory shows how the effect of an injection on a region's level of income will depend upon the nature and importance of the various leakages in the multiplier. Wilson pointed out that the injection itself was subject to leakages before undergoing multiplier expansion; if the industrial structure of the region was such that its capital goods industries were little developed, then it was conceivable that the only part of the injection to pass through to the multiplier would be the wages and salaries of construction workers. Thus, following Wilson, the modified/...

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15. The Steele formulation, given the difficulties of comparison caused by his combined term S and its single coefficient value, appears to be similar to this.

16. Wilson, op. cit., p 378.

modified multiplicand can be expressed as (my symbols),

$$\Delta Y_r = k_r J(1-m^*) \qquad (9)$$

where m^* is the direct leakage in imported capital goods. The importance of this modification is that, if the value of m^* is taken to be the same as m (in the multiplier), say 0.5, which is not excessively high, then

$$\Delta Y_r = k_r J(1-m^*) < J \qquad (10)$$

In other words, if there is a significant import leakage in the injection, then the final multiplied expansion of income could be less than the original expenditure on investment that gave rise to it.

The final modification to the conventional model, following suggestions made by both Archibald and Wilson, is to attempt to incorporate the multiplier-accelerator relationship of a feedback effect from induced investment. In the simple model, I and G are assumed to be constant and autonomous. Wilson[17] argued that, as income and expenditure rise through the multiplier, some additional investment is likely to be induced, particularly if excess capacity is not present. Taken with the type of formulation suggested by the Greig multiplier model, where the income generation process is based on the interaction of income, expenditure and additional employment generated in both private and public sectors, it is reasonable to expect induced investment on increased capacity in both sectors to support the employment thus generated. If induced investment does occur, its effect is to introduce a further component into the multiplicand, with obvious and, it has been argued, considerable effects on regional income levels.

The only attempt to include induced investment in the formulation of the multiplier model was made by Archibald.[18] Looking at induced investment in a situation/...

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17. Op. cit., pp 379-81.
18. Op. cit., p 37.

in a situation where the initial injection or multiplicand took the form of wages and salaries paid to employees in a new project, all of whom were immigrants to the region, he argued that investment would be induced by the immigrants' expenditure; where (my symbols[19]) ΔN represents the annual induced investment in both private and public sectors and ΔZ the total annual earnings of immigrants, and where ΔN is functionally related to ΔZ,[20] i.e., then

$$\Delta N = n\Delta Z \qquad (11)$$

Given the context of Archibald's analysis, his ΔZ is identical to the injection (J) used in the conventional multiplier model, so that he can elaborate on this simple multiplicand and include induced investment as

$$\Delta Y_r = k_r\Delta Z + k_r\Delta N \qquad (12)$$

and, from equation (11), by substitution and rearrangement,

$$\Delta Y_r = k_r(1+n)\Delta Z \qquad (13)$$

In assessing the results of the various models, taking first of all the various multiplier formulations, it would seem that despite the variety of approaches taken, both in algebra and in statistical data used, the final estimated values for k_r tend to group in a fairly narrow range. Archibald estimated in the preliminary stages of his paper that the value would lie somewhere between 1.2 and 1.7, depending on a variety of factors; later he made a "best guess" estimate that the value would be 1.25 for a typical standard region. Brown estimated a value of 1.28 for the Development/...

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19. Archibald uses the symbol ΔI for induced investment, although from his comments elsewhere in the article, he would seem to be including a ΔG element of induced public sector capital expenditure in it. I have changed the symbol to indicate that both sectors are involved.

20. Archibald uses the immigration situation to avoid the functional relationship of $\Delta N = n\Delta Y$, where, given the formulation for the multiplier itself, the denominator may become negative (op. cit., p 37, see footnote).

Development Areas as a whole and about 1.24 for a very small region. Allen estimated that the k_r value for Scotland would be between 1.4 and 1.5. The Steele estimates of k_r for the various regions lie, excluding the Scottish figure, between 1.19 and 1.41; the Scottish figure, as a result of a remarkably low import leakage coefficient, was estimated at about 1.70 to 1.89. Greig's estimate, for the sub-region around Corpach gave the range as between 1.44 to 1.54; the relatively higher values for this small region follow from his modifications to the basic model. Overall, there would seem to be fairly general agreement that the value of the regional multiplier is likely to lie within the range 1.24 to 1.54. The actual value for any given region will depend on a number of factors, such as size, industrial structure and social characteristics, as these affect the various multiplier leakages, particularly the important import leakage.

Taking next the suggested modifications to the multiplicand, the effect of reformulating this to include feedback from inter-regional trade is, as mentioned earlier, somewhat under dispute but, at most, would only increase the range of estimates by 0.16. The other two suggested modifications would seem to be rather more significant. Allowance for import leakages in the multiplicand, as in equation (9) could reduce drastically the final multiplied expansion of income; on the other hand, the inclusion of an induced investment effect could increase considerably the final income expansion.[21]

Development of the Model

Given the broad agreement on the value for k_r it would seem that the most profitable/...

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21. Archibald argues, from equation (13) that if n = 1 (my symbols), then the income change is double that estimated by k_r alone.

profitable area of future development would lie in the formulation of the multiplicand. In view of the relatively small economic base of the Study Area, it is argued that it is unlikely to cause or receive significant repercussions from inter-regional trade; the feedback effects from this source, as in equation (8), are therefore ignored in building up a model to analyse the impact of the University. On the other hand, given the duration of the construction activity on the University campus, the Wilson leakage modification should be incorporated. Equally, given the past levels of economic activity in the Study Area[22] and taking even the most pessimistic of the population increases which have been projected,[23] it seems unlikely that there is or will be any significant underutilisation of capacity in the area. Thus, following arguments advanced by both Wilson and Archibald, the gradual and prolonged rise in the level of income and expenditure associated with the growth of the University, coupled with the considerable inflow of immigrants anticipated,[24] should induce a significant amount of additional investment in the area; the effects of induced investment must also be incorporated into the model.

The model which can be constructed from the suggestions made in the current literature would involve bringing together the suggested Wilson modification, as in equation (9) and the suggested Archibald modification for induced investment, as in equation (12), but this time in the context of a more normal situation where, as for the University employment, there is some proportion of non-immigrants on the staff of the new project (i.e. $\Delta Z < J$). Then:-

$$\Delta Y_r = k_r J(1-m^*) + k_r \Delta N$$

and, by substituting/...

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22. See Chapter 3.
23. See Chapter 4.
24. See Chapter 5.

and, by substituting from equation (11),

$$\Delta Y_r = k_r\left(J(1-m^*) + n\Delta Z\right) \qquad (14)$$

Before attempting to estimate the values of these new coefficients m* and n, it is clear that the modifications suggested need further analysis and redefinition.

Current literature has treated the multiplicand component for the initial injection, as opposed to the component for induced investment, as representing in some situations, the investment expenditure on the construction and equipment of a new project in the region, in other situations as representing the income received in wages and salaries of staff employed in the continuing operation of the project and, indeed, in some cases as loosely representing both sources of regional income. Only Archibald appears to consider the effects of different types of injection and even he does not examine the consequences of the combination of different types of injection. For most new regional projects, e.g. the Pulp and Paper Mill at Corpach, the new University of Stirling and the aluminium smelter at Invergordon, the J component of the multiplicand will have two elements. The first, J_1, will represent the construction expenditure involved in setting up and equipping the project. The second, J_2, will represent the continuing flow of income arising from the employment given by the project. In some circumstances, J_1 will cover only a year or so of expenditure and, since it will have, in theory, no permanent effect on the level of income,[25] can be ignored (as it was by Greig for Corpach, for which his model was effectively $\Delta Y_r = k_r J_2$). In other circumstances, e.g. the continuing period of 14 years of constructional activity associated with the development of the University/...

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25. A typical example of this would be the post-war Hydro-Electric construction programme in the Highlands.

the University of Stirling, to exclude it would be to understate the multiplied income effects of the project. Secondly, it is obvious that when considering the problem of injection leakages, the Wilson modification should be applied to J_1 and not J_2, i.e. equation (9) can be rewritten as,[26]

$$\Delta Y_r = k_r J_1(1-m^*) + k_r J_2$$

or,

$$\Delta Y_r = k_r\left(J_1(1-m^*) + J_2\right) \qquad (9')$$

The importance of applying this import leakage to the construction expenditure component of J is that, since induced investment, as normally defined, relates to the construction of additional capacity in the Services sector (e.g. offices, shops, housing in the private sector and housing, schools, hospitals, roads etc. in the public sector), then a similar injection leakage must be applied to the induced investment component. Thus, depending on the value given to import leakages, the effect of induced investment,on regional income generation could be considerably less than suggested. To restate the model, as given in equation (14), for these corrections

$$\Delta Y_r = k_r J_1(1-m^*) + k_r J_2 + k_r \Delta N(1-m^*)$$

which, by substitution and rearrangement becomes[27]

$$\Delta Y_r = k_r\left(J_2 + (J_1 + n\Delta Z)(1-m^*)\right) \qquad (14')$$

Estimation of the Values of the New Terms

Equation (14') provides the basic model which will be used to estimate the income and employment effects of the University on the Study Area. While/...

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26. By redefining this component, it would seem that it is less likely that $k_r J(1-m^*) < J$, given reasonable proportions for J_1 and J_2.

27. In most cases, where J_1 will be of a temporary nature, unlike the Stirling University case, then

$$\Delta Y_r = k_r\left(J_2 + n\Delta Z(1-m^*)\right).$$

While developed for this purpose, it is nevertheless a model which is open to more general application and is capable of being used to assess the economic impact of any new project on the income level of the sub-region in question, e.g. the aluminium smelter at Invergordon. The values for J_1, J_2 and ΔZ will obviously depend upon the nature of each individual project, although a further examination of ΔZ will be made later in the chapter in view of the importance of this component of the multiplicand for regional income generation. However, the effect of these components on regional income cannot be assessed without some idea of the possible values for n and m*. Without doubt, the more difficult estimate is for the coefficient of induced investment (n), given the various problems to be taken into account in the estimation of regional capital-output ratios.[28] The actual induced investment for any new regional project will depend on factors such as the degree, if any, of excess capacity in the Services sector mainly, the various lags involved in consumers' expenditure and suppliers' reaction, and the size and industrial structure of the region in question. To compound these problems, there is, predictably, the absence of almost the full range of necessary regional statistics, even at standard region level.

In the face of these difficulties, a much more simple approach was taken in the attempt to estimate a plausible value for n.[29] If $\Delta N = n\Delta Z$, then $n = \frac{\Delta N}{\Delta Z}$. Briefly, on the basic assumption that a figure can be taken for capital requirements per immigrant, and further assumptions made as to the period of time over which these capital requirements will be provided, then an annual value for ΔN can be estimated for the group of immigrants. Secondly, the annual value of ΔZ can be estimated by calculating the numbers of the group who will be economically active, and the average/...

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28. Wilson, op. cit., pp 385-87.
29. See Statistical Appendix 6.1.

the average earnings per person of these. The value estimated for n was 2.4. Compared to the estimated national capital-output ratio of about 2,[30] this may seem a little high at first sight. However, it is argued that, while the estimate is undeniably tentative, in a regional situation of a considerable immigration inflow and a reasonable degree of utilisation of existing capacity, a ratio of this magnitude is not totally implausible. If this argument is accepted, it can be seen that both Archibald's and Wilson's comments on the effect of induced investment on a region's income were justified - given that these comments did not take account of import leakages from this component of the multiplicand; indeed, the former commented that "(the) multiplier effects of the migrant's wage are probably much less important than the multiplied induced investment his presence leads to."[31]

The second necessary estimate[32] is for the value of the import leakage coefficient (m*) from construction expenditure in the multiplicand and, in the light of the above comment, the importance of this leakage is obvious. Briefly, apart from the problem of obtaining adequate data, the main problem is that the magnitude of the leakage varies between the different cost elements in construction; Local Value Added can be virtually non-existent in some cost categories, e.g. overheads and capital equipment, but quite considerable in others, e.g. direct labour costs. Using data which reflected national as much as local experience, it has been estimated that the value for m* will lie[33] in the range 0.7 to 0.8, although again this must be regarded as a tentative/...

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30. "Long-term growth and short-term policy", W A H Godley & J R Shepherd, National Institute Economic Review, August 1964.

31. Op. cit., p 37.

32. See Statistical Appendix 6.2.

33. It must be emphasised that this value relates to a sub-region rather than a standard region, where leakages would tend to be less.

tentative first estimate. Despite this, it would seem probable that import leakages from construction expenditure components in the multiplicand are relatively more serious than the import leakages experienced during the multiplier process, where m, for a similar size of region might lie between 0.6 and a maximum of about 0.7. A plausible explanation of this might be found in the unique characteristics of the construction industry, which tend to undermine what are conventionally regarded as the minimal L.V.A. components of mark-up on materials used and wages paid to construction workers. On the one hand, this industry tends to import the bulk of its materials from central depots to the region; on the other hand it also imports central teams of key workers as the core element in the labour force at any given site. By reducing its reliance on local purchases of materials and labour, the industry causes a relatively greater leakage than might be the case for other industries.

An import leakage of this magnitude has obvious and serious effects on the income generation potential of induced investment. Since this was brought into the model by the symbol ΔZ, i.e. annual immigrants earnings, some benefit can be gained from a further examination of this multiplicand component. Basically, three main points can be made. Firstly, only in extreme cases, e.g. where the labour reserves of the region have been entirely exhausted and the manning of new projects depends completely on immigrant labour, will the Archibald situation, where $\Delta Z \equiv J_2$ apply. Normally, ΔZ will be a proportion of J_2, varying with the dependence on immigrant labour, which might be minimal in some projects, when only key management and production training posts are filled from immigration, and very close to the Archibald situation in others. In all situations,

$$\Delta Z = zJ_2 \qquad (15)$$

Substituting this into the formulation of the model would give

$$\Delta Y_r = k_r\left(J_1(1-m^*) + J_2(1 + nz\{1-m^*\})\right) \qquad (14'')$$

which has the benefit of specifying more clearly the immigration source which induces the investment in question.[34] The second main point concerns the estimation of z for the individual project. It must be remembered that, given the assumptions on the time pattern of induced investment made in Statistical Appendix 6.1, the annual total of induced investment is not related to the final proportion of J_2 earned by immigrants at the end of the period of immigration but to the total earnings of any one year's group of immigrants to the project. Thus, if immigrants will ultimately make up 50% of the labour force after a five year period of build-up, z is not $0.5J_2$; if immigration is a steady inflow over the period, then z is $0.1J_2$. To relate induced investment to the total annual earnings of all immigrants would be to overstate seriously the effect on regional income. To complete the second main point, since immigration to any project will typically be biased towards the more senior posts, z cannot be taken as the proportion of immigrant persons in the labour force, but must be weighted to take account of the higher income received where this is the case. For the purposes of the University model, the value of z will be estimated, along with J_1 and J_2 in the following chapter.

The third and probably most important point on induced investment is that, since in the Archibald type of formulation it has been defined as constructional expenditure related to immigration, then, once the period of immigration to the project has finished and the capital requirements of the immigrants have been met, ΔN will drop out from the multiplicand,[35] as would J_1 at, presumably, an earlier stage, and the model will revert to the simple

$$\Delta Y_r = k_r J_2 \qquad (16)$$

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34. In the situation where J_1 is of a temporary nature and is ignored, then of course

$$\Delta Y_r = k_r\left(J_2(1 + nz\{1-m^*\})\right).$$

35. Or, at best, reduce to the annual depreciation on the additional capital stock.

For example, in analysing the impact of the University on regional incomes, there will be a steady build-up of staff and students from 1966 to the early 1980's, with immigration being a significant and steady inflow over the entire period and with there being no evident under-utilisation of capacity from the start. Here, the income multiplier effects of the University for any year during the period of growth would include feedback from induced investment; however, an estimate of income generation for, say 1985, would be made not from the type of formulation of equation (14'') but from (16) above, since immigration will have ceased by this later year and, presumably, the capital requirements of even the final year's immigrants finally met.

It would seem that, at least in the context of the Archibald type of formulation, the effect of including induced investment in the formulation of the multiplicand is not as great as was expected, even in the short and medium term. Nevertheless, during the period of immigration, the model, as given in equation (14'') does indicate that, despite import leakages and the reduced z, the inclusion of an effect for induced investment can still result in a significantly larger multiplicand than might have been used in a more conventional model; if m^* is taken as 0.75, n as 2.4 and z as 0.1, then the effect of including induced investment is to increase the conventional multiplicand J_2 by about 20%, with all the resultant repercussions on income and employment generated.

In conclusion, the model developed for use in estimating the effect of the new University on regional income and, from this, employment and population, is as given in equation (14''), i.e.

$$\Delta Y_r = k_r\left(J_1(1-m^*) + J_2(1 + nz\{1-m^*\})\right)$$

The values for J_1, J_2 and z will be estimated in Chapter 7. The value of m^* has been estimated at 0.75 and n as 2.4. Two values will be taken for k_r to provide a lower case and an upper case estimate of the income/...

income impact. The lower case value of k_r will be taken from the Brown model and estimates for a small region, at 1.24; the upper case value will be taken from the Greig sub-regional model, with its immigrant modifications, at 1.54.

CHAPTER 7

The Impact of the University on Income and Employment

The previous chapter developed the regional income multiplier model from which the estimates of income generation are to be made. It was suggested that lower case and upper case multiplier values should be applied to a multiplicand for the University, which included three components, one for construction expenditure on the University (J_1), one for the total income of staff directly employed and students (J_2) and one covering the estimated additional investment in the area induced by the development of the University, this being related to the earnings of immigrants to the project ($n\Delta Z$).

This chapter falls into three main sections; first it computes the values of J_1, J_2 and ΔZ, then, from the model, estimates the lower and upper case values for income generated by the mid 1970's. Secondly, from the data gathered for these income figures, further estimates are made of the indirect employment generated by the University. An attempt is then made to allocate total employment, direct and indirect, to the various industries involved, to allow the completion of the employment projections of Chapter 4. Following this, broad estimates are made of the impact of the University at its Phase 3 size, i.e. the early 1980's. Thirdly, the estimates made in this chapter from the income and employment models are compared to the estimates made from other sources.[1]

The Effect of the University on Income

The term J_1 represents the expenditure of the University on the construction/...

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1. See Chapter 5.

construction of the teaching buildings, residences and the campus in general, plus the expenditure involved in the equipping and furnishing of these premises, once they have been constructed. While a J_1 component will be present over all phases of University growth, its amount, as an annual value, will vary over the period. For construction expenditure over Phase 2 growth, an average expenditure figure has been calculated for the period 1966-73[2] of £1.37 millions per annum, as financed by both U G C and Appeal Fund sources. While this average includes a downwards bias as a result of the first two, rather unrepresentative, years' expenditure on the Phase 1 Pathfoot buildings, there is, on the other hand, the possibility of a slight slow-down in construction activity from 1973-75; in view of this, the average over the period, rather than for the strict Phase 2 growth, has been retained.[3]

The second component of J_1 represents expenditure on furnishing the premises. While this item, as would be expected, fluctuates with the building programme and the completion of building sections, it has been estimated[4] that it will amount to between £250,000 and £300,000 per annum for the mid 1970's. The actual figure taken is of little consequence; since only minimal purchases have been and will be made from local sources, the import content accounts for 98%[5] of total expenditure, i.e. leaves an annual figure of about £7,000 to be added to J_1.

The final adjustment to J_1 represents the deduction made from this of an annual/...

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2. See table 7.1. Phase 2 construction will end by 1973 and be replaced by further work on the Phase 3 building programme; as yet, no estimates have been made of the annual expenditure for this, although this will, strictly, represent the 1976 income contribution.
3. Given that $m^* = 0.75$, reasonable variation around £1.5 millions will have little effect on income and employment generation.
4. On the basis of discussions with Accounts and Supplies departments.
5. From an analysis of invoices to the Supplies department and discussions with the Supplies Officer.

annual figure for service facilities used by staff and students, which might normally be expected to be provided as part of the induced investment total (ΔN),[6] e.g. staff-student club facilities, restaurants, coffee lounges, shopping facilities etc. on the campus. Expenditure on the provision of these facilities by the University averages, over Phase 1 and Phase 2 growth, at about £66,000 per annum. Deducted from J_1 to avoid double-counting in the multiplicand, it reduces the value of the former from £1.37 millions to about £1.3 millions per annum.

The figure for J_2 will have two separate components, namely the wages and salary bill of direct staff (j_a) and student income (j_b). The value for staff income (j_a) can be calculated for 1976 if estimates are made of staff numbers for the various grades for this year and also of the average income for these grades.[7] Briefly, if staff figures are taken from the Development Plan estimates for 1976, and adjusted for divergencies observed in some grades by 1970/71 and, secondly, for the inclusion of staff paid by non-University funds, this yields a figure of about 1,300 employees for 1976.[8] Taken with the estimates made of the average incomes of the various staff grades (at 1969/70 constant prices), these direct employees will inject a total income of £1.87 millions per annum into the Study Area economy by that year.

The calculation of the figure for total student income proved to be rather more complex.[9] Student numbers were taken from the Development Plan[10] as 3,050 undergraduates and 350 postgraduates. The difficulties lay in estimating/...

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6. See Statistical Appendix 6.1 for fuller discussion of this point.
7. See Statistical Appendix 7.1 for detailed estimates and sources.
8. See table 7.2.
9. See Statistical Appendix 7.2 for detailed estimates and sources.
10. The official view is that the Plan targets may well be exceeded slightly by 1975/76.

lay in estimating the average student income figures. Firstly, the estimates had to make allowance for the three sources from which the student might receive income, namely the grant paying authority, parental contribution and vacation earnings. Secondly, before total students' income could be calculated, further adjustments had to be made to allow for commuting and resident students. Thirdly, in connection with students resident on the campus, the average income had to be stated net of rent paid to the University. There were two reasons for this: firstly, part of the rent received for student residences by the University is remitted directly from the Study Area as capital and interest repayments on loans incurred for the construction of the residences; and, secondly, the remainder of rent receipts is used by the University to pay the wages and salaries of staff connected with the residences. Thus all rent was deducted since, in the former case it leaks from the Study Area and, in the latter case, it has already been counted in the j_a component of the multiplicand. After these adjustments, it was estimated that the annual total net income of the 3,400 students in 1976 would be (at 1969/70 constant prices) £1.07 millions.[11]

However, student rent is not the only source of double-counting which has to be guarded against in the computation of J_2, since both staff and students spend part of their income on catering and other facilities offered on the campus. Part of the receipts from this expenditure are used by the University to pay the wages and salaries of staff employed to provide these services and is therefore already included in j_a; the remainder leaks from the area in purchases of drink, foodstuffs etc,[12] or is absorbed by the University to cover other operational costs. Thus, from/...

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11. See table 7.3.

12. Analysis of the accounts of the refectory and staff/student club shows that only 10% of total purchases are local goods; given the weightings for labour and other costs, this amounts to, at most, 3% of total expenditure on these services.

from $(j_a + j_b)$ must be deducted $(d_a + d_b)$, where the latter represents the deducted expenditure on University services by staff (d_a) and by students (d_b). The values estimated for these deductions were £67,000 and £313,000 per annum respectively, for 1976 (again at 1969/70 prices).[13]

Thus, since $J_2 = (j_a + j_b) - (d_a + d_b)$, where, for 1976, j_a has been estimated as £1.87 millions, j_b at £1.07 millions, d_a at £67,000 and d_b at £313,000, the estimated value for total direct staff and student incomes for 1976 is £2.56 millions.

While, in some situations, the Archibald approach of assuming ΔZ to be identical to J_2 can be taken, (e.g. the effect of a new project on the Midlands, with their low levels of unemployment and virtually exhausted labour reserves), in most cases, as with the University[14] a significant proportion of direct employees will be non-immigrant. For the University, experience has shown that the actual proportion of immigrants will vary between the types of staff; some (e.g. cleaning and catering) will be recruited virtually exclusively from local labour, whereas others (e.g. academic and senior administration and other staff) will be almost entirely immigrant.

Briefly, the estimates of total ΔZ for each grade of staff and students[15] was based on the current and anticipated future patterns of recruitment and admission. For non-academic staff, given the bias of immigration in the past to the more senior posts, the number of immigrants was weighted by salary scales to avoid understating earnings. Finally, the time pattern of the immigration was established and the estimates for the resultant/...

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13. For a detailed discussion of the deductions, see Statistical Appendices 7.1 and 7.2.

14. Particularly for Development Area projects, which are normally established to absorb local labour, even if key technical and management posts have to be filled with immigrants.

15. See table 7.4.

the resultant annual flow of immigrants[16] made; the annual total earnings for a year's inflow of immigrants was estimated at £230,000 (at constant 1969/70 prices) for 1976. Since $\Delta Z = zJ_2$,[17] for the purposes of the model, the value of z can be estimated at 0.09 J_2.

The income multiplier model was developed in the previous chapter as:-

$$\Delta Y_r = k_r\left(J_1(1-m^*) + J_2(1 + nz\{1-m^*\})\right)$$

As discussed there, a lower case and an upper case value for k_r will be used to provide a range within which the additional income attributable to the University will lie at the end of Phase 2 growth in 1976. Filling in the values of the various terms in the model,[18] it has been estimated that, in the lower case, the increase in regional income generated by the University will be £3.75 millions and the upper case increase £4.66 millions, both at constant 1969/70 prices. By 1976, the effect of the University will be to add between about £4 millions and £5 millions to the income level of the Study Area.

It is interesting to compare these estimates to those which would have been made by the other types of model which were discussed in Chapter 6. Dropping the component for induced investment and taking only $(J_1\{1-m^*\} + J_2)$ as the multiplicand, i.e. expanding the conventional multiplicand to include construction expenditure, as adjusted for import leakages, the estimated range becomes £3.58 millions to £4.44 millions; the exclusion of the component for induced investment, weakened as it is by the assumption of a time pattern for investment and the heavy import leakages involved, reduces the estimated income generated by about 5%. While it still provides a significant boost to the multiplicand, the importance/...

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16. See Chapter 6 and also Statistical Appendix 7.3 for a discussion of the need to apply a time pattern to immigration in order to estimate an annual total for induced investment.
17. Chapter 6, equation (15).
18. See table 7.5 for a summary of the values.

the importance of induced investment is not nearly of the magnitude suggested by many of the writers on multiplier theory. Finally, if construction expenditure is also dropped from the multiplicand and only the conventional J_2 subjected to the multiplier, the estimated range becomes £3.17 millions to £3.94 millions.

The above series of estimates underlines the importance of specifying clearly the multiplicand relating to the project. The effect of including values for construction expenditure and induced investment, despite their heavy leakages, is to increase the size of the conventional multiplicand by, for the University, 18%. Given the range of values estimated for the multiplier in Chapter 6, the result of the fuller multiplicand used here, would be to increase the total income generated by between 22% and 28%.

The Effect of the University on Employment

As in the previous section, the estimates for the impact of the University on employment will be given as a range between lower and upper case figures. The overall effect of the University on employment will be made up of, firstly, the employment in the construction of the campus, secondly the direct employment at the University and, thirdly, the indirect employment generated in the supporting industries. Numbers for direct employment have been estimated in the previous section; this leaves estimates to be made of the employment in construction and indirect employment for 1976.

Total construction expenditure for 1976 has been estimated as about £1.3 millions and, from data obtained elsewhere,[19] it can be assumed that 30% of this/...

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19. See Statistical Appendix 6.2, breakdown of construction costs.

of this, or £390,000 will represent wages paid to construction workers.[20] The average earnings of construction workers in Scotland for 1969 were about £1,220 per annum.[21] Taken with the wages bill of £390,000 this would seem to indicate a total labour force in University construction of about 320 workers by 1976.

The estimation of indirect employment was approached through the type of formulation given by the Greig employment multiplier model,[22] as checked against the much cruder type of approach as used for the construction worker estimates.[23] Using the basic information already gathered on employment in construction in the University itself, and on the income injection of these employees and students, coupled with assumptions on the L.V.A. component of this when spent locally, it can be estimated that, by 1976, the lower case figure for direct employment will be about 850 persons and the upper case about 1,650 persons.

Given[24] a combined figure for University staff and construction employees of 1,596 persons by 1976, the lower case to upper case range of estimates for indirect employment of between 850 and 1,650 persons, when added to this, provides a final estimate that the effect of the University on employment in the Study Area will be to add between 2,450 and 3,250 additional jobs to its employment structure.

The next step is to break down these figures for employment into a S.I.C. order pattern/...

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20. Following the D.E.P. classification system of employment, these are employees at workplaces within the Study Area, although they may well commute to the area from outside; the impact on local employment is not confined to local residents.

21. D.E.P. Gazette, March 1970, table 122.

22. Greig, op. cit., pp 33-35.

23. See Statistical Appendix 7.4 for the modifications to the Greig model and confirmation of the results by the simpler approach.

24. See table 7.6.

order pattern, to provide some idea of the nature of the demand for labour stemming from the development of the University and to allow the amalgamation of the University impact figures with the earlier projections of employment in the Study Area to 1976.[25] The allocation of the University development employment to S.I.C. orders was made on the basis of two assumptions: firstly, it was assumed that the indirect employment created by the University would follow the same S.I.C. pattern as the probable pattern of the expenditure of University incomes, since the employment would be generated by this expenditure; secondly, it was assumed that the expenditure pattern of the total income of University staff, students and construction workers would be similar to the Scottish one, as given by the Family Expenditure Survey, averaged over the years 1967-69.[26] Having established the expenditure pattern by S.I.C. order,[27] this was used to allocate the indirect employment. Finally, the construction workers were allocated to S.I.C. order XVII (Construction) and University employees to S.I.C. order XXII (Professional and Scientific services[28]) and these added to the breakdown of indirectly employed.[29]

As a result, it was estimated that in the lower case, the University would account for just over half of the total employment figure of 2,450, with Distributive Trades (accounting for 18% or 450) and Construction (16% or 390 persons) as the next two largest industrial groups. In the upper case allocation, since the figure for University employment is unchanged/...

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25. See Chapter 4, table 4.6.
26. For detailed estimates, sources and discussion, see Statistical Appendix 7.5.
27. M.L.H. definitions can be used to provide a rough conversion of the detailed analysis of the expenditure categories to S.I.C. orders - see Statistical Appendix 7.5.
28. The D.E.P. allocate by workplace, not occupation; all University employment is allocated to M.L.H. 872, in Order XXII.
29. See table 7.7.

unchanged, the University proportion falls to about 39% of the total; the next two largest groups remain Distributive Trades (27% or about 870 persons) and Construction (14% or about 450 persons).

As predicted, the main employment impact of the University will be felt by the Services sector, which will, by 1976, account for between 47% and 48% of the labour force of the Study Area, since about 83% of the employment from the University source has been estimated to fall in this sector. However, the analysis does indicate that about 17% of the additional employment will be in Construction and Manufacturing, mainly. Equally, employment in Services will not be exclusively in the Distributive Trades - a conclusion often explicit, or implicit, in the other forecasts of employment effect.[30]

Finally, this breakdown of employment from the impact of the University was amalgamated with the earlier employment projections for the Study Area, to provide final estimates of the employment pattern of the area, covering both internal and University inspired growth.[31] It would seem that the effect of including employment from the development of the University is to raise the earlier projected increase in employment over the period from about 6% to, in the lower case, 12% and, in the upper case, to over 14%. Thus the growth of the University could at least double the rate of growth in employment which could reasonably have been expected over the period 1961-76.

Again, the impact of the University, while it does not alter greatly the projected ranking of the main industries, does tend to exaggerate or confirm/...

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30. There is a minor reservation here in that the implicit assumption of an average expenditure/job ratio involved in the method of allocation could cause some understatement of employment in lower paid industries such as Distribution; however, it would be unlikely to raise numbers enough to change the conclusion.

31. See table 7.8.

confirm the importance of the growth sectors. Professional and Scientific Services, under the impetus of growth from both internal and University sources, increases from the 5th largest industry in 1961 with about 3,000 employees, to be the largest industry by 1976, with about 6,200 employees. Another industry which is affected by both sources of growth is Distributive Trades; from the 3rd largest in 1961 with about 3,600 employees this has been projected to increase to the 2nd largest, with about 4,700 to 5,100 employees. Again, Construction, the 6th largest industry in 1961, with about 2,900 employees, has been projected to increase to over 4,000 employees by 1976 and become the 3rd largest Order. The other main industries affected by University growth, although to a much lesser extent, are Public Administration and Miscellaneous Services; the effect on the other S.I.C. orders is insignificant.

The Income and Employment Impact by 1981

Finally, estimates must be made of the impact of the University on incomes and employment by the end of the Phase 3 growth in 1981.[32] By then the construction work on the University will have been completed so that the injection effect of this can be taken from the multiplicand. In addition, while the date for the completion of Phase 3 growth (i.e. 6,000 students steady state size) has been taken as 1981, this is intended to represent the equilibrium situation which should occur in the early or mid 1980's; in equilibrium immigration to employment in or study at the University will cease, as will the investment induced by this immigration situation,[33] so that this component too must be taken from the multiplicand. The model will then revert to the simple form of equation (16) in Chapter 6

$$\Delta Y_r = k_r J_2$$

With J_2/...

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32. See Statistical Appendix 7.6 for the detailed estimates and discussion of the 1981 income and employment figures given in this section.

33. As discussed in Chapter 6, this will reduce to a replacement level.

With J_2 for 1981 estimated as £5.19 millions, at constant 1969/70 prices, the effect of the University on the flow of income in the Study Area will be to add between, in the lower case £6.5 millions and, in the upper case, about £8 millions per annum to this.

Considering next the effect on employment in the Study Area, the completion of construction will mean that direct employment will consist solely of employment in the University itself; by 1981 this will amount to about 2,700.[34] Using again the modified Greig employment multiplier, it can be estimated that indirect employment by 1981 will amount to between 1,600 to 3,100 jobs. Thus, overall, it can be estimated that the University will add between 4,300 and 5,800 jobs to the demand for labour in the Study Area by 1981. Using the F.E.S. allocation approach to provide only the broad categories of Primary, Manufacturing, Construction and Public Utilities, and Services employment, it can be estimated that both Primary and Manufacturing sectors will continue to decline over the period in terms of relative size.[35] Construction gains marginally from internal and University sources in numbers employed, but declines a little in terms of relative size. Services, gaining employment from both sources increases to about 50% to 52% of the total labour force by 1981. The combination of internal and University growth will cause a massive shift from the older, traditional sources of employment to a new employment structure where one in every two jobs will be in Services and only one in three in Primary and Manufacturing.

Comparison of Estimates

If the estimates of employment made in this chapter are compared to the estimates/...

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34. Taken directly from the Development Plan, Appendix figures, without adjustment for current experience, on the grounds that current divergencies cannot be taken as a guide for 1981.

35. See table 7.9.

estimates made for the Land Use Group,[36] then apart from a marginal difference in the figures of University staff for 1976, there is a considerable difference in the estimates made for the indirect employment generated by the University; even the upper case University figure falls short of the Land Use Group estimates by about 1,300 jobs.[37]

The estimates provided for the Land Use Study Group were based on the assumption that there would be student: direct employees and staff: indirect employees ratios of 2:1 and 1:1 respectively; these ratios were supported apparently by the experience of the Bristol College of Science and Technology,[38] although the Planning Consultants adjusted the final estimates downwards in their conclusions to bring them more into line with further figures suggested by the County Planning Officers of Kent and Cambridgeshire.[39]

It is argued here that both the Bristol-based ratios and the lower ratios implicit in the revised figures are too high; it may be that they reflected the experience of areas in which there was a complete absence of the type of service facilities needed by a new College or University. The Study Area, before the establishment of the University, catered for a considerable through tourist trade and also provided service facilities for an extensive catchment area throughout the year; a developed base of service facilities does exist and, while this will have to be expanded to cater for the development of the University, this growth will hardly be of the magnitude suggested by the above ratios.[40] Secondly, given the formulation/...

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36. See Chapter 5.
37. See table 7.10.
38. Land Use Report, 1966, Appendix A, p 2
39. Land Use Report, 1966, Appendix A, pp 1 and 2, also Report, p 1.
40. The student ratio implies that the entire income of two students must be spent locally and pass, without leakage, entirely into wages of service sector employees to support one additional job (excluding, among other items, other components in the type of cost per job calculations performed by Brown and Greig).

the formulation of both the regional income and employment multiplier models, it is not defensible to apply directly ratios relating to Bristol or Kent/Cambridgeshire to the Study Area. In the income model alone, the various leakages, particularly for imports, are likely to be quite different; it seems reasonable to expect[41] rather larger multiplied effects for both income and employment in such English areas where, due to the lower leakage coefficient values, more income passes from the multiplicand to second and subsequent rounds of the multiplier, thus generating a higher total for expenditure and, through this, indirect employment, than could be expected for the Study Area. Apart from the existence of services facilities then, the estimates based on the multiplier models should be more accurate; at least, given the various leakages, the additional income generated is sufficient to support the indirect employment as estimated by the employment multiplier.[42]

No detailed estimates of employment have been made for 1981, beyond those implicit in the suggestion that the total population attributable to the University would probably double between 1976 and 1981. If the earlier ratios for indirect staff are applied to the estimates of direct staff and students, the result is to approximately double the number of jobs in indirect employment;[37] the resultant estimate of over 6,000 jobs in indirect employment is well in excess of the 1,600 to 3,100 estimated here, for the reasons discussed above.

Comparison with the estimated figures for income[43] shows that the only other estimates, both of which relate to the mid 1970's, again differ from/...

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41. This type of difference in regional multiplier values is suggested by work such as Steele, op. cit.
42. See Statistical Appendix 7.4 for check on Greig multiplier values.
43. See Chapter 5.

from those made in this chapter. The range of estimated income generation of £4 millions to £5 millions by 1976, as derived from the income multiplier, contrasts to the estimates of, in one case, about £3 millions and, in the other, about £7 millions.

In conclusion, it has been estimated from the regional income and multiplier models used in this chapter that the effect of the University will be to increase the income level of the Study Area by between £3.75 millions and £4.66 millions by 1976 and between £6.5 millions and £8 millions by 1981, all at constant 1969/70 prices. The effect on employment will be to add a total of between 2,450 to 3,250 jobs to the local economy by 1975 and a total of 4,300 to 5,800 jobs by 1981. These estimates, particularly those concerning indirect employment generation, differ considerably from estimates made in earlier years; given the reliance on immigration for at least part of the estimated increase on employment, these differences will have further repercussions on the estimates of the effect of the University on local population and, therefore, for Local Authority planning on housing, schools, hospitals, roads etc.[44]

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44. A recent article in the Stirling Observer, 20.7.71 indicates that current planning for housing, service facilities and industrial space are still based on the estimates given in Chapter 5.

Table 7.1

Construction Expenditure on University

Year	U.G.C. £'000	Appeal Fund £'000	Total £'000
1966-67	606	-	606
1967-68	594	-	594
1968-69	1,200	944	2,144
1969-70	1,138	646	1,784
1970-71	1,150	276	1,426
1971-72	1,160	41	1,201
1972-73	1,120	700	1,820
1973-74	-	-	-

Source: Estates and Buildings plan of expenditure

Table 7.2

Estimate of Wages and Salaries Component of J_2 (1975-76)

Staff	Estimated staff numbers	Estimated average wage/ salary	Estimated total wage/ salary (£'000)
Academic	453	£2,328	1,055
Departmental	178	1,182	210
Administration	114	1,372	156
Library	53	1,435	76
Others	478	771	369
	1,276		1,866

Table 7.3

Estimates of Students' Income 1975-76

Students	Numbers	Net Income from grant 1975-76 (per student) £	Total net student income (£'000)
Undergraduates			
University residents	2,044	266	543.7
Private lodgings	396	364	144.1
Home:			
within Study Area	305	294	89.7
outside Study Area	305	221	67.4
Postgraduates			
University residents	234	360	84.2
Private lodgings	46	550	25.3
Home:			
within Study Area	35	550	19.3
outside Study Area	35	413	14.5
	3,400		988.2
Vacation earnings (per student) £25			85.0
			1,073.2

Source: Statistical Appendix 7.2

Table 7.4

Estimates of Earnings of Immigrants for 1975-76

	Estimated net income (£m)	Estimated share for 1975-76 immigrants	Estimated ΔZ for 1975-76
Students	0.757	10.6%	£80,242
Staff			
Academic	1.022	11.1	113,442
Departmental	0.197	7.2	14,184
Administration	0.148	6.7	9,916
Library	0.72	8.9	6,408
Others	0.358	2.1	7,518
			£231,710

Table 7.5

The Value of the Terms in the Model for 1975-76

J_1	£1.30 n.
J_2	£2.56 n.
ΔZ	£0.232 n.
k_r (lower)	1.24
k_r (upper)	1.54
m*	0.75
n	2.43
z	0.09
ΔY (lower)	£3.75 millions (at 1969/70 prices)
ΔY (upper)	£4.66 millions (at 1969/70 prices)

Table 6

Estimated Employment Effect of University (1975-76)

University staff		
Academic	453	
Departmental	178	
Administration	114	
Library	53	
Others	478	
		1,276
Construction workers on University site		320
"Direct employment"		1,596

	Lower	Upper
Indirect employment	850	1,650
Direct employment, say	1,600	1,600
Total employment	2,450	3,250

Table 7.7

Estimated Breakdown of Employment Effect of the University 1975-76

S.I.C. order		Lower Case (persons)	%	Lower Case (persons)	%
III	Food, Drink & Tobacco	26	1	50	2
XVII	Construction	388	16	452	14
XVIII	Gas, Electricity & Water	26	1	50	2
XIX	Transport & Communication	17	1	33	1
XX	Distributive Trades	450	18	874	27
XXII	Professional & Scientific	1,280	52	1,280	39
XXIII	Miscellaneous Services	127	5	247	8
XXIV	Public Administration	136	6	264	8
		2,450		3,250	

Table 7.8

Projected Employment Structure in the Study Area 1961-1975/76

S.I.C. order		(a) 1961	%	(b) 1976	%	(c) University employment 1976 lower	upper	(d) Total estimates lower	%	upper	%
II	Mining	5,044	13.5	3,250	8.2	-	-	3,250	7.7	3,250	7.6
X	Textiles	4,346	11.6	3,950	10.0	-	-	3,950	9.4	3,950	9.2
XX	Distributive Trades	3,612	9.7	4,250	10.7	450	874	4,700	11.2	5,124	12.0
XXIII	Miscellaneous Services	3,138	8.4	3,450	8.7	127	247	3,577	8.5	3,697	8.6
XX	Professional & Scientific	2,995	8.0	4,900	12.4	1,280	1,280	6,180	14.7	6,180	14.4
XVII	Construction	2,899	7.7	3,650	9.2	388	452	4,038	9.6	4,102	9.6
XXIV	Public Administration	2,652	7.1	2,650	6.7	136	264	2,786	6.6	2,914	6.8
III	Food, Drink & Tobacco	2,398	6.4	2,100	5.3	26	50	2,126	5.1	2,150	5.0
XIX	Transport	1,719	4.6	1,700	4.3	17	33	1,717	4.1	1,733	4.0
XV	Paper & Printing	1,569	4.2	1,700	4.3	-	-	1,700	4.0	1,700	4.0
VI	Engineering	1,503	4.0	1,700	4.3	-	-	1,700	4.0	1,700	4.0
XIII	Bricks, Potteries & Glass	1,340	3.6	1,750	4.4	-	-	1,750	4.2	1,750	4.1
All other orders		4,198	11.2	4,500	11.4	26	50	4,526	10.8	4,550	10.6
Total		37,413		39,550		2,450	3,250	42,000		42,800	

Summary:-

	1961	%	1976 Growth without University	%	Growth including University lower		upper	
Primary	5,725	15.3	3,735	9.4	3,735	8.9	3,735	8.7
Manufacturing	13,291	35.5	13,002	32.9	13,028	31.0	13,052	30.5
Construction & Public Utilities	3,799	10.1	5,054	12.8	5,468	13.0	5,556	13.0
Services	14,618	39.1	17,759	44.9	19,769	47.1	20,457	47.8
	37,413		39,555		42,000		42,800	

Table 7.9

Breakdown of 1981 Employment Effect into Broad Groups

			1981			
	1961	%	lower	%	upper	%
Primary	5,725	15.3	3,700	8.2	3,700	7.9
Manufacturing	13,291	35.5	13,207	29.2	13,252	28.4
Construction etc	3,779	10.1	5,517	12.2	5,682	12.2
Services	14,618	39.1	22,811	50.4	24,101	51.6
	37,413		45,235		46,735	

Table 7.10 (a)

Comparison of estimates (1976)

	Existing estimates	University model estimates	
		lower	upper
Students	3,400	3,400	3,400
University staff	1,222	1,596	1,596
Indirect employment	2,945	850	1,650
Total	7,567	5,846	6,646

Table 7.10 (b)

Comparison of Estimates (1981)

	Existing estimates	University model estimates	
		lower	upper
Students	6,950	6,950	6,950
University staff	2,685	2,685	2,685
Indirect employment	6,160	1,600	3,100
Total	15,795	11,235	12,735

CHAPTER 8

The Impact of the University on Population

The impact of the University on the population of the Study Area will depend on the number of immigrants to the area who will be associated with the development of the University. The purpose of this chapter is to provide estimates of the additional population directly attributable to the University at the completion of its two main growth phases, i.e. for 1976 and 1981.

The immigrants who will form the basis of the population effect of the University will consist of non-local students, academic, administrative and other directly employed staff, plus immigrants to the area for employment in the jobs generated in the secondary growth industries as a result of the University. The final immigrant population will be made up of these persons plus their dependents.

One way of estimating these numbers would be to use a questionnaire of staff and students to establish the patterns of age, sex, married proportions and family size, then take this as a 1970/71 population base for the population projection model developed in Chapter 4, to project for 1976 and 1981; assumptions of the timing of growth in numbers of students, staff and dependents, could be incorporated as the migration inflow data. This approach was not taken since, firstly, the existing age structures of students and staff are badly distorted towards the younger age groups[1]/...

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1. The current age structure for students is distorted by the build-up from small initial intakes of 1967/68 and 1968/69, followed by the larger Phase II intakes of 1970/71 onwards. For staff, recruitment and senior appointments in the early years of the University have also resulted in a considerable divergence from the average pattern - University Court Papers.

younger age groups and would not provide a satisfactory population base and, secondly, the timing of the questionnaire, during the period of settlement into the new permanent buildings, would have caused a great deal of inconvenience, no matter how simply the form was constructed.

Accordingly, the approach adopted was to take the population age structure and sex figures as being the same as the pattern for Scottish universities as a whole, with dependents also calculated from average Scottish figures, as estimated by the Registrar General for Scotland, or as shown in the Sample Census of 1966, for Scotland. Since, over the period of its growth, the new University will "age" towards the average pattern for all Scottish universities, the method is fairly defensible.

The chapter firstly estimates the total immigrant population attributable to the University for 1976, and compares this to the existing estimates given in Chapter 5. Next, a similar exercise is performed for 1981. Finally, the University population is added to the earlier projections of Chapter 4 and the general implications for the Study Area of the overall population and its age pattern discussed.

Estimates of Immigrant Students, Direct Staff and their Dependents for 1976

The figures for undergraduate and postgraduate students have been taken from the Development Plan.[2] From these figures have been deducted the estimated number of students already resident in the area,[3] to provide final estimated figures for students immigrant to the Study Area in 1976 of 2,898 undergraduates and 334 postgraduates. If the age and sex distribution of these follows the Scottish pattern then it can be expected that 93% of undergraduates and about 51% of postgraduates will fall/...

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2. Development Plan, Appendix C.
3. Statistical Appendix 7.3, pp 1, 2 and table (a).

fall into the age range 15-24, and that there will be 2,221 male and 1,011 female students.[4]

The next stage is to provide estimates of the number of dependents brought into the Study Area by these immigrant students. In the absence of official statistics, local and S.E.D. grant sources suggest that about 10% of undergraduate and 50% of postgraduate students will be married. Making allowances for female students married to male students,[5] both at the University of Stirling, or married to persons already resident in the area, or to persons resident within commuting distance of the Study Area, it has been estimated that there will be 326 wives brought into the Study Area who have not been included in any other population estimate for 1976. Next, to estimate the number of child dependents of these married students, use has been made of Sample Census (1966) material on household composition by socio-economic group;[6] from this it has been estimated that there will be a further 313 child dependents, giving a total immigrant population of about 3,900 students and dependents.[7]

Next, the number of academic staff, covering all full time teaching and research personnel, has been estimated earlier[8] as 453 persons by 1976; if these follow the average sex pattern for all universities, 90% will be male staff and 10% female staff. All staff will be immigrants to the area.[9]/...

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4. See Statistical Appendix 8.1. In fact there may well be fewer female students than suggested by the Scottish pattern due to the bias at Stirling towards sciences and technology in the subjects offered.
5. These female students have been counted as immigrant dependents rather than separately as immigrant students - see Statistical Appendix 8.1.
6. Sample Census, 1966, Household Composition tables, table 23, p 80.
7. See table 8.1.
8. Statistical Appendix 7.1, table (a).
9. Statistical Appendix 7.3.

area. To provide estimates of the number of dependents it has been assumed that female staff will either be married to male staff (academic or other) or will be single and have no dependents. Hence adult dependents will be wives of married male staff; to obtain figures for these, it has been assumed that there will be the same proportion of married males per age group as for all professional employees in Scotland.[10] With the resultant figure of 331 married households in academic staff, again, given the professional employee pattern, it has been estimated that there will be 621 child dependents, 318 male and 303 female. Thus, with the 439 staff[11] there will be a population in 1976 of about 950 dependents. Even taking the slightly older age pattern for all Scottish universities, this immigrant population section will be relatively young; about 80% of this population will be aged under 40.[10]

Non-academic staff have been estimated in two components: firstly, effectively non-manual workers, i.e. departmental, administrative and library staff, where there is a fair proportion of immigrants; secondly, estimates have been made for all other directly employed staff, effectively manual workers, i.e. work staff, maintenance, porters, groundsmen, cleaners and caterers, where there is a rather smaller proportion of immigrants.[12] Of the original estimated total[13] of 823 staff in these various grades, it has been estimated that only 104 male and 178 female staff, a total of 282, will be immigrant to the area and therefore/...

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10. See Statistical Appendix 8.2 for detailed working and sources.
11. The shortfall is due to the exclusion of married female staff, who will appear as dependents here, or elsewhere. See Statistical Appendix 8.2
12. See Statistical Appendix 8.3 for sources and detailed working.
13. Statistical Appendix 7.1.

therefore be part of the impact of the University on local population.[14] It has been estimated that there will be a further 181 dependents of these employees, consisting of 84 wives and 97 children.[15]

Thus the total immigrant population in 1976 of students, direct staff and dependents can be estimated at about 5,700, consisting of about 4,000 staff and students and about 1,700 dependents, 1,000 of these being children.[15]

Estimates of Population from Secondary Growth by 1976

To complete the estimates for population impact, the immigrant population attributable to the growth of secondary employment generated by the University must be calculated.

Two figures for secondary employment have been estimated earlier,[16] giving a range from a lower to an upper case. The lower case estimate was based on a low value for the regional income multiplier and a high value for the necessary amount of L.V.A. needed to create an additional job. The upper case estimate was based on a higher value for the regional multiplier and a lower ratio of L.V.A.:employment creation. It was estimated[17] that the figures for secondary growth employment generation would lie between the 850 of the lower case and the 1,650 of the upper case, for 1976.

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14. To what extent local residents employed by the University might have emigrated if there had been no employment of this nature (e.g. the younger age groups identified as losing population in Chapter 2), is problematic. Here it has been assumed that none of the local residents fall into this category. To the extent that employment at the University or in secondary growth industries has halted emigration, the population impact estimates of this chapter have been understated; stopped emigrants are effectively immigrants.
15. See table 8.1.
16. Statistical Appendix 7.4.
17. Table 7.6.

The first step[18] in making the estimates for this chapter was to make allowance for the employment of any persons already resident in the Study Area,[14] on the grounds that the direct impact of the University would be measured in terms of additional immigrants to the area. Then, on the basis of previous estimates[19] of male/female proportions in the S.I.C. order structure of this type of employment, it was estimated that 55% of the employment in secondary growth industries will be for males and 45% for females. It was then assumed that no female employees would be immigrants to the Study Area in their own right; they would be recruited from persons already immigrant to the Study Area, e.g. as dependents of other employees, or persons already resident in the Study Area, or would be commuters from outside the Study Area boundaries. The basis of the assumption is that no family will move to the Study Area purely for female employment.[20] On the other hand, it was assumed that all male employment in the secondary growth will be filled by immigrants, or by residents who would have to be replaced elsewhere by immigrants.[20] From these assumptions, it has been estimated that there will be between 465 and 900 immigrant employees in the lower and upper cases, respectively. If it is then taken that these males will be aged between 20-64 and that, within this range, they will have the same age structure as is typical for Scottish migrants,[21] then estimates can be made of adult dependents, and , in turn, the number and age/sex structure/...

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18. See Statistical Appendix 8.4 for statistical sources and detailed working estimates.

19. Statistical Appendix 7.5, tables (b) and (c).

20. Both assumptions are obviously rather extreme. There may be some (very minor - see Statistical Appendix 8.3, where the calculation has been made) component of widowed/divorced women with families. Equally, there may well be some recruitment to secondary growth employment of unemployed males (again, in view of the findings of Chapter 3 on the industrial structure and duration of unemployment, this will tend to be a very minor influence). In total numbers, there will tend to be some offset, but in age and sex structure, there will be only minor inaccuracies added as a result of the assumptions.

21. Statistical Appendix 4.1, table (c).

structure of child dependents. In the lower case it was estimated that there would be 341 adult and 227 child dependents; in the upper case, this will be 659 adult and 443 child dependents.[22]

Now all the various components of immigrant population to the Study Area as a result of the establishment of the University, have been estimated. By 1976, it has been estimated that immigrants to direct employment and study at the University will amount to about 3,950 and that these will add to the local population a further 1,800 of their dependents. Further immigrants to the Study Area as a result of the jobs generated by the University in indirect employment, have been estimated to number between 450 and 900 persons, who will bring with them between 550 and 1,100 dependents. In total, it has been estimated that the existence of the University will add, by 1976, between 6,700 and 7,700 persons to the population of the Study Area.[22]

Finally, the estimated age and sex structure of this new immigrant population is given in table 8.3;[23] about 90% of the population in both lower and upper cases is under 40 years of age. The largest proportion, due to the influence of the student population, is in the 10 year age range of 15-24 (effectively 18-24), which accounts for between 43% and 48%, or about 3,300 of the immigrants. Again, in 1976, since the immigration has been to study and employment, there is no population component aged 65 and over. The effect of such an age structure in the immigrant population is discussed later in the chapter.

Comparison of Population Estimates for 1976

The existing/...

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22. See table 8.2.

23. See also figure 8.4 for comparison with existing population. The data is taken from Statistical Appendix 8.1 to 8.5 inclusive.

The existing estimates of the impact of the University on population, employment and income have been summarised earlier.[24] While the estimates made in this chapter indicate that there will be a total immigrant population of between 6,700 and 7,700, it was estimated by the Planning Consultants to amount to 13,000, effectively double.[25] There is no significant difference between the sets of estimates for immigrant population to direct employment. The estimates made here show marginally fewer immigrant staff and students but use of the Sample Census and Registrar General figures in the estimation of dependents has resulted in a slightly higher ratio of dependents to staff and students, 0.45:1 as against the 0.40:1 assumed by the Planning Consultants.[26]

The real difference arises in the estimates of immigration from the generation of indirect employment. There would seem to be three main reasons for the divergence of the estimates here. Firstly, as argued before,[27] insufficient allowance was made by the Planning Consultants for the existing capacity in the Services sector of the Study Area economy and for expenditure leakages from the sub-region; thus their estimate of indirect employment of 2,945 persons by 1976 lies well above the range of 850 to 1,650 estimated from the basis of income generation. Secondly, the Planning Consultants have assumed[28] that all persons employed indirectly as a result of the University, will be immigrants; in view of the bias of this indirect employment towards the Services sector,[29] with its usage/...

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24. See Chapter 5.
25. See table 8.5.
26. This is the weighted average of the assumed ratios of table 5.4(a).
27. See Chapter 7.
28. See table 3, Appendix A, Report by Land Use Study Group Technical Sub-Committee, January 1966.
29. Statistical Appendix 7.5, tables (b) and (c).

usage of female labour, this is unlikely. This second reduction for resident indirect employees has resulted in an estimate of immigrant employees in this section of between 465 and 900 rather than the 2,310 taken by the Planning Consultants. Thirdly, and finally, there is a difference in the ratio of dependents to employees in this section. The Planning Consultants have taken the ratio of 2.3:1 for their estimates, against the ratio of 1.2:1 derived from Sample Census and Registrar General figures. In terms of the Sample Census, the higher ratio would effectively need all immigrant employees to be married and to have slightly more children per family than indicated by the Census. While the Registrar General figures for family size[30] are nearer the ratio taken by the Planning Consultants, these are based on completed families; since migrants typically have a rather younger age structure than the population as a whole, it is likely that at least many of the immigrants will not have completed their families, so that the dependent ratio is likely to be lower than 2.3:1.

These points, when taken together, provide some explanation for the rather lower figure estimated in this thesis for direct population impact. Nevertheless, while it does indicate an immigrant population of considerably less than was previously estimated, it still represents a massive and important injection into the population of the Study Area by the completion of the second phase of the growth of the University.

The University's Impact on Population by 1981

It is necessary to make some estimate of the impact of the University on the local population by the completion of its growth towards its equilibrium size for Phase 3. By 1981, the immigrant population directly attributable/...

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30. See Annual Report, 1969, table S.1.9.

attributable to the University will consist of the earlier staff and indirect employment immigrants for 1976, adjusted for deaths and births over the quinquennium, plus new immigrants to employment at the University and secondary growth industries, plus the new, larger body of students and their dependents.[31]

Applying the model developed for population projection of the Study Area population to the 1976 immigrant population, then assuming a continuation of the same type of pattern for age/sex structure, marriage and family size for students and new employees at the University and secondary growth industries, provides estimates that, by 1981, the population impact from the University will amount to between 14,500 and 16,500.[32] Over the period 1976-81, it has been estimated[33] that the normal increase in family size of the earlier immigrants will increase slightly the relative size of the 0-14 age group; equally, there will be a slight movement onwards through the age structure which will increase slightly the relative size of the 40-60 age group. Nevertheless, the main impact remains in the mid 15-39 group, which will still account for about 66% to 68% of the total, or 12,500 to 14,00 persons.

Comparison with existing estimates shows that here the immigrant population for 1981 has been estimated to be 26,500 as against the 14,500 to 16,500 range forecast here. The reasons for the divergence are obviously the same as for the 1976 comparison of figures. In one sense, however, the assumptions of the Planning Consultants may be better suited to this/...

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31. See Statistical Appendix 8.5 for statistical sources and detailed estimates.

32. The point raised in footnote 14 becomes relevent again here. If the considerable growth associated with the University by 1981 plays any part in halting the emigration outflow in the younger age range or elsewhere, then these figures will have been understated.

33. See table 8.6.

to this later year; the family size of previous immigrants will tend to have moved nearer to their assumed ratio and, secondly, the inevitable depletion of the labour reserves of the Study Area by the growth to the later year will tend to have increased the dependence on immigrants for employment, particularly in secondary growth industries, rather than the fairly specific work associated with much of the University employment. In the estimates made for this chapter, both points have been taken into account; the use of the projection model has covered the increase in family size of existing immigrants and, for secondary growth, the ratio of immigrants: residents has been increased.[31]

The Estimated Total Population of the Study Area, 1976 and 1981

Finally, an estimate must be made of the overall population of the Study Area for these years, taking account of both the internal growth of the area and University inspired growth. This involves, for 1976, adding the lower and upper case estimates of 6,758 to 7,727 of the University population to the projected totals for the Study Area for this year.[34] Given the population size of the Study Area, as defined, the overall effect of including the University in total population is to increase the projected totals by about 7% in the lower and 8% in the upper case. Depending upon the assumptions on migration patterns over the period and the level of employment generated by the University, it has the effect of raising the projected total population to between 108,000 and 119,000 persons.[35] Since 70% of the University based population lies in the age group 15-39, as against the 33% in this age group at the time of the 1961 Census/...

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34. See Chapter 4, table 4.4.

35. See table 8.7: since the objective is to indicate a range within which population might fall, Projection II (zero migration case has been ignored.

1961 Census, the additional 5,000 persons in this age group increases the relative size of this group by a further 2%, reducing slightly the relative size of the other groups, as shown in the original projections.[34]

For 1981,[36] adding the lower case to upper case range of 14,392 to 16,585 persons to the various population projections, increases these projected totals by a further 15% in the lower and 18% in the upper case. Again, depending on assumptions of migration pattern and the size of the regional multiplier, this provides a range of estimated populations by 1981 of between 118,000 and 135,000 persons. This time about 68% of the additional population will be in the 15-39 age group, raising its relative size by a further 4% from 1976. Comparison of 1981 figures to the 1961 population base figures of the Census, shows that 40% of the estimated population will be in this age group as against the 1961 figure of 33%

The size and nature of such a population increase could have far reaching effects on both private and public sectors of the local economy.[37] The private sector has already received and will continue to receive a considerable increase in overall turnover, concentrated on the goods and services demanded by a larger and younger population. County Planning Offices have already made additional provision for this in their estimates for spatial demands for private house construction, retail distribution and other types of services; they have already identified a rapid growth in the area occupied with predictable outlets like house furnishing, car sales and servicing, entertainments, bookstores, supermarkets/...

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36. See table 8.8.

37. In this case, the upper Greig value of the income multiplier and the modification of the multiplicand for induced investment, would both be fully justified.

supermarkets etc.[38] In the public sector, current pressures and expectation of even more severe pressure in the future have triggered off a high level of activity in the improvement of existing capacity and the provision of additional capacity throughout the Study Area for education, hospitals, roads and housing facilities.

These changes, in turn will alter significantly the attraction of the Study Area as a possible site for the location of new industrial activity, in both Manufacturing and Services sectors. Local D.E.P. as well as Planning Officials have gradually come to consider the possibility of a third wave of development, along the pattern of the Grangemouth experience. As a result of the establishment of the University and the initial commuting developments in housing estates,[39] the final population could be considerably greater than as projected here. Debatably at least, the indirect effects of establishing the University could be far greater than the direct effects, as estimated in this chapter.

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38. Based on correspondence and conversations with County Planning officials. Some of the changes can be attributed directly to the University, e.g. road works and new maternity unit extension; others have stemmed from internal development, e.g. the wave of school extensions/construction from the present commuter population inflow; some are related to both sets of pressure, e.g. Stirling's attempts to extend its boundaries for house construction.

39. It would seem that the initial private housing developments which started the wave of commuters, were in many cases themselves triggered off by the announcement of the coming of the new University (based on both press reports and some correspondence with the main builders). To what extent the announcement merely affected timing rather than the volume of construction, is an open question.

Table 8.1

Estimates of Total Immigrant Population for Students and Staff (1976)

	Male	Female	Total
Students	2,221	1,011	3,232
adult dependents		326	326
child dependents	160	153	313
Total	2,381	1,490	3,871
Academic staff	408	31	439
adult dependents		331	331
child dependents	318	303	621
	726	665	1,391
Other staff	104	178	282
adult dependents		84	84
child dependents	50	47	97
	154	309	463

Table 8.2

Estimated Impact of the University on Population of the Study Area (1976)

	Lower case			Upper case		
	Male	Female	Total	Male	Female	Total
"Direct Employment"						
Students and staff	2,733	1,220	3,953			
Dependents:						
Adult		741	741			
Child	528	503	1,031			
	3,261	2,464	5,725	3,261	2,464	5,725
"Indirect Employment"						
Employees	465		465	900		900
Dependents:						
Adult		341	341		659	659
Child	117	110	227	227	216	443
	3,843	2,915	6,758	4,388	3,339	7,727

Table 8.3

Total Immigrant Population by Age and Sex (1976)

a)	Lower case				Upper case			
Age	Male	Female	Total	%	Male	Female	Total	%
0 - 4	232	219	451	6.7	270	255	525	6.8
5 - 9	242	232	474	7.0	283	271	554	7.2
10 - 14	143	137	280	4.1	169	163	332	4.3
15 - 19	768	521	1,289	19.1	772	525	1,297	16.8
20 - 24	1,281	648	1,929	28.5	1,365	679	2,044	26.5
25 - 29	383	308	691	10.2	474	375	849	11.0
30 - 34	253	249	502	7.4	349	328	677	8.8
35 - 39	177	198	375	5.5	234	247	481	6.2
40 - 44	149	182	331	4.9	197	223	420	5.4
45 - 49	83	87	170	2.5	113	113	226	2.9
50 - 54	65	68	133	2.0	82	83	165	2.1
55 - 59	62	62	124	1.8	71	70	141	1.8
60 - 64	5	4	9	0.1	9	7	16	0.2
	3,843	2,915	6,758		4,388	3,339	7,727	

b)	Lower		Upper	
	Persons	%	Persons	%
0 - 14	1,205	17.8	1,411	18.3
15 - 39	4,786	70.8	5,348	69.2
40 - 64	767	11.3	968	12.5
	6,758		7,727	

FIGURE 8.4 COMPARISON OF AGE AND SEX STRUCTURE OF NEW IMMIGRANT POPULATION WITH STUDY AREA POPULATION AS AT 1961

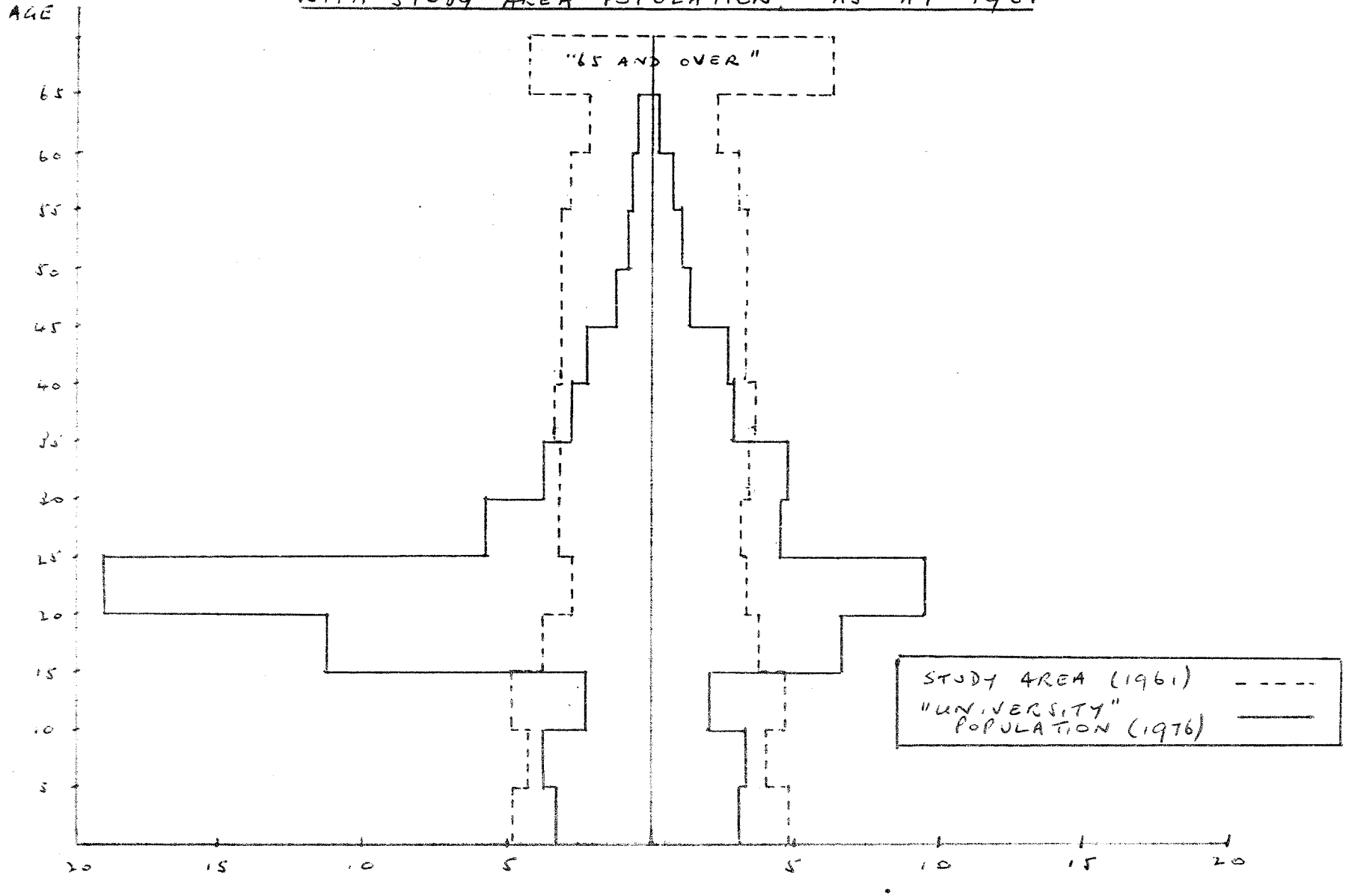

Table 8.5

Comparison of Population Estimates for 1976

		Existing estimates*		Lower case estimates†		Upper case estimates†
Immigrants to "direct" employment						
Students and staff		3,972		3,953		3,953
Dependents		1,591		1,772		1,772
		5,563		5,725		5,725
to "indirect" employment						
Employees	2,310		465		900	
Dependents	5,313	7,623	568	1,033	1,102	2,002
		13,186		6,758		7,727

Sources: * Chapter 5
† table 8.2

Table 8.6

Estimate of Total Population Impact by 1981

	Lower case		Upper case	
	Persons	%	Persons	%
0 - 14	2,672	18.6	3,182	19.2
15 - 39	9,831	68.3	10,984	66.2
40 - 64	1,889	13.1	2,419	14.6
	14,392		16,585	

Table 8.7

Estimated Population of the Study Area, including University (1976)

a) Lower case

Age	1961 Persons	%	1976 Projection I Persons	%	1976 Projection III Persons	%
0 - 14	25,445	27.4	28,357	26.3	31,256	26.4
15 - 39	30,614	33.0	40,144	37,3	44,508	37.6
40 - 64	27,603	29.7	27,007	25.1	30,390	25.6
65 and over	9,243	9.9	12,161	11.3	12,374	10.4
	92,905		107,669		118,528	

b) Upper case

Age	1976 Projection I Persons	%	1976 Projection III Persons	%
0 - 14	28,563	26.3	31,462	26.3
15 - 39	40,706	37.5	45,070	37.7
40 - 64	27,208	25.0	30,591	25.6
65 and over	12,161	11.2	12,374	10.4
	108,638		119,497	

Table 8.8

Estimated Population of the Study Area, including University (1981)

a) Lower case

Age	1961 Persons	%	1981 Projection I Persons	%	1981 Projection III Persons	%
0 - 14	25,445	27.4	30,308	25.7	34,497	26.0
15 - 39	30,614	33.0	47,964	40.7	53,439	40.2
40 - 64	27,603	29.7	26,740	22.7	31,822	23.9
65 and over	9,243	9.9	12,710	10.8	13,119	9.9
	92,905		117,722		132,877	

b) Upper case

Age	1981 Projection I Persons	%	1981 Projection III Persons	%
0 - 14	30,818	25.7	35,007	25.9
15 - 39	49,117	41.0	54,592	40.4
40 - 64	27,264	22.7	32,346	23.9
65 and over	12,716	10.6	13,125	9.7
	119,915		135,070	

CHAPTER 9

Conclusions

This chapter falls into three sections. Firstly, the overall objectives of the thesis and the methods used to achieve these are discussed. Secondly, the results contained in the various chapters are summarised and conclusions drawn on the effect of the combined forces of internal and University growth on the Study Area. Thirdly, and finally, some of the more general aspects of the application of the regional income multiplier as a tool of analysis are discussed, and some of the problems inherent in this type of approach considered.

Objectives and Methods

The purpose of the thesis has been to attempt to predict the situation in the Study Area, both in the course of and at the end of the development of the University of Stirling. This involved two main objectives, firstly, the analysis of recent and current internal characteristics of the Study Area economy, to allow projections to be made covering the aspect of internal growth and, secondly, the analysis of the extent of the economic impact of the growth of the University on the local area.

The analysis of internal characteristics and growth forces was based on a study of recent population, industrial structure and employment trends for the Study Area. For population, this involved the examination of its overall size and geographical distribution, its age structure, its rate of increase and the direction and volume of its net migration flow. For industrial structure and employment it involved an analysis of the type of industrial activity in the region, its degree of diversification and specialisation/...

and specialisation and the patterns of growth and decline in the years prior to the establishment of the new University; secondly, it involved an analysis of the state of the local labour market, of its response to the forces of change in industrial structure, as these were reflected in unemployment data.

The method of projection used for population was to construct a component type projection model based on the main population variables and using Scottish data, modified in the light of past local trends. Since these trends seemed to indicate that the net migration flow was changing in volume and possibly direction, the model was used to project a series of population figures on the basis of different migration assumptions. The projections of employment structure were made by a simpler type of model using anticipated national rates of employment change by industry, again being modified for both local experience of change in the past and current knowledge of future local developments.

The completion of this series of projections allowed the fulfillment of the first main objective of the thesis, i.e. the prediction of the situation in the Study Area for 1976 and 1981, in so far as this stems from internal - as divorced from University expansion - forces. These years were chosen to represent the situation both in the middle and at the end of the planned development of the University.

As the second main objective of the thesis, the economic impact of the development of the University on the three main aspects of the local economy of income, employment and population had to be estimated. Firstly, a regional income multiplier model was constructed to provide estimates of income generation within the Study Area from the expenditure of staff and student incomes, and construction expenditure on the campus and on capacity extensions induced elsewhere. From the additional income/...

income generated, further estimates were made, by the use of an employment multiplier model, of the number of secondary or indirect jobs created in the supporting industrial sectors as a result of University development. To these figures for indirect employment, based on the estimated volume and pattern of expenditure of incomes, were then added the figures for direct employment at the University and, where applicable, on the construction of the campus, these, in turn, being governed by teaching and other physical requirements. Finally, the numbers estimated for students and persons employed were analysed and further estimates made of the resultant number of immigrants and their dependents, who between them would constitute the additional population introduced to the Study Area as a result of the development of the University.

Having completed this series of estimates then, by amalgamating the projections for internal and University inspired growth, the population and employment situation in the Study Area by 1976 and 1981 could be predicted.

Conclusions for the Study Area

a) Internal growth to 1976 and 1981

Examination of past trends in population and employment indicated that the Study Area was one of the more prosperous sub-regions in Scotland. In terms of population, its faster rate of increase in population was due not to any marked difference in birth rates and death rates compared to the Scottish pattern but to a significantly lower rate of net loss of population through emigration. Given the typical bias in the age structure of migrants towards the younger age groups, this also tended to give the Study Area a marginally younger age structure than the Scottish one. There was also some indication that the migration inflow to the area was increasing over the period/...

over the period, which, with the continuing commuter development in the area, raised the possibility of a zero or possibly even a positive net migration flow for the future.

In terms of employment, while the industrial structure was biased a little towards the Primary sector, it was nevertheless fairly well diversified, although the largest industrial groups in terms of employment tended to be in the female predominant Services rather than the male predominant Manufacturing sector. The savage run-down in Primary sector employment in the years preceding the University was offset by a significant expansion of employment in many of the Services sector industries. This swing from the more traditional industries towards employment in Services caused an overall increase in the labour force, but this as a result of a marked increase in female employment; male employment, influenced mainly by the decline in mining, fell both in relative and absolute terms. Nevertheless, due to the diversified industrial structure, the accessibility of adjoining growth areas such as Falkirk/Grangemouth and Cumbernauld and, to some extent, emigration to employment elsewhere, these harsh changes in male employment were absorbed without lasting effects on unemployment rates or duration of unemployment in the Study Area. Despite the changes, the area fared well relative to most regions in Scotland, with an unemployment rate fluctuating at around 2% of the labour force, well below the average for Scotland and only a little higher than the national average for the U.K.

It might seem that, to some extent, the growth in employment at the University and in its supporting industries might be competitive to continuing growth from internal forces in the Study Area. However, current experience seems to reflect the pattern of development of the nearby/...

the nearby Falkirk/Grangemouth area, in that, far from deterring expansion by other firms, the existence of the University appears to act as a stimulus to this. In location and expansion decisions the unquantifiable variable of the ethos of the area can play an important part; nothing makes an area more attractive than apparent prosperity and successful industrial expansion.

Given this argument, the type of employment expansion forecast at national level, combined with the local weighting for industrial structure and experience, indicates that a further marked expansion of the Services sector to 1976 and 1981 is probable; the projections indicate an overall increase of about 6% in employment by 1976 and about 10% by 1981. At the same time, the projected figures for population indicate that, by 1976, this could increase from its 1961 base figure of 93,000 to between 101,000 and 112,000 persons, depending upon the migration assumptions made. By 1981, the population range has been projected to between 103,000 and 118,000. Taking the 1976 figures, the comparison of a 6% increase in local employment with the projected increase of between 9% and 20% in population does not indicate that the local activity rate will fall. The sets of projections are compatible, in that much of the additional population will be commuters and thus not interested in local employment, while much of the additional employment locally will be drawn either from natural increase or from female dependents of the commuter inflow.

b) <u>The economic effects of the University on the local economy</u>

The effect of the development of the University on the level of local incomes has been estimated as a range by using lower case and upper case values for the regional income multiplier. By 1976, the University will add per annum, from construction expenditure on the campus/...

the campus, earnings of staff and students and other investment induced locally to support its development, between £3.75 millions and £4.66 millions, at 1969/70 constant prices, to the income level of the Study Area economy. By 1981, even allowing for the completion of construction work on the campus and on capacity extensions elsewhere, the University will still add an estimated £6.5 millions to £8.0 millions to local income, again at 1969/70 prices.

The University impact figures for employment generation, based as they are partly on the income estimates made above and partly on the assumption of different ratios for income:employment generation, have also been estimated as a range. It has been estimated that the total of all forms of employment associated with the development of the University would amount to, by 1976, between 2,450 and 3,250 jobs. By 1981, even with the completion of the construction work on the campus, it has been estimated that there will be between 4,300 and 5,800 jobs. This was composed of, in 1976, employment at the University for about 1,600 persons, with between 850 and 1,650 persons employed indirectly; for 1981, direct employment at the University has been estimated at about 2,700 persons, with a further 1,600 to 3,100 persons employed in secondary growth.

Finally, the effect of the University on the population of the Study Area will depend upon the number of additional persons, i.e. non-residents, brought to the area to study or to employment, both direct and indirect, together with the dependents of all these. It has been estimated that, for 1976, there will be an immigrant population of about 4,000 students and staff and a further 1,800 dependents of these. With the estimates for immigrant indirect employees and their dependents, the overall additional population attributable/...

attributable to the University becomes between 6,800 and 7,700 persons. For 1981, taking account of the increases in the family size of previous immigrants as well as the additional immigrants to study and employment, with their dependents, the total immigrant population attributable to the University has been estimated at between 14,500 and 16,500 persons.

Returning to the original estimates of income generation, which provide the basis for part of the employment and therefore population estimates, it can be argued that the upper case multiplier value used of $k_r = 1.54$ is likely to be more relevant to the situation in the Study Area than the lower case value of $k_r = 1.24$. The explanation for this is that the upper case value was estimated from a model which was constructed specifically to deal with the income/employment interaction of the type of immigration situation likely to occur in the Study Area; the lower case value is based on a simple, conventional multiplier model which ignores immigration effects. Thus, while its use to provide a lower case income figure can be justified, it is nevertheless likely that the actual income figure will tend to lie towards the upper end of the range estimated. If this is so, then the type of situation prevailing in the Study Area will tend to push the estimates for indirect and therefore total employment, in their turn, towards the upper end of the ranges estimated. Given the influence of the income estimates on employment, it can then be argued that the estimates for immigrant population to the University and secondary growth sectors will also tend to lie towards the upper end of the range estimated.

c) <u>The overall situation in the Study Area for 1976 and 1981</u>

Amalgamating the two series of projections for population growth, i.e. covering both internal and University based forces, raises the overall/...

overall estimated figures for population in the Study Area to between 108,000 and 119,000 persons by 1976 and between 118,000 and 135,000 persons by 1981. From the base population of 93,000 in 1961 this represents an increase of between 16% and 28% by 1976 and between 27% and 45% by 1981, depending on the assumptions made on migration, income and employment generation. While any figure within these ranges would represent a considerable population increase over only a 15 or 20 year period, it must also be remembered that such an increase is likely to be biased towards the younger age groups. Certainly, this would apply to the University component as it would probably to any other source of immigration contained in the increase. If, as is likely, there results a markedly younger age structure, not only would this carry its own implications for housing and educational demands in particular, but as a result of the concentration of migrants typically in the key reproductive age groups, it would suggest an even faster rate of growth of population in the years following the period which has been examined.

When the employment projections are amalgamated for internal and University growth, the effect of the inclusion of the latter is to at least double the rate of employment expansion previously estimated for the Study Area. Secondly, since apart from some employment in Construction, University-based employment is virtually entirely in the Services sector, the effect of this is to accelerate the already considerable swing from the older, traditional industries to a situation where only 1 job in 3 will be in Primary and Manufacturing sectors combined, with 1 job in 2 in the Services sector. This continuing expansion in female predominant employment, in view of the already high female Activity Rate for the area, might seem to suggest a possible constraint on growth as a result of a shortage in, mainly/...

mainly, female labour. However, it is likely that the female Activity Rate will rise as more socially acceptable jobs appear in the Services sector, as opposed to the operative type of work in Manufacturing; secondly, the female labour supply will be augmented over the period by the inflow of female dependents from the University and other immigration sources.

All of this serves to indicate the possibility of still further development along the lines of the Grangemouth experience, as a result of the interaction of growth in employment, population, income and expenditure. At the end of the period of expansion shown by the projections, the Study Area will be an extremely prosperous and dynamic sub-region relative to many other Scottish locations. Given the, at the moment, blanket Development Area status of this section of the East Central belt, the Study Area might well come into location decisions of firms seeking an attractive area for expansion; failing this, its situation as a green belt University district for industrial development around the Cumbernauld/South bank Forth axis is expected to provide long-term residential construction activity. In either case, it is at least possible that the boost given to population and employment by the establishment of the University of Stirling could well exceed the direct impact which has been estimated in this thesis.

Conclusions for Similar Studies

Both at the local and central government level, some work has been and is being done to analyse the repercussions of various projects in terms of regional input-output models; while the information gathered into such tables ultimately provides valuable data on regional industrial relationships for planners, in many cases the main economic questions could be answered by the type of multiplier model used in this thesis. With its more modest data requirements, it is quicker to complete and probably/...

probably simpler to operate; from its estimates of income generation, further estimates of indirect employment can be made and, with further information on direct employment and reliance on immigration, total employment and population effects of the project can then be estimated.

The development of the income model for the University impact study includes three main innovations to the conventional application of the multiplier analysis. Firstly, the multiplier is essentially a macro-economic concept and its formulation for an economy of standard region size may well have seemed a translation to a sufficiently micro level - especially in view of the non-availability of adequate regional statistics. Yet, for example, the impact at full Scottish level of even major new projects such as the pulp mill at Corpach, the University of Stirling, or the aluminium smelter at Invergordon, will be relatively insignificant, whereas the local impact on income, employment and population will be considerable. For practical planning purposes, surely the ultimate objective of both input-output and multiplier analysis, the relevant economic base would seem to be the sub-region, i.e. the local area around the project. At first sight, it might be felt that the application of a multiplier model to a smaller base, would reduce the multiplier effects of the project. While some regional variation would be experienced in all leakages, the one most affected would be the import leakage; normally the smaller the economic base, the more likely the dependence of the region on imported goods. While Steele has pointed out that there is no clear cut relationship between the size of the region and its import leakage coefficient, there is little doubt that, for both the multiplier and the multiplicand, the smaller economic base of the sub-region is likely to raise its import leakage coefficients. Nevertheless, for the reasons that follow, it is this smaller base which should be used.

Secondly/...

Secondly, the decision to base the analysis on the sub-region increases the probability of immigration to the project, both from other standard regions and from other parts of the standard region in which the project is situated, e.g. the attraction of Fort William, Stirling and Invergordon as areas of prosperity and employment opportunity, at least in the early years following the siting of new projects there. Where there does result a significant flow of immigrants to the local economy, then the effects of the volume and pattern of their expenditure and the indirect employment generated by this from existing capacity in the region, necessitates the use of the Greig type of formulation rather than the conventional one for the multiplier. The consequence of this is, despite the higher import leakage in the multiplier, to raise the value of the multiplier itself; the use of the conventional model would understate the economic effects of a project in this type of situation.

Thirdly, the inflow of immigrants to a sub-region has further important implications for the formulation of the multiplicand. The rising income and expenditure from the new project, coupled with the pressures from the additional population in the area, will place considerable strain on existing capacity in both private and public sectors. In the local area, the pressures generated by the multiplied expansion of incomes are likely to induce capacity extensions in both sectors, so that there is no longer any justification for excluding a term for induced investment from the multiplicand. On a broader level, the main theoretical contribution of the model is to draw attention to the need for the careful and complete formulation of the multiplicand for the project in question. In most of the multiplier publications, only wages and salaries from the operation of the project have been taken as the multiplicand; for the University and possibly for many more projects, this multiplicand must be increased to include components for the construction expenditure on the project/...

the project and on the capacity extensions induced by the existence of the project. Despite the heavy leakages involved, the inclusion of these terms in the multiplicand has the effect of increasing the multiplied expansion of income by between 25% and 30%, with all its repercussions on indirect employment and population. This does not imply however that only these three components are relevant to the multiplicand; it only underlines the need for including all the items which are important to a given project.

However, there are two main serious problem areas involved in the use of the regional income multiplier model as contained in this thesis. Firstly, the model will operate smoothly only in a situation where capacity in the local economy is fairly well utilised, i.e. there is no significant degree of slack. In such a situation the generation of both additional employment for existing capacity and induced investment in capacity extension is likely. On the other hand, if the project is sited in an area where there exists a considerable degree of underutilised capacity in both labour and capital, then it becomes difficult to estimate clearly the full income and employment effects of the new project. Here it is likely that some, possibly most of the employment in the project will be taken from local labour, thus removing or reducing the inflow of immigrants to the area; in turn, the generation of additional indirect employment and induced investment seems less likely. In such a situation, the establishment of a new project might seem only to maintain existing employment, income, services and employment, without any improvement to the area. In fact there is a counter argument to this in that where employment is replaced and held, emigration from the sub-region is halted or reduced; the retention of a potential emigrant, in strict multiplier terms, is equivalent to the attraction of an immigrant, i.e. the income and employment effects of the project should be measured/...

be measured not merely against past levels, where employment is replaced, but against the possible levels which would have resulted if the run-down had not been stopped or the spare capacity taken up. Both Archibald and Brown argue that such a run-down would be cumulative and considerable and there exists much prima facie evidence in Scotland to support this claim. Yet, while in theory the retention of indirect employment and capacity can be attributed to the project, in reality to what extent can this be quantified by the sub-regional model?

Secondly, there is the whole problem of timing in the multiplier process, an aspect of the analysis which seems to be, as yet, untouched in terms of publication. Even assuming a reasonable degree of capacity utilisation, it is difficult to estimate how quickly the various multiplier lags will operate and the income, expenditure, employment generation and income cycle be completed. Equally, in the multiplicand, it is difficult to estimate with certainty how quickly construction on the project and on induced investment will take effect on income levels, or for how long, after its completion, it will continue to influence incomes. In particular, where the project is relatively large, as at Fort William, or Stirling, or Invergordon, the prolonged and considerable activity in construction is likely to cause an expansion in the employment and size of many construction or construction servicing firms locally; while, in theory, the completion of this work will cause lay-offs and the return to the previous "equilibrium" levels, to what extent in reality might it not stimulate continuing growth in these firms, or at least the desire to hold the firms at their expanded size? And, finally, in relation to induced investment, how quickly will this be induced by expenditure pressures and to what extent will the decision to provide extended capacity and the time-path of its provision be undermined by "queuing"? In a slack capacity situation, the problems of lagged/...

lagged response will multiply; equally, the difficulties in the assessment of the timing of the run-down and contraction in the region are obvious and considerable.

Despite these problems however - and any method of analysis of the complex of economic, sociological, historical and political forces of regional economics will encounter problems - the analysis of the impact effect of a new project on its local sub-region by the type of model used in this thesis is possible and, hopefully, capable of producing sufficiently accurate results for its main purpose of assisting decisions in local planning for the project.

THE STATISTICAL APPENDICES TO CHAPTER 2

Statistical Appendix 2.1

Estimates of migration flows for 1951 - 66

The method chosen to estimate the direction and size of the net migration flows for the Study Area and its component parts consists of taking the statistics for births and deaths, as published by the Registrar General for Scotland[1] to compute the natural increase over the period and comparing this to the actual increase, as calculated from the Census returns for the beginning and the end of the period. Where the natural increase exceeds the actual increase there has been net migration outwards; where the actual increase exceeds the natural increase, there has been net migration inwards. Only the net balance of migration can be estimated by this method[2].

The period 1951 - 61

Data for births and deaths for this period were taken from the Annual Reports of the Registrar General[3]; the actual intercensal increase was taken from the Census Reports for 1951 and 1961. Since both of the Census reports relate to the month of April, allowance has to be made for this in calculating the natural increase figures for the period; only 2/3 of the births and deaths for 1951 have been taken and a compensating 1/3 of the births and deaths for 1961 included. A further problem was that no separate figures were available for Central No. 1 D.C. until 1962; however, the average figures for 1962 - 66 showed that births in Central No. 1 were 23% of the total for all landward districts and deaths 16% of the total. It was assumed that/...

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1. both births and deaths were adjusted for normal residence.
2. in Stat. App. 2.2 the model used shows the effect of the gross flows but cannot, of course, estimate the actual numbers involved.
3. table 47 in all reports.

assumed that the same proportions applied to the period 1951 - 61.

The estimated figures for births, deaths, natural increase and migration for the various sections of the Study Area for 1951 - 61 are given in table (a) to this appendix.

The period 1961 - 66

These estimates were made by the same method as for the previous period. The intercensal change figures were taken from the Census returns of 1961 and 1966, with figures from the former rounded to the nearest ten for comparison with the latter. The figures for births and deaths have again been adjusted to allow for the April dates of both Census returns. The Central No. 1 figures were estimated as for the previous period, but were taken from the Annual Reports for each of the years from 1962 onwards.

Statistical Appendix 2.1

Table (a)

ESTIMATES OF MIGRATION 1951-61

	Census Popn 1951	Births 1951-61	Deaths 1951-61	Natural Increase	Actual Increase	Migration Persons	%
Alloa	13,521	2,627	1,635	992	377	- 615	- 4.5
Alva	4,106	678	555	123	- 149	- 272	- 6.6
Dollar	1,389	208	224	- 16	350	+ 366	+25.1
Tillicoultry	3,876	774	505	269	87	- 182	- 4.7
Landward	14,640	3,456	1,471	1,985	2,981	+ 996	+ 6.8
Doune	834	150	137	13	- 48	- 61	- 7.3
Dunblane	3,017	413	468	- 55	- 94	- 39	- 1.3
Stirling	27,151	4,963	3,202	1,761	400	-1,361	- 5.0
Bridge of Allan	3,173	480	459	21	116	+ 95	3.7
Central No. 1	16,560	3,656	1,536	2,120	513	-1,607	- 9.7
Study Area	88,267	17,405	10,192	7,213	4,533	-2,680	- 3.0

Sources Census Reports 1951 and 1961

Annual Reports of Registrar General Table 47.

Statistical Appendix 2.1

Table (b)

ESTIMATES OF MIGRATION 1961-6

	Census 1961	Births 1961/6	Deaths 1961/6	Natural Increase	Actual Increase	Migration Persons	%
Alloa	13,900	1,419	858	561	- 150	-710	- 5
Alva	3,960	396	295	101	100	0	0
Dollar	1,740	96	118	- 22	100	+120	+ 7
Tillicoultry	3,960	392	215	177	310	+130	+ 3
Landward	17,620	1,868	807	1,061	890	-170	- 1
Doune	790	63	47	16	50	+ 30	+ 4
Dunblane	2,920	326	263	63	840	+780	+27
Stirling	27,550	2,742	1,734	1,008	480	-530	- 2
Bridge of Allan	3,320	305	233	72	490	+420	+13
Central No. 1	17,070	1,855	826	1,029	70	-960	- 6
Study Area	92,830	9,462	5,396	4,066	3,180	-890	- 1

Statistical Appendix 2.2

Estimates of the effects of migration on age structure

Previous migration estimates related to the net balance of migration. While there is no satisfactory method of estimating the totals of the gross flows inwards and outwards, the model developed in the University of Glasgow work "The Lothians Regional Survey and Plan"[1] gives some indication of the effect of the gross flows on the age structure of the area. The model itself is quite simple. The base year population age structure is taken from Census data; at the end of that year births[2] are added to the population aged 0 - 4, deaths[2] are deducted by age group and the survivors, who are assumed to be evenly spread over the age group, (as in fact are the deaths recorded for each group), "aged" by one year. The process is repeated for each year of the period and the resulting population is compared by age group to the Census report for that year. Where the estimated population for any age group exceeds the Census population, there has been a net inflow to that age group, and conversely. While each group is still analysed by its net flow, the overall migration pattern for the area, or better still for its component parts, can be traced where there is an age difference between the outflow and the inflow.

The period 1951 - 61

The base population was taken from the 1951 Census and adjusted for births and deaths as described above; the normal adjustment was made/...

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1. see chapter 3, "Population", by B.M. Swift and appendix A to that Chapter.
2. tables 7 and 7a in the reports.

was made for the April dates of the Census reports for 1951 and 1961. For the "ageing" adjustment it was assumed that the population's ages were distributed evenly within any given age group up to the age of 54. Thus, for the age group 25 - 34, one tenth of the total were assumed to be aged 34 and were aged into the following age group each year. However, for the age groups 55 - 64 and 65 - 74 an attempt was made to take account of the heavier mortality rates at higher ages in this section of the population. Based on the Scottish statistics published[3] 9% of the 55 - 64 group and 8% of the 65 - 74 group were aged into the following groups each year. Finally, similar assumptions for the births and deaths for Central No. 1 were made as in the previous statistical appendix.

From these assumptions, a hypothetical population was estimated by age group for 1961. In table A, row (a) shows the Census figures for 1961; row (b) shows by how much this was greater than or less than the hypothetical population, i.e. the net balance of migration by age group; row (c) expresses the net flow as a percentage of the 1961 figures to which they relate.

The table can give only broad, general guidance on the strength of the flows and on the actual age of the migrants; a gain in the 45 - 54 group could include a migrant aged 36 in 1952 or 53 in 1960, or again, an immigrant aged 50 in 1955 would appear as 55 - 64 by the Census date.

The estimates for the period 1951 - 61 for the various sections of the Study Area are given in table A to this appendix.

The period/...

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3. see the General Tables for Scotland, table 21.

The period 1961 - 66

The methods of estimation used were the same as for table A. While separate births were given for Central No. 1 from 1962 onwards, separate deaths by age group were still not provided; the usual figure of 16% of Stirling landward districts was applied to each age group of this total set of figures.

In calculating the migration flows for the period to 1966, the Sample Census data for that year was taken; therefore the migration figures must be treated with more than the ususal degree of reservation. For example, the Census showed that 27% of the population of Doune were in the age group 15 - 44; this was based on 84 observations and, when correction is made for standard error of population, at the 95% confidence level the true population in that age group could be expected to lie in the range $27\% \pm 2(4.8)$, i.e. 17% to 37%, or between 140 and 310 persons. The estimated net outflow of 70 persons from this age group is meaningless. For Dunblane, on the other hand (376 observations) the sample census proportion of 39% of the population in this age group, when corrected for standard error, becomes the narrower range of 34% - 44%, i.e. 800 - 1,150 persons, so that the net inflow of about 500 persons is significant. Since, as the number of observations is increased, the standard error of the proportion is reduced, the migration flow estimates for 1961 - 66 have been summarised into three main age groups and are discussed mainly in terms of the Study Area as a whole.

Statistical Appendix 2.2

Table A

Estimates of the Effect of Migration on the Age Structure 1951-61

		0 - 4	5 - 9	10 - 4	15 - 9	25 - 4	35 - 9	45 - 4	55 - 9	65 - 4	75 and over	TOTAL
Clackmannan County Small Burghs												
	(a)	2,127	1,727	2,235	3,027	2,960	3,151	3,096	2,610	1,690	934	23,557
	(b)	+ 220	- 305	+ 144	- 386	- 313	- 29	+ 100	- 1	- 56	+ 31	
	(c)	10	- 18	6	- 13	- 11	- 1	3	0	- 3	3	
Landward												
	(a)	1,813	1,776	1,818	2,428	2,278	2,486	2,229	1,518	856	419	17,621
	(b)	+ 345	+ 97	+ 220	- 149	+ 12	+ 285	+ 282	- 34	- 104	- 114	
	(c)	19	- 6	12	6	1	12	11	- 2	- 2	- 27	
Perth County Doune												
	(a)	58	61	60	87	96	108	108	116	53	39	786
	(b)	- 4	- 9	- 7	- 29	- 19	- 4	- 6	+ 23	- 8	+ 6	
	(c)	- 7	- 15	- 12	- 33	- 20	- 4	- 6	20	- 15	15	
Dunblane												
	(a)	212	155	216	313	305	340	426	423	319	214	2,923
	(b)	+ 12	- 51	+ 18	- 51	- 45	- 32	+ 24	+ 22	+ 27	+ 60	
	(c)	9	- 33	8	- 16	- 15	- 9	6	5	12	28	
Stirling County Stirling												
	(a)	2,582	2,156	2,392	3,770	3,463	3,400	3,698	3,049	1,900	1,141	27,551
	(b)	+ 346	- 263	+ 64	- 501	- 416	- 329	+ 181	+ 27	- 160	- 171	
	(c)	13	- 12	3	- 13	- 12	- 10	5	1	- 8	- 15	
Bridge of Allan												
	(a)	233	226	249	382	348	411	490	440	308	202	3,289
	(b)	+ 21	- 23	+ 9	- 26	- 34	- 9	+ 69	+ 56	+ 17	+ 27	
	(c)	9	- 10	4	- 7	- 10	- 2	+ 14	+ 13	6	13	
Central No 1												
	(a)	1,777	1,614	1,666	2,480	2,357	2,339	1,986	1,574	858	422	17,073
	(b)	+ 223	- 215	- 103	- 341	- 234	- 283	- 311	- 76	- 256	+ 13	
	(c)	13	- 13	- 6	- 14	- 10	- 12	- 16	- 5	- 30	3	
Total	(a)	8,802	7,797	8,554	-12,487	11,807	12,235	12,033	9,730	5,984	+3,371	92,800
	(b)	+1,169	- 687	+ 263	- 1,483	- 1,049	- 401	+ 339	17	- 530	- 148	- 2,510
	(c)	3	- 9	3	- 12	- 9	- 3	3	0	- 9	- 4	- 3

Statistical Appendix 2.2

Table B

ESTIMATES OF EFFECT OF MIGRATION ON STUDY AREA AGE STRUCTURE

1961-6

		0-14	15-44	45 & over	Total
Clackmannan County	(a)	11,720	17,210	13,500	42,430
	(b)	- 240	- 620	- 600	
	(c)	- 2	- 4	- 4	
Doune	(a)	210	230	400	840
	(b)	- 40	- 70	+ 80	
	(c)	- 19	- 30	20	
Dunblane	(a)	980	1,480	1,300	3,760
	(b)	+ 290	+ 500	+ 10	
	(c)	30	34	1	
Stirling	(a)	7,320	10,500	10,210	28,030
	(b)	- 80	- 740	+ 280	
	(c)	- 1	- 7	3	
Bridge of Allan	(a)	880	1,260	1,670	3,810
	(b)	+ 110	+ 60	+ 250	
	(c)	13	5	15	
Central No. 1	(a)	5,140	7,300	4,700	17,140
	(b)	- 80	- 340	- 400	
	(c)	- 2	- 4	- 9	
Total	(a)	26,250	37,980	31,780	96,010
	(b)	- 40	- 1,210	- 380	- 1,630
	(c)	0	- 3	- 1	- 2

Sources: Census reports 1961 and 1966

Annual Reports of Registrar General Tables 7 and 56.

THE STATISTICAL APPENDICES TO CHAPTER 3

Statistical Appendix 3.1

The adjustment of the D.E.P. Exchange areas to the Study Area boundaries

The area covered by the Stirling and Alloa D.E.P. offices exceeds the boundaries of the Study Area by, in Stirling County, all of Western No. 1 D.C. and a series of parishes accounting for about 80% of the population of Western No. 2; in Perth County the D.E.P. area includes Callander and parishes covering a further 50% of the Western D.C.; finally, the D.E.P. area includes Kincardine, in Fife County. The Census of 1961's sample (10%) of Occupation and Industry, was used to estimate the numbers employed in the various industries for these excess areas, with the figures being deducted from the D.E.P. employment returns to bring these into conformance with the Study Area's boundaries.

Firstly, in the area adjustment, only part of the employment figures for some of the excess areas could be adjusted; while all Stirling Western No. 1 employees could be deducted, only 80% of Western No. 2 were covered by the D.E.P. figures, so that, on this population basis, only 80% was the employment figures for the latter were deducted from the D.E.P. returns.

Secondly, the full S.I.C. order breakdown was not published for the area in question and the unpublished figures at the Census office grouped the industries together for Production (Orders III to XVIII) and Services (Orders XIX to XXIV). After the area adjustment, it was estimated that 1,620 persons had to be deducted from Production and 3,750 from Services. To allocate this adjustment within the groups, it was assumed that these excess areas had the same pattern of employment as/...

employment as the total D.E.P. areas; thus, Order X, which accounted for 26% of employment within the Production group had 26% of 1,620 persons, i.e. 275 persons deducted. This type of adjustment was made for all industries in the Production and Services groups.

While the method of working, without correction for standard error, from the sample in the Census, and the allocation of employment totals on a population basis, or indeed the allocation system within the broad employment groups, involves rather arbitrary assumptions, the adjustments made appear to have given, in the opinion of the local D.E.P. officials, a broadly accurate account of employment within the boundaries of the Study Area.

Statistical Appendix 3.2

Estimates of income paid by S.I.C. Order in the Study Area

The approach taken was to estimate components for persons employed, including self employed, and average income by S.I.C. order. Broadly, since the D.E.P. employment figures give only employees, the number of self employed in the various industries had to be estimated and added to these. In estimating earnings, a number of serious difficulties had to be overcome. In the absence of sub-regional earnings figures, Scottish regional figures were used wherever possible; where these were not available, Great Britain or U.K. figures were taken and adjusted to Scottish levels.

The figures in table (a) were estimated as follows. Firstly, persons employed in Study Area workplaces were taken from local D.E.P. statistics for June 1966. Secondly, average weekly earnings were estimated by industry from a number of sources. Scottish male earnings figures for 1966 were taken from the M.O.L. Gazette for August of that year (table 22). Industries not covered in this survey were taken from other sources[1] and adjusted from G.B. to Scottish levels[2]. No female earnings figures were available on a regional basis, therefore U.K. weekly figures were taken for wages and salaries[3]. To calculate a figure for average earnings, it was assumed that the proportion of non-manual to manual workers was 2 : 1[4]. Female earnings/...

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1. Agriculture from Statistics on Incomes, Prices and Productivity, Dec. 1966, table B.10, Distribution from M.O.L. Gazette, Dec. 1966, sample survey, derived from table 8, Insurance from D.E.P. Gazette, March 1969, special enquiry, p.220, with Professional and Scientific taken from the same source.
2. reduced to 96.4% of the G.B. figures on the basis of the Regional Survey, D.E.P. Gazette, March 1969, table 3, p.234.
3. M.O.L. Gazette, April 1967, tables 122 and 123.
4. Based on the sample proportion in the Government Special Survey on Women's Employment, by Audrey Hunt.

Female earnings figures for the industries covered in footnote 1 were taken directly from these sources and adjusted to Scottish levels on the assumption that there was the same relationship between regions for females as for males. The total weekly income figures by S.I.C. order could then be estimated for employees by multiplying persons employed and average income for the industry.

The next stage was to estimate the numbers and average income of self employed by industry. Since no figures for self employed locally were available from the D.E.P., the 1966 Sample Census was used[5]. From this it was estimated that there were 1,700 male and 300 female self employed[6]. These were allocated to S.I.C. orders on the same pattern as for G.B. as a whole[7]. In the complete absence of earnings figures for self employed, it was assumed that these would, on average, earn a premium of 30% over average income for employees in all industries[8]. Weekly income from self employed was then estimated and added to income from employees; the final income figures were then converted from weekly to an annual basis and are shown in table (a). They have been summarised for the ten main industries in table 3.3.

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5. Data on Economic Activity, some published in table 3 of the County tables, but mostly taken from the unpublished data at the Census Office.
6. These figures have only been rounded and are not corrected to any confidence level.
7. Economic Activity Tables, Sample Census 1966, Great Britain Part I, table 4, pp. 80 - 82.
8. the premium of 30% is quite arbitrary and likely to understate.

Table (a)

Estimates of income received from Study Area workplaces

		1966 PERSONS (incl. S/E)				INCOME per annum (£'000)			
		M	F	T	%	M	F	T	%
1	Agric. etc	815	97	912	2.3	630	36	666	2.0
2	Mining	3,161	189	3,350	8.5	3,041	112	3,153	9.7
3	Food	1,422	707	2,129	5.4	1,372	364	1,736	5.3
4	Chemical	11	6	17	0.0	12	3	15	0.0
5	Metal	45	2	47	0.1	48	1	49	0.2
6	Engineering	1,229	409	1,638	4.1	1,382	234	1,616	5.0
7	S/building	17	-	17	0.0	18	-	18	0.1
8	Vehicles	11	3	14	0.0	12	2	14	0.0
9	Metal gds.	516	730	1,246	3.2	541	376	917	2.8
10	Textiles	1,190	3,010	4,200	10.6	1,049	1,433	2,482	7.6
11	Leather	24	3	27	0.1	26	2	28	0.1
12	Clothing	22	67	89	0.2	25	39	64	0.2
13	Bricks	1,493	174	1,667	4.2	1,479	84	1,563	4.8
14	Timber	386	44	430	1.1	368	22	390	1.2
15	Paper etc	940	697	1,637	4.1	1,017	368	1,385	4.3
16	Other man.	173	63	236	0.6	170	33	203	0.6
17	Constr.	3,384	131	3,515	8.9	3,492	66	3,558	10.9
18	Gas	1,046	198	1,244	3.1	965	122	1,087	3.3
19	Transport	1,345	403	1,748	4.4	1,356	270	1,626	5.0
20	Distrib.	1,840	2,357	4,197	10.6	1,770	1,084	2,854	8.8
21	Ins. etc	323	444	767	1.9	432	267	699	2.1
22	Prof. & scient.	1,211	3,122	4,333	11.0	1,703	2,670	4,373	13.4
23	Miscellaneous	1,642	2,383	4,025	10.2	1,488	1,058	2,546	7.8
24	Pub. admin.	1,469	544	2,013	5.1	1,119	368	1,487	4.6
		23,715	15,783	39,498		23,515	9,014	32,529	

Statistical Appendix 3.3

Estimates of female Activity Rates for the Study Area

Regional A.R.'s when available, normally relate to large areas, such as Scotland as a whole. The rates are difficult to estimate for smaller regions for a number of reasons. Since they relate female working populations (D.E.P. National Insurance card count) to the female population aged 15 and over (Census returns, based on local authority areas), there is the possibility of a clash between geographical bases, as in the case of the Study Area. A further sub-regional problem is that the D.E.P. figures, even if corrected for area, relate to employment at local workplaces and, by ignoring in/out commutor flows, may well provide an inaccurate estimate of the relationship between the local labour force and the resident population.

The standard region most closely corresponding to the Study Area is Falkirk/Stirling. A recent estimate[1] of the female A.R. for this region was 38% against the Scottish figure of 40%. On the grounds that the Study Area, with its female predominant industries was likely to show a greater female A.R. than this, the figure was not used.

To avoid the geographical clash between D.E.P. and Census returns, the estimates made were based entirely on figures taken from the Sample Census, 1966, corrected for standard error to a 95% confidence level[2]. The results are given in table/...

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1. The Intermediate Areas, CMND 3998, Appendix C, p.214.
2. Clackmannan County data from the County tables for Economic Activity, with Perth and Stirling county sections taken from unpublished data at the Census office.

in table 3.9, with the economically active female population expressed as a percentage of the resident female population aged 15 and over

THE STATISTICAL APPENDICES TO CHAPTER 4

Statistical Appendix 4.1

(1) Fertility rates for Births projection

In forecasting births, projection models of the component type, give some weighting to variables such as proportion of women married, duration of marriage (since birth is likeliest in the earlier years of marriage), the likely incidence of divorce and widowhood over the period, with an adjustment for probability of remarriage during the period and, probable trends in illegitimate births. Because of the difficulties involved in collecting and using at sub-regional level much of the statistics concerned with these variables, I have simplified the relationship between women of fertile age and births. If it is assumed that, over the period 1961-1981, there are no significant changes in the proportion of women married[1], that the duration of marriage pattern remains constant, that, at sub-region level, divorce and widowhood with possible remarriage have an insignificant effect on births and resultant population, then a fertility rate can be calculated and applied to all women of reproductive age, married and unmarried (thus covering illegitimacy), to obtain a total of live births for any year.

At sub-regional level, however, the Registrar General statistics provide no age breakdown of women giving birth. From the/. . .

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1. effectively the proportion chosen is not that ruling at the beginning of the period, but the average proportion for 1960 - 67.

From the statistics for all Scotland[2] for the period 1960 - 67 inclusive, average age specific fertility rates for all women were calculated. These rates were then applied to female population in the Study Area aged 15 - 49 and total births calculated. Next, total births in the Study Area were averaged over the period and this total compared to the figure derived from the age specific fertility rates. The forecast for total annual births fell 68 short of the average for the period. This shortfall was added to forecast births in the same proportions as the original forecast. New adjusted A.S.F.R. for the Study Area were calculated yielding a revised total of births equal to the average of actual births. The adjusted forecast of total births was then converted to a total fertility rate (F_t), which, when applied to all women aged 15 - 49 (P_y) yielded the average annual total of births.[3]

The formula for birth estimation and its adjustment for the effects of deaths and migration are discussed later.[4]

(2) Mortality rates and survival factors

Since a population projection provides not merely a possible total population figure for some date in the future but also a possible sex and age structure breakdown of the figure, the incidence of death must be calculated not for total population, but by sex and age group.

Again it/...

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2. Annual Reports of the Registrar General, table 23.
3. See table (a).
4. See Statistical Appendix 4.2.

Again it is impossible to obtain all the necessary data by sex and age at sub-regional level to allow the calculation of local age specific mortality rates[5]. Once again the rates used had to be calculated from figures relating to the whole of Scotland[6]. Even using this best available (in terms of age and sex breakdown) source, age specific mortality rates for all age groups over 15 years of age, are given in ten year age groups, with an open-ended age group for "85 and over". For the purposes of the projection, it was necessary to estimate A.S.M.R. for 5 year age groups.

The method adopted was to plot the average Scottish A.S.M.R. for the period 1960 - 67 on semi-log graphs and fit curves by eye. The A.S.M.R. for male and female 5 year age groups were then estimated by interpolation. The resultant mortality rates were then applied to the base population to estimate a figure for total deaths per annum for the Study Area. An annual average of actual deaths for the period was then calculated[7] and compared to the estimate; actual deaths exceeded the estimated figure by 40 deaths. To adjust for this and allow mortality rates to predict total deaths for the Study Area accurately for the first part of the projection period, the A.S.M.R. for both sexes were all increased by 3.95% (the excess of actual over estimated).

A final/...

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5. The most detailed set of local statistics in the Reports (table 55) does not cover many parts of the Study Area. Other tables do not attempt a sex breakdown and, in any case, still omit Central D.C. No.1
6. Annual Reports of Registrar General, table T37, averaged 1960 - 67
7. Source data from Annual Reports, tables 7 and 7a.

A final comment on the use of A.S.M.R. for this projection model is that, while conventionally A.S.M.R. are represented by the symbol m_x (crude central mortality rates for age group x, based on a three year average) and, for survival factor purposes, are refined to a death probability factor per thousand of population, q_x[8] the method of calculation of A.S.M.R. in this projection has tended to make $m_x \equiv q_x$. Thus, for projection purposes, since m_x estimates probable deaths for any given year (as does q_x in other models) the A.S.M.R. values will be used as q_x.

In any year, the population in age group x will either survive or die, ($\pi_x + q_x = 1$), thus the survival factor per thousand of population for any age group x, is $\pi_x = 1 - q_x$.[9] The survival factors for the quinquennium are given in table (B).

(3) Migration: sex and age assumptions for the projection

The basic assumptions on direction and volume of the net migration flows have been discussed in the chapter; this section is only concerned with the sex and age pattern composition of the net flows.

There is no satisfactory method of breaking down migration flows into gross out/in directions, sexes or age groups. From the start, only the net balance of the flows can be "analysed". Several alternative sources/...

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8. a typical adjustment process is discussed in "Statistics" by Ilersic, 12th edition, pp.303 - 311
9. see later discussion on calculation of quinquennial survival factors in Statistical Appendix 4.2.

alternative sources of information were available from which assumptions on the Study Area's migration pattern over the projection period could have been made, such as New Town studies, Census (1961) Migration tables, or Glasgow overspill statistics.

However for a number of reasons, it was decided to use the unpublished net migration estimates of the Registrar General for Scotland. Firstly, while their age and sex pattern is based on the sample surveys on migration in the Census Reports for 1961 and 1966, it has been broken down from the rather broad age groups of the Census to the 5 year age groups used for the rest of the projection. Secondly, the Registrar's office have further adjusted the Census figures in the light of results from their own series of samples for migration by air and sea and also in light of their experience or, for example, age errors in survey returns. Thirdly, the pattern is based on all Scotland, has been computed and checked annually, so far as is possible, has been used over a fair period of time and has tended to show a steady, confirmed (by their various surveys) pattern, uninfluenced by minor, sub-regional quirks.

While the Registrar's figures[10] provide a reasonable basis for studying the effect of migration on population over the projection period, they cannot hope to be completely satisfactory. Thus if/...

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10. see quinquennial figures for migration in table (c)

Thus, if the two way flow of younger persons out and older persons into the Study Area continues over the projection period, a net outflow assumption for all age groups, even if it is of the same magnitude as the net loss experienced, will tend to underestimate the younger persons lost, and indicate a net loss for older persons where there should be a net gain.[11] Given the concentration of migration flows on the low mortality age groups, the effect of this known weakness will tend to be on the age composition rather than the final total of the projected population.

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11. the effects of this can be seen in the various projections made in the Chapter.

Statistical Appendix 4.1 table (a)

Age specific and total fertility rates for S.A.

age	1961 females	fertility rate (per '000)
15 - 19	3354	40.02
20 - 4	3060	186.48
25 - 9	2901	197.51
30 - 4	3143	117.52
35 - 9	3239	57.65
40 - 4	3051	15.57
45 - 9	3146	0.99
	21894 ($^{n+1}P_y$)	86.11 (F_t)

Statistical Appendix 4.1 table (b)

Mortality and survival factors for the S.A.

Age	One year Mortality rates		Quinquennial Survival factors	
	Male	Female	Male	Female
0	0.03056	0.02328	-	-
1 - 4	.00114	.00094	0.9943	0.9953
5 - 9	.00062	.00031	.9969	.9984
10 - 4	.00052	.00031	.9974	.9984
15 - 9	.00072	.00042	.9964	.9979
20 - 4	.00104	.00052	.9948	.9974
25 - 9	.00125	.00073	.9937	.9963
30 - 4	.00177	.00114	.9912	.9943
35 - 9	.00260	.00177	.9870	.9911
40 - 4	.00437	.00291	.9782	.9854
45 - 9	.00728	.00457	.9637	.9771
50 - 4	.01206	.00707	.9401	.9646
55 - 9	.02037	.01091	.8992	.9454
60 - 4	.02547	.01819	.8743	.9090
65 - 9	.04886	.02911	.7615	.8544
70 - 4	.07640	.04802	.6321	.7599
75 - 9	.11279	.07900	$(0.8872)^5$	$(0.9210)^5$
80 - 4	.16840	.12214	$(0.8316)^5$	$(0.8779)^5$
85 & over	.23129	.18971	$(0.7687)^5$	$(0.8103)^5$

Quinquennial migration totals by age group for 300 persons per annum net flow

age	persons male	persons female
0	29	28
1 - 4	40	38
5 - 9	51	51
10 - 4	51	51
15 - 9	54	51
20 - 4	111	93
25 - 9	120	108
30 - 4	126	99
35 - 9	75	66
40 - 4	66	42
45 - 9	42	27
50 - 4	24	21
55 - 9	9	12
60 - 4	3	6
65 - 9	3	3
	804	696

Statistical Appendix 4.2

The Population Projection Model

Taking the 1961 Census population, adjusted to bring it to 30th June, 1961, as its base population, the model projects the five year age groups over a series of quinquennial steps from 1961 to 1981; this base population is subject to the three main adjustments of deaths, births and migration.

(a) Deaths

The probability of death in any year for a person in the 5 year age group x is given by the value of q_x (given the method of estimation of A.S.M.R. for the Study Area, the m_x, are identical to q_x). The probability of survival, or simply the survival factor is therefore $\pi_x = 1 - q_x$. Since the probability of death over a quinquennium for a given age group will be five times the probability of death in one year, or $5q_x$, then the survival factor over the five years is

$$^5\pi_x = 1 - {}_5q_x \qquad (1)$$

Thus, where there is no net migration flow to be taken into account, the numbers of the population of age group x, (P_x), surviving the quinquennium can be calculated as $P_x . {}^5\pi_x$.

Use is made of two types of modified survival factors. In the case of the final two age groups for "80 - 4" and "85 and over", adjustment for death via a straightforward survival factor of $^5\pi_x$ (i.e. $1 - 5q_x$) results in too severe a reduction of population of this age. Here the device of applying q_x to survivors of

successive years/...

successive years has been used, i.e. a one year survival factor of π_x is applied to the survivors of the first year of the quinquennium, namely, $P_x\pi_x$, as $(P_x\pi_x)\pi_x$, and becomes $P_x(\pi_x)^2$; thus the modified survival factor for these age groups for the quinquennium becomes $P_x(\pi_x)^5$. The second type of modification used is where births, or in-migrants, are under consideration; both of these sources of population must be treated not only as annual flows during each quinquennium but also as flows during or within each year itself. This implies that for, say, immigrants, the total coming into the Study Area in year one of the period are exposed, on average, to only half of the probability of death for that year, (i.e. some of the migrants arrive at the beginning, some in the middle and some at the end of the period, each with a different time of exposure to death - so that only the first migrants are exposed to the full q_x). Thus, for those exposed to only half the annual probability of death, a separate survival factor of $\pi'_x = 1 - \frac{1}{2}q_x$ is calculated and applied; for simplicity, it is assumed that, for the remainder of the quinquennium following their first year of entry, survivors are exposed to the full probability of death for each year, so that the full adjustment for first year of the quinquennium entrants becomes, for immigrants, $M_x.\pi'_x.^4\pi_x$. (For second year entrants it would become $M_x.\pi'_x.^3\pi_x$ and so on.) The same type of survival factor is used for births, i.e. a double adjustment for survival of first then subsequent years of life during the quinquennium in question.

(b) Births

Total births for any single year of the projection period can be estimated by applying the total fertility rate[1] to all women of reproductive age alive in that year, i.e. $F_t.P_y$. When estimating/...

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1. See Statistical Appendix 4.1.

When estimating births over a quinquennium, however, given no migration net flow[2] to complicate the issue, P_y will decline under the incidence of death, as it affects each age group within the range 15 - 49 years. The survivors of the original group of women of reproductive age, P_y becomes $P_y {}^5\pi_y$ (where ${}^5\pi_y$ is merely a summary expression for all the quinquennial survival factors for each age group of this section of the population). As a result of this, given a constant fertility rate F_t, total births will fall in successive years as the quinquennium progresses. To simplify, it has been assumed that there is a constant annual flow of births (B_o), which is made up of half the births from women alive at the beginning of the period (n+1) and half the births from women alive at the end of the quinquennium (n+6), i.e.

$$B_o = \frac{F_t \left({}^{n+1}P_y + {}^{n+6}P_y \, {}^5\pi_y \right)}{2} \qquad (2)$$

(c) Migration

The Registrar General's estimates of net migration flow for Scotland allow the calculation of the number of persons[3], male and female of the net flow of the Study Area for any year, or over the quinquennium. Net migrants for any single year are denoted by the symbol M_x, where x is again the five year age group of the migrant.

For Projection I, it is assumed that there is a net annual outflow of 300 persons from the Study Area. For the purposes of the projection formulae, it is also assumed that this figure for emigration, when taken over the quinquennium (giving a total of 1,500 emigrants), is net of death. The emigration total represents those who have actually left the Study Area, not merely those intending to emigrate (some of whom are likely to have died over the quinquennium). Thus, in Projection/...

2. for correction of formula for migration effect, see later section (c) of this Statistical Appendix.
3. see Statistical Appendix 4.1, table (c)

in Projection I, the emigration adjustment is:-

$$-\sum_{r=1}^{5} {}_{n+r}M_x \qquad (3)$$

For Projection III, it is assumed that there is a net inflow of migrants to the Study Area of 300 persons per annum. In this case, however, the inflow enters the Study Area during each year of the quinquennium, thus experiencing a modified probability of death[4]. Thus a dual survival factor must be used, with its first component relating to the year of entry into the Study Area and its second component relating to subsequent years of the quinquennium, when, for simplicity, it is assumed that immigrants face the full annual probability of death. For this projection, the formula adjustment for immigration becomes:-

$$+\sum_{r=1}^{5} {}_{n+r}M_x \cdot \pi'_x {}^{5-r}\pi_x \qquad (4)$$

However, in the actual computation of the projection by quinquennium, the fairly complex survival adjustments for immigrants have an insignificant effect on the migration figure for most age groups; if migration inflow over the quinquennium into any given age group (apart from "under 1"[5]) is taken as net of death, in no case is there a difference of more than one person per age group per quinquennium. The reasons for this are fairly obvious, given the age structure of the migration flow. Migration is at its heaviest in younger age groups, where q_x is at an extremely low value, so that ignoring the latter entirely, including its modified/...

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4. see section (a) of this Appendix.
5. see section (d) of this Statistical Appendix.

its modified first year, has little effect on the M_x total. Equally, where q_x rises to a more significant level, i.e. in the older age groups, migration flow is either a trickle, or even zero, over the quinquennium; again the effect on M_x is negligible. Thus, for all practical purposes, the net inflow, as with the net outflow, can be taken as net of death and the formula simplified to:-

$$+\sum_{r=1}^{5} {}_{n+r}M_x \qquad (4')$$

Finally, the formulae for estimating births can be adjusted to take account of migration effects. Projection II, with zero net migration remains as in section (b) of this Appendix. Projection I, with net outflow becomes:-

$$B_o = \frac{F_t\left({}_{n+1}P_y + \left({}_{n+1}P_y \cdot {}_5\pi_y - \sum_{r=1}^{5} {}_{n+r}M_y\right)\right)}{2} \qquad (2')$$

Projection III, with a net migration inflow, becomes:-

$$B_o = \frac{F_t\left({}_{n+1}P_y + \left({}_{n+1}P_y \cdot {}_5\pi_y + \sum_{r=1}^{5} {}_{n+r}M_y\right)\right)}{2} \qquad (2'')$$

(d) <u>The Final Projection formulae</u>

The model projects the male and female population by five year age group in quinquennial steps from 1961 (n+1) to 1981.

(i) For all/...

For all age groups other than "0 - 4", "80 - 4" and "85 and over" in 1966 (year n+6), the projection formula for zero net migration (Projection II) is:- $${}^{n+6}P_{x+5} = {}^{n+1}P_x \, {}^{5}\pi_x \qquad (5)$$

For Projection I the formula is:-

$${}^{n+6}P_{x+5} = {}^{n+1}P_x \, {}^{5}\pi_x - \sum_{r=1}^{5} {}^{n+r}M_x \qquad (5')$$

For Projection III the formula is:-

$${}^{n+6}P_{x+5} = {}^{n+1}P_x \, {}^{5}\pi_x + \sum_{r=1}^{5} {}^{n+r}M_x \qquad (5'')$$

(ii) In projecting for age group "0 - 4", account must be taken of the variation in death rates between the first year of life and the remainder of the age range "1 - 4". While several possible approaches exist, it has been decided to calculate two separate survival factors, one for the first year of life (π_o) and one covering any year in the range 1 - 4 (π_α). Further, the first survival factor must be modified, as discussed previously[6], to π'_o.

The formula for Projection II in this age group becomes:-

$${}^{n+6}P_{0-4} = \sum_{r=1}^{5} {}^{n+r}B_o \cdot \pi'_o \cdot {}^{5-r}\pi_\alpha \qquad (6)$$

For Projection I, the formula takes account of net emigration:-

$${}^{n+6}P_{0-4} = \sum_{r=1}^{5} {}^{n+r}B_o \cdot \pi'_o \cdot {}^{5-r}\pi_\alpha - \sum_{r=1}^{5} {}^{n+r}M_o \qquad (6')$$

For Projection III, the formula takes account of net immigration and is the only age group where the survival factor for migrants is modified as discussed previously (since both migration flow and q_x are significant here). It becomes:-

$${}^{n+6}P_{0-4} = \sum_{r=1}^{5} ({}^{n+r}B_o + {}^{n+r}M_o) \cdot \pi'_o \cdot {}^{5-r}\pi_\alpha \qquad (6'')$$

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6. see section (a) of this Appendix

Formulae for age groups "80 - 4" and "85 and over"

The adjustment to the quinquennial survival factor has been discussed earlier[7] and the modified survival factor is used for both age groups. For age group "80 - 4" the projection formula is:-

$$ {}^{n+6}P_{80-4} = {}^{n+1}P_{75-9} \, (\pi_{75-9})^5 \qquad (7) $$

In the case of the older age group, "85 and over", there are two sources of population by year n+6, namely survivors over the quinquennium from age group "80 - 4" and survivors of the population aged "85 and over" of year n+1. Thus:-

$$ {}^{n+6}P_{85-} = {}^{n+1}P_{80-4}(\pi_{80-4})^5 + {}^{n+1}P_{85-}(\pi_{85-})^5 \qquad (8) $$

In neither case are there any migration adjustments for inflow or outflow. The formulae are the same for Projections I, II and III.

The projected population totals for each quinquennium are given in table (a) of the appendix. The 1976 projections by 5 year age group and sex are given in tables (b) and (c) and, for 1981, tables (d) and (e).

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7. see section (a) of this Appendix.

Statistical Appendix 4.2 table (a)

	1961	1966	1971	1976	1981
Projection I					
Males	44682	46193	47661	48998	50324
Females	48223	49562	50806	51913	53006
Total	92905	95755	98467	100911	103330
Projection II					
Males	44682	47067	49509	51908	54368
Females	48223	50305	52418	54487	56616
Total	92905	97372	101927	106395	110984
Projection III					
Males	44682	47920	51313	54752	58321
Females	48223	51053	54014	57018	60164
Total	92905	98973	105327	111770	118485

Statistical Appendix 4.2 table (b)

Age structure comparison of projections, 1976

Male

	1961		1976					
age	Persons	%	I	%	II	%	III	%
0 - 4	4643	5.0	4761	4.7	5089	4.8	5393	4.8
5 - 9	3957	4.3	4669	4.6	4921	4.6	5154	4.6
10-14	4417	4.8	4505	4.5	4703	4.4	4877	4.4
15-19	3377	3.6	4449	4.4	4591	4.3	4732	4.2
20-24	2690	2.9	3765	3.7	3921	3.7	4076	3.6
25-29	2869	3.1	4162	4.1	4367	4.1	4581	4.1
30-34	2882	3.1	3043	3.0	3327	3.1	3610	3.2
35-39	3099	3.3	2282	2.3	2636	2.5	2990	2.7
40-44	2836	3.1	2472	2.4	2789	2.6	3106	2.8
45-49	2900	3.1	2497	2.5	2759	2.6	3018	2.7
50-54	2875	3.1	2707	2.6	2883	2.7	3059	2.7
55-59	2600	2.8	2390	2.4	2513	2.4	2636	2.4
60-64	1916	2.1	2297	2.3	2363	2.2	2428	2.2
65-69	1367	1.5	2093	2.1	2125	2.0	2155	1.9
70-74	1023	1.1	1545	1.5	1557	1.5	1568	1.3
75-79	692	0.7	803	0.8	807	0.8	810	0.7
80-84	378	0.4	361	0.4	362	0.3	363	0.3
85 and over	161	0.2	195	0.2	195	0.2	196	0.2
	44682		48998		51908		54752	

Statistical Appendix 4.2 table (c)

Age structure comparison of projections, 1976

Female

	1961		1981					
age	Persons	%	I	%	II	%	III	%
0 - 4	4455	4.8	4499	4.5	4815	4.5	5105	4.6
5 - 9	3756	4.0	4418	4.4	4663	4.4	4890	4.4
10-14	4217	4.5	4300	4.3	4463	4.2	4632	4.1
15-19	3354	3.6	4280	4.2	4420	4.2	4560	4.1
20-24	3060	3.3	3583	3.6	3736	3.5	3889	3.5
25-29	2901	3.1	3995	4.0	4190	3.9	4385	3.9
30-34	3143	3.4	3074	3.0	3326	3.1	3577	3.2
35-39	3239	3.5	2725	2.7	3024	2.8	3322	3.0
40-44	3051	3.3	2577	2.6	2848	2.7	3119	2.8
45-49	3146	3.4	2848	2.8	3052	2.9	3255	2.9
50-54	3094	3.3	2959	2.9	3091	2.9	3222	2.9
55-59	2790	3.0	2746	2.7	2833	2.7	2920	2.6
60-64	2395	2.6	2747	2.7	2803	2.6	2860	2.6
65-69	1995	2.1	2529	2.5	2564	2.4	2599	2.3
70-74	1553	1.7	2031	2.0	2049	1.9	2066	1.8
75-79	1098	1.2	1407	1.4	1413	1.3	1419	1.3
80-84	677	0.7	782	0.8	784	0.7	785	0.7
85-89	299	0.3	413	0.4	413	0.4	413	0.4
	48223		51913		54487		57018	

Statistical Appendix 4.2 table (d)

Age structure comparison of projections, 1981

Male

	1961		1981					
age	Persons	%	I	%	II	%	III	%
0 - 4	4643	5.0	4900	4.7	5333	4.8	5742	4.8
5 - 9	3957	4.3	4694	4.5	5060	4.6	5402	4.6
10-14	4417	4.8	4604	4.5	4906	4.4	5189	4.4
15-19	3377	3.6	4442	4.3	4691	4.2	4915	4.1
20-24	2690	2.9	4379	4.2	4574	4.1	4769	4.0
25-29	2869	3.1	3634	3.5	3901	3.5	4166	3.5
30-34	2882	3.1	4016	3.9	4339	3.9	4672	3.9
35-39	3099	3.3	2890	2.8	3298	3.0	3704	3.1
40-44	2836	3.1	2177	2.1	2602	2.3	3026	2.6
45-49	2900	3.1	2352	2.3	2728	2.5	3104	2.6
50-54	2875	3.1	2364	2.3	2659	2.4	2950	2.5
55-59	2600	2.8	2521	2.4	2710	2.4	2900	2.4
60-64	1916	2.1	2140	2.1	2260	2.0	2379	2.0
65-69	1367	1.5	2005	1.9	2066	1.9	2126	1.8
70-74	1023	1.1	1592	1.5	1618	1.5	1644	1.4
75-79	692	0.7	977	0.9	984	0.9	991	0.8
80-84	378	0.4	441	0.4	443	0.4	445	0.4
85 and over	196	0.2	196	0.2	196	0.2	197	0.2
	44682		50324		54368		58321	

Statistical Appendix 4.2 table (e)

Age structure comparison of projections, 1981

Female

	1961		1981					
age	Persons	%	I	%	II	%	III	%
0 - 4	4455	4.8	4638	4.6	5050	4.6	5440	4.6
5 - 9	3756	4.0	4440	4.3	4792	4.3	5119	4.3
10-14	4217	4.5	4360	4.2	4656	4.2	4933	4.2
15-19	3354	3.6	4242	4.1	4456	4.0	4676	4.0
20-24	3060	3.3	4220	4.1	4411	4.0	4601	3.9
25-29	2901	3.1	3481	3.4	3726	3.4	3972	3.4
30-34	3143	3.4	3872	3.7	4174	3.8	4477	3.8
35-39	3239	3.5	2957	2.9	3307	3.0	3656	3.1
40-44	3051	3.3	2635	2.6	2997	2.7	3358	2.8
45-49	3146	3.4	2497	2.4	2806	2.5	3115	2.6
50-54	3094	3.3	2756	2.7	2982	2.7	3207	2.7
55-59	2790	3.0	2833	2.7	2981	2.7	3129	2.6
60-64	2395	2.6	2584	2.5	2678	2.4	2773	2.3
65-69	1995	2.1	2491	2.4	2548	2.3	2606	2.2
70-74	1553	1.7	2158	2.1	2191	2.0	2224	1.9
75-79	1098	1.2	1543	1.5	1557	1.4	1570	1.3
80-84	677	0.7	851	0.8	855	0.8	858	0.7
85 and over	299	0.3	448	0.4	449	0.4	450	0.4
	48223		53006		56616		60164	

Statistical Appendix 4.3

Projection IV: sensitivity of results to changing birth and death rates

The main projections I - III were based on the assumption that mortality rates (and therefore π_x) and birth rates remained constant over the projection period at levels based on averages, for Scotland, of 1960-67 inclusive. Against these constant rates, the direction and level of migration was varied and its results analysed.

It cannot be expected that birth and death rates will remain constant over the period; obviously they are expected to exhibit certain trends in the direction and volume of their changes. Some idea must be gained of their effects on previous projections results. To do this, there has been no attempt to use a series of possible combinations held constant over the period to yield a new series of projected results; the sensitivity test has been to vary rates according to the Registrar General's forecast behaviour for Scottish rates over the same period.[1]

For births, the Registrar General forecasts that for all Scotland, the total will fall to about 95,000 (from an average of 103,000 for 1960-67) per annum for 1967-69, rising to about 100,000 per annum for 1977-78 and again, slowly to 110,000 per annum by 1987-88. This has/...

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1. See table 5 comments in Annual Reports 1960-67.

This has been converted for the sensitivity test to the following changes in fertility:

a) a fall for 1966-71 to 92.23% of level for 1961-66

i.e. $F_t = 0.07942$

b) a rise for 1971-76 to 94.66% of 1961-66 level

i.e. $F_t = 0.08151$

c) a rise to 99.52% of 1961-66 level for final quinquennium of 1976-81

i.e. $F_t = 0.08570$

For deaths, the Registrar General forecasts that, "at younger ages .... decline to about one half of current (1967) rates after 20 years. At higher ages the rates of decline become progressively smaller as age advances."[2] Miss B M Swift in Vol. I of the Lothians Regional Survey and Plan has estimated the effect of these forecasts on falling mortality rates for a period similar to my own projection period.[3] While her data relates to a sub-region other than the Study Area, her base figures are reasonably near the 1961 Study Area rates and, for the purposes of testing the sensitivity of the model, can be taken as an approximate guide to the behaviour of π_x for the Study Area over the period.[4]

The varying mortality and fertility rates as adapted from the Scottish forecasts are applied to the zero net migration Projection II for the purpose of comparing results and therefore the effect of changes in the rates. The projection indicates that the Study Area's natural increase,/...

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2. Op. cit. 1967 volume, p.88
3. Lothians Survey, App. B, pp. 256-8
4. See tables (a) and (b)

natural increase, given the forecast changes in birth and death rates would be from about 92,900 in 1961 to about 106,000 in 1976 and about 111,600 in 1981. This exceeds the Projection II total by only 0.6%, due to the compensation of improved mortality rates by a much lower level of births over the period. Comparison by sex and age group[5] of the two projections suggests that variation of death rates have no significant effect on population, male or female between the ages of 15 - 59. The effect of forecast mortality improvements becomes more marked for females for each successive age group 60 and over. For men, the improvement is less marked but this is likely to have been caused by the using of mortality rates for the Lothians area; male mortality rates for these ages were significantly heavier for the Lothians than for the Study Area, so that the improvement of the rates tends to understate the improvement likely for the Study Area.[6] At the other extreme of the age range, 0 - 14, the effects of falling total births per annum can be seen particularly over the ages 5 - 14; 0 - 4 show little difference between the projections, since the forecast rise in births to nearly the 1961-66 level by the last quinquennium of the projection period, is supplemented by improvements in mortality rates (especially for "less than 1") resulting in a marginal excess of IV over II.

Overall, it is not likely that actual changes in the level of birth and death rates, if these conform to the expected trends for Scotland, will have any significant effect on total population figures as given by the Projections.

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5. See table (c)
6. Given the level of difference for females between Projection IV and II, even if separate rates for the Study Area had been used, it would not have widened significantly the gap between the Projections.

Revised Survival Factors, Males and Females

Statistical Appendix 4.3(a)

Males

age	1966-71 $_5\pi_x$	1971-76 $_5\pi_x$	1976-81 $_5\pi_x$
0	.8624	.8748	.8859
1	.9958	.9971	.9979
5	.9975	.9980	.9984
10	.9979	.9983	.9986
15	.9967	.9970	.9976
20	.9956	.9958	.9963
25	.9949	.9953	.9959
30	.9935	.9945	.9951
35	.9910	.9920	.9930
40	.9840	.9858	.9880
45	.9675	.9700	.9730
50	.9435	.9475	.9510
55	.9075	.9125	.9175
60	.8500	.8600	.8645
65	.7650	.7750	.7850
70	.6550	.6750	.6900
75	$(.9020)^5$	$(.9080)^5$	$(.9120)^5$
80	$(.8550)^5$	$(.8600)^5$	$(.8650)^5$
85	$(.7483)^5$	$(.7529)^5$	$(.7573)^5$

Statistical Appendix 4.3(b)

Females

age	1966-71 $_5\pi_x$	1971-76 $_5\pi_x$	1976-81 $_5\pi_x$
0	.9017	.9131	.9231
1	.9971	.9979	.9994
5	.9984	.9988	.9991
10	.9988	.9991	.9993
15	.9986	.9988	.9990
20	.9979	.9981	.9981
25	.9971	.9974	.9975
30	.9956	.9960	.9966
35	.9930	.9940	.9948
40	.9885	.9900	.9914
45	.9820	.9840	.9855
50	.9720	.9745	.9765
55	.9565	.9600	.9630
60	.9260	.9325	.9355
65	.8675	.8750	.8795
70	.7850	.7900	.8000
75	.6625	.6785	.6850
80	.4575	.4685	.4825
85	$(.7610)^5$	$(.7642)^5$	$(.7672)^5$

Statistical Appendix 4.3(c)

Sensitivity test

	Males		IV-II		Females			
age	Proj II	Proj IV	diff	%	Proj II	Proj IV	diff	%
0	1069	1073	+ 4		1012	1015	+ 3	
1	4264	4288	+ 24		4038	4057	+ 19	
5	5060	4839	- 221		4792	4583	- 209	
10	4906	4562	- 344		4656	4322	- 334	
15	4691	4709	+ 18		4456	4470	+ 14	
20	4574	4586	+ 12		4411	4419	+ 8	
25	3901	3910	+ 9		3726	3736	+ 10	
30	4339	4355	+ 16		4174	4186	+ 12	
35	3298	3318	+ 20		3307	3320	+ 13	
40	2602	2628	+ 26		2997	3015	+ 18	
45	2728	2775	+ 47		2806	2835	+ 29	
50	2659	2716	+ 57		2982	3027	+ 45	
55	2710	2777	+ 67		2981	3049	+ 68	
60	2260	2333	+ 73		2678	2771	+ 93	
65	2066	2080	+ 14		2548	2683	+ 135	
70	1618	1656	+ 38		2191	2340	+ 149	
75	984	1063	+ 79		1557	1710	+ 153	
80	443	546	+ 103		855	1022	+ 167	
85+	196	263	+ 67		449	563	+ 114	
	54368	54477	+ 109	0.2%	56616	57123	+ 507	+ 0.9%

Statistical Appendix 4.4

Estimation of local modification factors for 1961-76

The method chosen to project the employment pattern of the Study Area applies a series of national estimated rates of change to the employment structure of the local area at the beginning of the period and then corrects these preliminary estimates for local influences. The figures chosen for the national estimates are discussed in the chapter. This appendix is concerned with the estimation of the local residual component, as based on the comparison of national and local changes in employment over the period 1961-68. A straightforward comparison of the figures for these years could result in residuals of false magnitude, partly reflecting regional differences in the impact of cyclical trends and partly as the result of, say, a coincidence of an industrial dispute with the June count figures for persons in employment; where one of the areas to be compared is rather small, like the Study Area, local disturbances can distort employment figures significantly. To avoid this, the figures for employment by S.I.C. Order for the beginning of the period were taken as the average of the persons employed in each industry for 1960-62, and the end of the period figures as the average of 1966-68.

The first step in the calculation was to find the national rate of change by industry for the period[1]. This was then applied to the Study Area/...

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1. see column (c) to table A for this appendix.

Study Area employment structure for the beginning of the period[2] to estimate persons employed by the end of the period solely on national trends[3]. These figures were then compared to the actual[4] numbers of persons employed, and the difference expressed as a modification or correction factor from the national change figures[5]. (The value for the modification factor was calculated by dividing the actual numbers by estimated numbers employed in the industry.) The modification factor for Bricks, Potteries, and Glass, of 1.229 shows that, for the period 1960-68, the actual numbers employed were 22.9% greater than forecast by national trends. Alternatively the modification factor of 0.839 for Food, Drink and Tobacco were 16.1% less than estimated by the national trend, i.e. 83.9% of the national figure.

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2. see column (d) - the average figures for 1960-62.
3. see column (f).
4. the actual figures are given in column (e).
5. see column (g).

Table A Estimation of local modification factor

		U.K. ('000 persons)			GA. persons		National Δ applied to 1960-62	Modification factor
		average ('000) 1960-62	average ('000) 1966-68	percent charge	average 1960-62	average 1966-68		
		(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	agriculture	619	460	- 25.69	681	513	506	1.014
2	mining	746	552	- 26.01	5044	3332	3732	0.893
3	food	842	864	+ 2.61	2398	2065	2461	0.839
4	chemicals	532	522	- 1.88	17	14	17	0.824
5	metal	622	608	- 2.25	52	38	51	0.745
6	engineering	2139	2373	+ 10.94	1503	1568	1667	0.941
7	Shipbuilding	277	215	- 22.38	15	8	12	0.667
8	vehicles	905	838	- 7.40	89	12	82	0.146
9	metal NES	559	589	+ 5.37	1070	1096	1127	0.972
10	textiles	895	779	- 12.96	4346	3849	3783	1.017
11	leather	64	59	- 7.81	32	5	30	0.167
12	clothing	597	538	- 9.88	27	33	24	1.375
13	bricks etc	351	363	+ 3.42	1340	1703	1386	1.229
14	timber	295	322	+ 9.15	420	294	458	0.642
15	paper	620	650	+ 4.84	1569	1610	1645	0.979
16	other manufactures	309	352	+ 13.92	413	364	470	0.774
17	construction	1558	1689	+ 8.41	2899	3437	3143	1.094
18	gas	389	432	+ 11.05	880	1090	977	1.116
19	transport	1685	1661	- 1.42	1719	1699	1695	1.002
20	distribution	2912	2940	+ 0.96	3612	3510	3647	0.962
21	insurance	569	669	+ 17.57	502	747	590	1.266
22	professional	2110	2680	+ 27.01	2995	4163	3803	1.095
23	miscellaneous services	2071	2220	+ 7.19	3138	3359	3364	0.999
24	public administration	1318	1438	+ 9.10	2652	2398	2893	0.829
		22984	23813	+ 3.61	37413	36907	37563	0.983

Statistical Appendix 4.5

Adjustments to employment estimates

These adjustments have been made where, on the basis of employment statistics up to 1968, it seems that either the Beckerman estimates of national change were in error, or where the modification factors estimated for 1960 - 68 were distorted by events over this period. Mining, and Food Drink and Tobacco were dealt with in the chapter and will not be discussed further here. The other adjustments referred to were as follows.

In Engineering and Electrical Goods, it seems that the estimated increase of 12% for the fifteen year period was too low; by the mid year of the period, an increase of about 11% had already been recorded. The employment trend nationally for the period has therefore been extrapolated to yield an estimated increase of 19.2% by 1976; this figure has been applied to the Study Area and, after local modification yields an estimate of 1,686 persons employed by that year.

A similar adjustment was made to Bricks, Potteries and Glass, where the experienced rate of increase appears to be rather higher than that estimated; the extrapolated increase of about 7% for the period, given the fairly high local modification factor, raises the employment estimate to 1,759.

For Construction, a correction was made to the modification factor. Over the earlier period, growth in this industry was considerably in excess of the national trend, reflecting a number of factors, including, for the average of the later years, some of the early construction work on the University and its surrounds. While local Planning and D.E.P. sources expect that this industry/...

this industry will continue to operate at a high level, in view of the completion of part, at least of its activities, particularly in roadworks, the modification factor was reduced from the original 20.04% to 10% greater than the national trend, giving a final estimate of 3,663 persons in employment in this industry by 1976.

The next series of corrections relate to the S.A.M. industry group 31 used by Beckerman, covering S.I.C. orders for Insurance, Professional, and Miscellaneous services; the collective estimated increase of just over 10% for this group appears to be reasonable only for Miscellaneous services. The increase experienced by Insurance, Banking and Finance, at national level, by the mid point of the period was just under 18%; even allowing a considerable flattening of the trend, an extrapolated figure of an increase of about 28% does not seem unreasonable. A further porblem here is related to the effect on the local modification factor of the opening of the Scottish Amicable H.Q. during the period. Even when the modification factor is reduced to 30% above the national trend, the resultant estimate of 815 persons employed by 1976, is already well supported by current employment statistics. Finally, for Professional and Scientific services, by mid point these had increased in employment nationally by 27%; again assuming a marked flattening of the trend, an increased national estimate of growth of 37%, when corrected for local influence, raises the estimated number employed here to 4,896, a figure which, again, lies not too distant from current employment figures, even when the latter are adjusted for University employment by the end of 1968.

Finally, the S.I.C. transfer and the defence closures effect on local civilian employment for 1960 - 68 has distorted the residual for/...

residual for Public Administration and Defence. The decline indicated by the low modification factor will not continue over the period; indeed from 1967 onwards employment in this industry was increasing at about the national rate. Accordingly, the modification factor has been changed to 15% below national trends (to allow for the closures and transfers which have taken place) to provide an estimate of 2,757 persons employed by 1976.

THE STATISTICAL APPENDICES TO CHAPTER 6

Statistical Appendix 6.1

Estimation for the value of the induced investment coefficient

This estimate can only be made on two basic assumptions, firstly that existing Service capacity in the region is already fairly fully utilised and, secondly that immigrants to the region will have the same relative capital requirements as the population for the U.K. as a whole. Ideally, estimates of capital requirements should be based on data gathered from each region. However since the full range of statistics needed for even as simplistic an approach as this, is available at only U.K. level, rather than mix national with particular local statistics, the former have been used throughout although obviously items such as activity rates, earnings and specific type and quantity of capital required will vary between any region and the nation as a whole. In defence, it is argued that the purpose of the estimate is not to provide a definitive value for induced investment but only a plausible value which will give some idea of the importance of this additional component of ΔN in the multiplicand.

Capital required per immigrant is calculated in table (a) to this Appendix. The estimates of total U.K. population and of net capital stock at current replacement cost[1] are given for 1964-68, permitting the estimation of the net capital stock per person in the U.K. - a far from perfect, but nevertheless usable proxy for capital requirements per immigrant. The figures given for this are comparable/...

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1. Net of accrued capital consumption, sources given at foot of table; see also National Account Statistics, Sources and Methods pp 383-4.

are comparable to the Mishan/Needleman[2] estimate of capital requirements per immigrant household.

While the provision of these capital requirements in the receiving region involves induced investment in both private and public sectors (i.e. $\Delta I + \Delta G$) unlike Mishan and Needleman, no attempt will be made to allocate ΔN between these sectors, on the grounds that any allocative device would be arbitrary and that such a distinction is quite unnecessary for analysing the effect on total income of induced investment feedback.

Having estimated the total figure for capital requirements/induced investment per immigrant the next stage is to estimate the annual total for capital provision for a group, of say 1,000 immigrants to allow its inclusion in the multiplicand. It is unlikely that the capital requirements of an immigrant will be met in full within his first year of residence in an area. Mishan and Needleman assume that the provision will take place over a two year period; Archibald, having considered this period appears to opt for a three year period. If this larger period is taken and it is further assumed that the capital is provided in an even flow over the period, then for any given immigrant, or group of immigrants, 1/3 of their capital will be provided in any year. If, however, it is further assumed that there is an even flow of immigrants for each year of the period over which the immigration takes place, then after a three year build-up, the total for capital provided levels off at a figure equal to the total capital requirements for any single year's group of immigrants. Thus ΔN, as an annual figure for any year after the first/...

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2. L.B.R., July 1966 - although their capital requirements figure was used for a different purpose.

the first three of the period of immigration is not 1/3 of the estimate in table (a) but is the full amount. If one take a group of, say 1,000 immigrants to any region, then using U.K. rather than local statistics for that group, the estimated annual figure for ΔN are given in the first column of table (b).

The second main stage in the calculation is to estimate the total annual earnings for that group of immigrants over the same period. To estimate ΔZ, a calculation must be made of the number of that group likely to be in paid employment and a further calculation made of how much, on average, each will earn in a given year. Keeping to U.K. statistics, it would be possible to estimate the number employed by applying U.K. activity rates tc the immigrants. This would be unsatisfactory; research work on migration flows indicates that the typical age structure of migrants is rather younger than that of the nation as a whole. The application of normal U.K. activity rates would therefore under-state total earnings. To avoid this, it was assumed that the migrants have the same age and sex characteristics as indicated by the 1966 Sample Census returns; the resultant breakdown is given in table (c). To this breakdown were applied age and sex specific activity rates for the U.K.[3] to give a total activity rate for the immigrant group for each year of the period, as shown in table (d) and, from the numbers employed.

The figure/...

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3. Abstract of Regional Statistics, 1968, table 9; 1969 table 11.

The figure for average earnings has been taken from the Blue Book statistics of Personal Incomes before Tax,[4] rather than the Survey of Personal Incomes in the Abstract of Regional Statistics in view of some of the technical difficulties involved in use of the latter. The average income can be estimated from dividing the total number of incomes into the figure for total personal income before tax, for each year. If it is assumed that the employed immigrant in any year received this U.K. average income figure, then average earnings per immigrant for 1964/67 (latest figures available) can be estimated as in column 3 of the table (d). Column 2 multiplied by column 3 gives the total estimated ΔZ for the group of 1,000 immigrants for each year of the period.

Having estimated for this group ΔN and ΔZ over the period, the final step is to compute the estimated value of the coefficient for induced investment over the period (where $n = \Delta N/\Delta Z$). These estimates are given in column 3 of table (b) and range from 2.40 to 2.48, with a mean value of 2.43.

Thus it has been estimated that $n = 2.4$. Since this is based on average U.K. statistics which will not relate to any single region with its own figures for existing capacity, its own industrial structure, its own particular needs for additional capital provision, its own age and sex structure of migrants, its own level of earnings, it is obvious that this value can only be taken as a tentative first estimate of a plausible value for a regional capital and output ratio in the circumstances of immigration to/...

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4. 1968, table 26; 1969 table 23.

immigration to a new major project in the region.

A final point relates to methodology. Given the method used to estimate ΔN, the capital requirements of immigrants to the University, it might be argued that this involves an element of double-counting, in that the construction of the University represents the provision of part of these capital requirements. Firstly, since ΔN was estimated by dividing the net capital stock of the U.K. by the estimated population of the U.K. to obtain a net capital stock per capita figure, the construction of the University adds to capital stock and is therefore part of ΔN. Secondly, induced investment represents an increasing of capacity in private and public sectors; the University provides not only educational services, but also campus shops, restaurants, and social clubs and, in doing so, must substitute to some extent for increased capacity in induced investment.

It is argued that, in the first case, whereas a school would service a small local area and would qualify entirely for capital provision under ΔN, a University services not so much a local community as the nation as a whole (only 5% of students are expected to be local by the end of Phase 2). Thus, the construction expenditure on the University cannot be allocated entirely to the local community, but must be shared nationally - when the annual per capita figure becomes £0.27; such an adjustment to a per capita figure of about £1,500 per annum would be insignificant. The second argument advanced is far more important; the extent to which staff and students use the service facilities provided by the University will reduce the pressure on capacity elsewhere and therefore the need for induced investment in sectors outside the University. Rather than adjust/...

than adjust the value for ΔN, or n, since the University situation is unique and would not normally be experienced in the impact from a project, the method of adjustment chosen has been to establish the share of J_1 which represent the average annual expenditure by the University on the provision of these services and deduct it from J_1. The multiplier effects of the construction of this capacity on campus will then be applied to the induced investment component, i.e. is included in the values estimated for this. By stating J_1 net of this deduction, double-counting has been avoided; the adjustment is made in Chapter 7.

Table (a)

Estimates of capital needs of immigrants

	Estimation of[1] population in U K (M)	Net capital stock[2] at current replacement cost £M	Net capital stock etc per capital £
1964	54.01	69,700	1290.5
1965	54.36	76,700	1411.0
1966	54.65	82,400	1507.8
1967	54.98	87,400	1589.7
1968	55.28	93,300	1687.8

Sources:

1. Annual Abstract of Statistics, 1969, table 6.
2. National Income and Expenditure, 1969, table 62.

Table (b)

Estimation of value of coefficient for induced investment

	Estimate of annual capital requirement provision (ΔN) £M	Estimate of annual earnings (ΔZ) £'000	Estimate of induced coefficient ($n = \frac{\Delta N}{\Delta Z}$)
1964	1.291	536.4	2.41
1965	1.411	583.3	2.42
1966	1.508	627.3	2.40
1967	1.590	641.1	2.48
1968	1.688	N A	N A

Table (c)

Age and sex structure of immigrant group of 1,000

	Male	Female
under 15	114	112
15 - 24	110	96
25 - 44	258	210
45 - 64	52	44
65 and over	2	2
	536	464

Table (d)

Estimates of ΔZ

	Activity Rates for immigrant group %	Immigrants employed	Average earnings per person £	Total earnings of immigrant group of 1,000 (ΔZ)
1964	53.3	533	1,006.3	£536,358
1965	53.5	535	1,090.3	583,311
1966	54.2	542	1,157.4	627,311
1967	53.1	531	1,207.4	641,129
1968	-	-	N A	N A

Statistical Appendix 6.2

Estimation of the value of import leakages (m^*) from the multiplicand

Two components of the multiplicand will be affected by import leakages, firstly, and more obviously, J_1 expenditure i.e. the original construction expenditure on the new project, and secondly the construction expenditure involved in the induced investment component (ΔN). While there is some reason to expect that the import coefficients might vary between the two components, (e.g. J_1 may involve the construction of highly specialist industrial premises, with ΔN involving mainly additional capacity in retail distribution etc, schools, hospitals, housing, roads), as a first approximation, it is assumed that a "general" import leakage coefficient can be applied to both components.

Obviously, the type and volume of this type of constructional imports will vary between regions, reflecting in particular the type of industrial structure in the region and the geographical location of the region in relation to constructional supplies. Ideally the value for m^* applicable to any region should be based on local data for that region's construction industry on the various cost elements of direct material, direct labour, plant etc. Once again, however, for the area around the University of Stirling at least, difficulty in collecting or even obtaining access to local data has resulted in basing the estimates as much on "average" national data as on local figures and experience. While this is unsatisfactory, it does provide an offset in that the value of m^* estimated will be capable of more general application since it will not be completely distorted by any uniquely local characteristics. The statistics used are a combination of national cost structure figures for the industry and local data of both formal and confidential, and informal nature. Again/...

Again, the remarkably wide spread of constructional activity in the region, covering construction of University premises, housing (private and public sector), shops and office premises, schools, roads etc does help to provide a fairly plausible general value for m^*. Since no attempt, as yet, seems to have been made to estimate any empirical value for m^*, even this type of general approach is not without interest.

The method used was to break down construction expenditure/receipts into the various cost components and attempt to estimate the L.V.A. content of each of these, gathering the latter together into a final estimate of $(1-m^*)$. The average cost breakdown used by the industry and based on national experience is:-

Direct materials	30%
Direct labour	30
Plant etc	30
Overhead and profit	10
	100

The practice apparently is that these "rule of thumb" proportions are then adjusted in the light of the type of construction work to be completed, e.g. industrial premises or housing, if the latter whether high-rise or low-level etc. In view of the wide range of activity around the University, it was felt by civil engineers and others involved in the industry, that the overall breakdown would be fairly close to these average proportions (in fact, for this particular area and type of work, they suggested that materials would account for slightly more (about 35% at most) and capital equipment slightly less (about 25% at least) than the average breakdown). If the average figures are taken then it will tend to reduce the effect of unique local activity on the import estimate.

Taking materials/...

Taking materials first, L.V.A. here will cover materials used which were purchased or manufactured locally. If the area around the University is taken as a typical sub-region then the only local manufactures would seem to be the high-volume low-volume purchases of shale and quarry materials for grounding work. It would seem from local construction firms that this accounts for well under 5% of total material costs; say about 3%. As regard local purchases, it is obvious that there is a marked difference in policy between main contractors and sub-contractors; the former have central depots and import virtually all materials into the sub-region from these, whereas the latter, being typically more local-resident in nature, seem to rely much more on local purchases. For the construction work in general in the district, there appears to be a 60:40 breakdown between main and sub-contractors. Taking main contractors first (and excluding expenditure on local sand, gravel etc which has already been counted) it would seem that about 10% of their total direct material costs are from local purchases; but since these local purchases are of goods held locally but already imported to the sub-region, only the margin, say 20% is L.V.A. i.e. only 2% of the direct material costs of the main contractors is L.V.A. Further, using the 60:40 breakdown as a weighting device, this will then account for only 1.2% of the total direct material costs for the industry. Sub-contractors, on the other hand, appear to purchase about 2/3 of their materials within the sub-region: applying the same margin to this, only about 13% of their direct material costs are L.V.A, weighted for the 60:40 breakdown, this becomes 5.4% for the direct material costs at industry level. Thus, taking manufactures and purchases together, the L.V.A. component accounts for only about 10% of direct materials costs i.e. about 3% of total construction expenditure.

Much the/...

Much the same problems of differing behaviour between main and sub-contractors apply to direct labour costs. Main contractors have a central core of permanent workers in a district and move teams from this central pool into the various sites; these "core" teams are then augmented by local labour while they themselves commute daily to the site from often quite considerably distances (a round trip of 50/60 miles daily is not uncommon to the area around the University). While practice varies between firms, a fair average would seem to be that main contractors recruit about 60% of their men locally (including the local element in the "core" teams); this will account for about 36% of total direct labour costs for the industry. Sub-contractors employ about 75% of their labour force from local sources, bearing in mind that some of these smaller firms are highly specialist and may be hired from considerable distances outside the area; given 60:40 breakdown this will account for about 30% of total direct labour costs. Thus, in total about 66% of direct labour costs are L.V.A. or about 20% of total construction expenditure.

Plant and equipment costs are relatively simple to deal with from the point of view of estimating L.V.A. content. From local evidence, all plant and equipment used in site preparation or construction generally is either hired from firms outside the area or brought into the sub-region from outside depots by both main and sub-contractors. Thus this cost element has a zero L.V.A. content.

The most unsatisfactory data obviously concerns the L.V.A. content of overhead and profit. For main contractors, there is a total leakage of both from the area. For sub-contractors, it has been impossible to gather any information directly and the only guidance has/...

guidance has been received second-hand from civil engineers and main contractors. On the basis of it, it would appear that, at best, about 50% (possibly as low as 40%) of overhead and profit receipts remain in the area as L.V.A. If the guestimate of 50% L.V.A. is taken, then for the entire industry, this amounts to 20% of the total of this cost element, or 2% of total construction expenditure.

Thus to summarise, the L.V.A. content ($1-m^*$) for the various types of construction costs would seem to be

Direct materials	3%
Direct labour	20
Plant etc	0
Overhead and profit	2
	25%

From this it can be seen that m^* can be estimated at 0.75. Obviously the more developed is the construction industry in the sub-region's industrial structure, the lower will be the value for m^*; conversely the more J_1 expenditure relates to specialist capital equipment or ΔN to specialist civil engineering the less likely it will be that any sub-region - or even standard region - can supply this from within and the greater will be the value of m^*. A "normal" range, allowing on the one hand less leakages in overhead and profit, some local plant, materials etc to the more severe position of specialist work, might give m^* a range of about 0.7 to 0.8 i.e. still significantly above the relative size of import leakages from the multiplier itself.

THE STATISTICAL APPENDICES TO CHAPTER 7

Statistical Appendix 7.1

To obtain a salary bill estimate for University staff for 1976, two factors must be taken into account. Firstly, the numbers of staff employed and their distribution between salary grades will change over the period. Secondly, some increases on current income rates will be received by all grades between the current date and the end of the period. These factors make it difficult to use directly the published figures, or even the estimates[1] for the University Salary bill. These estimates are unsuitable, partly because they do not include staff paid by non-University funds[2] and partly because they do not take account of even current negotiations for wage and salary increases; thus, even if these estimates were available for 1976, they would undercast the figure for staff income for those two reasons.

The approach taken has been to assume that University staff will continue to grow in the same relationship to the Development Plan in the future as indicated by the comparison of actual establishment figures for 1970/1 and Development Plan estimates for that year. Further, as regards the income received by University staff, the total salary bill will be estimated, as was contribution expenditure in J_1 in terms of constant 1969/70 prices to avoid the pitfalls of estimating the various rates of inflation from 1969/70 to 1975/6 and 1980/1.

Firstly, numbers/...

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1. these estimates are made for a period of two academic years ahead by the Accounts Department.
2. the establishment figures for 1970/1 as given by the Accounts Department show a shortfall of about 20 academic staff as a result of this.

Firstly, numbers employed in the five broad staff grades were obtained from the Accounts Department and adjusted to include staff employed on non-University funds. These actual figures for 1970/1 were then compared to the Development Plan estimates for this year and expressed as a percentage of the projected figures, e.g. Departmental staff (secretaries and technicians) are about 16% less and Library staff about 15% more than estimated by the Plan. Thirdly, the Development Plan figures for 1975/6 were taken for the staff grades in question and, on the assumption that current trends of divergence of actual from projected numbers will continue to the end of the period, adjusted upwards or downwards for the various grades. Thus, it is estimated that the total direct staff employed by the University will amount to about 1,300 persons by 1976.[3]

The next step was to estimate the average annual wages/salaries of the staff group from the accounts for 1969/70. At first sight it might be argued that average salary grade figures for 1969/70 reflect a ratio between senior and junior staff which need not be repeated by 1976 or 1981; in fact the senior staff percentage for 1969/70 in academic and administrative grades (about 30% in each case) is of roughly the same pattern as anticipated for the later years, so that no distortion occurs. Secondly, it might appear that a slight upward bias is given to j_a by excluding staff paid by non-University funds (mainly research staff) in the staff figure for the Academic grade. In fact, the figures used for the average salary calculation include 27 research persons paid/...

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3. see table (a) to this Appendix.

persons paid by the University so that, to some extent, the average reflects the lower income figure for these. Further, the research persons paid by non-University funds receive payment from so many different sources at so many different levels that it has not proved practicable to calculate a separate average income figure for these; the assumption that they earn "average salary for Academics" is no more arbitrary than any other given that it does contain a weighting for lower income groups.

Having estimated both staff numbers and average incomes for 1969/70 this data is used in table ( ) to provide a total estimate for the annual wages and salaries received by direct staff in 1976 of £1.87 millions (at constant 1969/70 prices)[4]. In the context of the Chapter, this is the figure for j_a.

To estimate the annual amount spent by staff on University services (d_a), it was taken that Academic, Departmental, Administration and Library spend, on average, 30p a day on these services. If it is further assumed that this expenditure takes place over a 5 day week, 48 week year, then average annual expenditure for these grades will be £72. The "Other staff" grade will normally spend much less than this; it has been assumed that average expenditure here will be about 10p daily, amounting to an annual total of £24 per person. From these assumptions, d_a can then be estimated at about £67,000 per annum.

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4. see table (b).

Statistical Appendix 7.1

Table (a)

ESTIMATES OF PERSONNEL FOR 1975-6

Staff	Current estimates for 1970-1 (persons)	Dev. Plan estimates for 1970-1	"Actual" as % of Dev. Plan	Dev. Plan estimates 1975-6	Adjusted Dev. Plan
Academic	180*	181	99.4	456	453
Departmental	81	96	84.4	211	178
Administration	75	66	113.6	100	114
Library	38	28	135.7	39	53
Others	184	160	115.0	416	478
	558	531		1222	1276

Source : Accounts Department

* adjusted for staff (estimated) on non-University funds, who are not included in Accounts figures.

Table (b)

Estimated total bill for wages and salaries for University (1976)

Staff	Estimated Staff numbers	Estimated average salary	Estimated salary bill (£'000)
Academic	453	£2328	1055
Departmental	178	1182	210
Administration	114	1372	156
Library	53	1435	76
Others	478	771	369
	(1276)		1866

Statistical Appendix 7.2

Estimation of annual student's income 1976

The estimation of students' income j_b for this year requires, basically, an estimate of student numbers for that year and an estimate of income received by each student. The former figure is easily obtained from the Development Plan[1] as 3,050 undergraduate and 350 postgraduate students.

The main component of student income is normally the grant received by the student; the amount of this grant, as received by any single student, will vary depending on the authority from which it was received, the arrangement[2] under which it was given and the level of parental income with, in respect of this latter case, some reduction of grant received experienced by most students. To this grant, as adjusted by the paying authorities must be added a parental contribution and, finally, any other income earned by the student, normally, if anything, coming from vacation earnings.

As regards the first two components of student income it would be possible to calculate[3] the average grant received for each year, add some estimate of parental contribution and project to 1975/6. However a simpler, and probably equally accurate approach has been taken. Figures were obtained from the S.E.D., the largest grant paying authority to the students at Stirling, giving, over the 1960's, the maximum grant level for students at home or/...

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1. Development Plan Report, p.22.
2. e.g. the higher grants for mature students, teacher recruitment.
3. from the student grant records of the Accounts Department.

home or in lodgings; these figures assume zero parental contribution. It was then assumed that where, in the opinion of the S.E.D., no parental assistance could be expected, then this would, in fact, be the case. On the other hand, where less than this maximum grant figure was given then, as expected by the S.E.D. the full amount would be made up by parental funds. If, finally, it was taken that the S.E.D. figures were about average for all grant paying authorities, it could then be assumed that the average income for any student in 1969 from grant authority and parental sources was the maximum grant level given by the S.E.D. The 1969/70 figures for the students' grant were £290 per annum Home Rate and £380 per annum with Lodgings Allowance. Mature students (26 years of age and over) are paid an additional allowance over the normal grant. From current records this would seem to average out at an additional allowance of £60 per student. Again from current records, about 7% of the present student population are mature students. If it is assumed that the same proportion of student numbers in 1976 and 1981 are mature students and that (again from current records) these account for about 7% of both types of residence, then the approximate rates of student grant can be weighted to take account of this. The revised grant figures become, per student, £294 per annum Home Rate and £384 per annum with Lodgings Allowance.

To this estimated figure must be added further income earned by the student. Discussions with students indicate that the average student will be in paid employment for between 8 and 10 weeks of the year. However, an average earnings figure would be very difficult to estimate, given the geographical and occupational spread of/...

spread of the work undertaken. Again, a simpler approach is taken; it was assumed that the student's expenditure on holidays and entertainments etc. would vary directly with the amount earned and that, on average, about £25 of vacation earnings would remain to be added to income as estimated above.

The next step is to examine more closely the grant income received by students; there are a number of points to be considered before these figures can be taken as average student income. Firstly, students commuting to the University from homes outside the Study Area will spend part at least of their income in their home area; their income must be adjusted for this leakage. Secondly, as regards the students living in lodgings, most of these will live in the University residences, paying their rent for these to the University. As discussed in the chapter, the entire amount of rent paid to the University must be deducted from student expenditure, partly because it represents a leakage from the area in interest payments and partly to avoid a double-counting of income.

To separate the students into the various leakage and grant categories it has been assumed that the students breakdown of the 1975/6 academic year will follow the same pattern as for 1969/70, based on an analysis of student's record cards[4].

Secondly, it has been assumed that postgraduates will follow the same pattern/...

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4. see table (a); an adjustment has been made to reduce the proportion of students living at home as overall numbers rise from the early years.

same pattern, since this seems to be the case from current records, although the present sample may well not be representative.

Table (b) shows the calculation of the average rent per undergraduate student. This amounts to about £96 per annum on 1969/70 figures. This figure is then deducted from student income, in table (c) , for students (undergraduates) staying in these residences. Students staying in private lodgings will have no leakages to consider; the current pattern is that all private lodgings currently registered with the University lie within the Study Area, so that rent paid becomes services purchased, with the full multiplier consequences. The same argument applies to students resident at home within the Study Area. Finally, for students resident outside the Study Area, it is assumed that 75% of their income will be spent within the Study Area and the rest at home, thus only £289 of their income becomes eligible for the multiplicand.

The average grant to postgraduates has been estimated at about £550 per annum from current University records for 1969/70. Making the further assumptions that postgraduates will attend the University for about 45 weeks of the year and will, if in student residences, take the larger size of flats designed for them, this gives an annual rent deduction of about £190. The same arguments apply to all other postgraduate residential grades as above.

Table (d) brings together the estimates of students numbers for 1975/6, as broken down into residential grades and the estimates of/...

estimates of student income, net of the various deductions discussed above for each grade. From this table it can be seen that the estimated total student income (j_b) for 1975/6 amounts to £0.99 millions. When additional income of £25 for each student is added to this, the students income component rises to £1.07 millions.

As discussed in the Chapter, a further deduction (d_b) is necessary to avoid double counting of income in relation to the expenditure of students on the service facilities provided by the University, e.g. refrectory, coffee bar and staff-student club. The current S.E.D. estimate, broadly confirmed by a Stirling C.S.A. sample check, is that, on average, a student will spend at 1969/70 prices about £95 per annum on these services. For all students, by 1969/70, (at constant prices) the estimated deduction to avoid double-counting will be £313,000.

Statistical Appendix 7.2

Table (a)

Allocation of Students to types of residence

Category	1969-1970	Undergraduates	Postgraduates
University Residences	67%	2044	234
Private lodgings	13	396	46
Home			
- within S.A.	10	305	35
- outwith S.A.	10	305	35
	100	3050	350

Table (b)

Estimates of average rent per student for residences 1969/70

	Weekly rent	No. of students in accommodation	Total rent paid per week
Residence : basic flat	£3.75	292	£1095
larger flats	4.25	48	204
Halls of Residence			
basic flat (net of food)	3.75	264	990
shared flats	3.25	34	111
		638	£2400

Average rent per student $\frac{£2400}{638}$ £3.76 per week

£97.76 per academic year

Table (c)

Estimates of net grant income per student by type of Residence (1969/70)

Undergraduates		
University residences	(£364 - 98)	266
Private lodgings		364
Home		
- within S.A.		294
- outside S.A.	(£294 x .75)	221
Postgraduates		
University residences	(£550 - 190)	360
Private lodgings		550
Home		
- within S.A.		550
- outside S.A.		413

Table (d)

Estimates of student grant income 1975/6 at 1969/70 constant prices

Students	Numbers	Net Income from Grant per Student	Total £'000
		£	
Undergraduates			
University Residents	2044	266	543.7
Private lodgings	396	364	144.1
Home			
- within S.A.	305	294	89.7
- outside S.A.	305	221	67.4
	3050		
Postgraduates			
University Residents	234	360	84.2
Private lodgings	46	550	25.3
Home			
- within S.A.	35	550	19.3
- outside S.A.	35	413	14.5
	350		988.2

Statistical Appendix 7.3

Estimation of total earnings for immigrants for 1976

It is assumed that, despite the volume and duration of constructional activity on the University, there will be no immigration in connection with J_1; employment here will come for resident construction workers and commutors. Thus ΔZ will depend on the number of immigrants to the University and on the income received by them, as contained in J_2.

The only existing estimates of the immigration component of direct employees and students are contained in evidence given to the Land Use study group in March 1966.[1] These immigration proportions are given in table (a) to this Statistical Appendix. As could be expected, the proportions vary between students and the different types of staff. These immigration estimates have been checked against the current (1970/1) breakdown of staff and students and adjusted in the light of this comparison and the opinion of those concerned with staff recruitment, before being applied to the estimates for 1975/6.

For students, while the current figures suggest a higher proportion of locals than estimated, it is felt that the original estimate of 95% immigration is likely to be more accurate by 1975/6, i.e. a 5% local component is retained. Academic staff are currently 100% non-local and there seems to be no reason why this should change in the future/...

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1. see Report, Technical Appendix A, section 2.

the future; thus a zero local component is taken for 1975/6. Thirdly, rather fewer local technicians have been recruited than estimated and the opinion is that, based on past and current recruitment experience, for both senior and junior grades, a 40% local proportion is more likely than the estimated 50%. Fourthly, broadly the same problems have been experienced in Administration, where, currently 60% and not the estimated 90% are "local resident", although to some extent this reflects the bias towards the recruitment for senior posts in the early years of the University. However, even if the continuing increase to the estimated staff figures for 1975/6 is assumed to be 4/5ths. local, i.e. mainly junior staff, then, by this year, only 65% in this staff grade will be of local origin. Fifthly, this trend has been even more marked in the Library staff grade, where only 30% of the present staff are of local origin; taking the same bias towards junior and therefore local staff in recruitment to 1975/6, still only 35% and not the estimated 90% will be "local resident". Finally, the remaining grades of "other staff" are very much as estimated, apart from the recruitment of rather more local people to Maintenance etc. than was estimated; these local proportions are repeated, with the upwards adjustment for Maintenance for 1975/6.

The relationship between seniority and immigration must be taken into account in computing ΔZ for each grade. It is not enough to argue that, since 65% of Administration staff are local, ΔZ for this grade will be 35% of its total salary bill. The detailed establishment information on which these calculations have been based shows that senior posts in virtually all staff grades are almost 100% immigrant, with local bias showing only in the junior grades. Thus, if the 35% of immigrant staff in Administration/...

in Administration are predominantly senior staff, then ΔZ will be rather more than 35% of the salary bill. In column 4 of table (a)[2] ΔZ figures are given, based on calculations of immigration components of detailed establishment grades and the salary ranges applicable to these grades. Given the bias of immigration towards the more senior posts, they vary predictably from the proportions shown in column 3.

Finally, in table (b), ΔZ is estimated for 1975/6. As discussed in Chapter 6, care must be taken not to value ΔZ as earnings of all immigrants over the period, but only as earnings of one year's immigrants to the University. Column (3) of the table gives the overall total income of all immigrants to the University by 1975/6; this involves a period of immigration of nine years. If it is again assumed that immigration takes the form of a steady inflow over the period, then it can be estimated that the share of total income (J_2) received by the immigrants for 1975/6 will be 1/9th of the overall share in column (3). Column (4) gives this revised figure for annual immigration and column (5) the estimate earnings for each staff grade of immigrants for 1975/6, at constant 1969/70 prices. ΔZ is then estimated at £232,000.

Since in the model it is argued that $\Delta Z = zJ_2$, then it can be calculated that, with J_2 = £2.56M, $z = 0.09J_2$.

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2. the statistics from which this calculation has been made are confidential and cannot be listed.

Statistical Appendix 7.3

Table (a)

Current and future local components

	Land Use Technical Evidence (Dev. Plan base)	Breakdown as at 1970-1	Estimates for 1975-6	1975-6 Estimates of local income as % total for grades
Students	5%	10%	5%	5%
Academic staff	3	-	-	-
Technicians	50	40	40	35
Administration	90	60	65	40
Library	90	30	35	20
Maintenance etc.	70	80	80	78
Catering	90	90	90	88
Cleaning	100	100	100	100

Table (b)

Estimates of immigrant earnings for 1975/6

	Dev. Plan estimates (adjusted) 1975-6*	Total net income (adjusted) 1975-6+	Estimated share of income to immigrants over 1967-76†	Estimated share of income for one year's immigrants	Estimated ΔZ for immigrants per grade in 1975/6
Students	3400	£0.757	95%	10.6	£80,242
Staff					
Academic	453	£1.022	100	11.1	113,442
Departmental	178	197	65	7.2	14,184
Administration	114	148	60	6.7	9,916
Library	53	72	80	8.9	6,408
Others	478	358	19	2.1	7,518
	4676				£231,710

*Source : Statistical Appendix 7.1, table (a) : Development Plan for students

+Source : table 7.2 adjusted as for 7.4

†Source : Statistical Appendix 7.3, table (a)

Statistical Appendix 7.4

Estimation of indirect employment generated by the University

This will be estimated by the use of the Greig model for the employment multiplier,[1] as modified to deal with the University situation. Apart from the fact that it is the most detailed - if not the only formal - model in recent U.K. publications, it was developed to cater for a similar immigration situation as that resulting in the Study Area from the establishment of the University. Its formulation is defensible for the estimation of University impact on employment and the values set on its various coefficients[2] will tend to be similar to those which exist in the Study Area, which, like Fort William is a small sub-region with an existing and significant tourist trade using the existing service facilities.

The Grieg employment multiplier estimates total indirect employment (ΔE_i) in two stages; firstly it estimates indirect employment arising from the first round of expenditure (ΔE_a) then adds to this as estimate of indirect employment generated by the second and subsequent expenditure rounds (ΔE_b). ΔE_a is made up of the additional public service employees needed by the new direct employees, ($E_d\theta$) and, secondly, of additional employees in the private sector ($\frac{\Delta V}{L}$) and, thirdly, the additional public service employees required by these, i.e. ($\frac{\Delta V}{L}.\theta$ so that:-

$$\Delta E_a = E_d\theta + \frac{\Delta V}{L} \quad (1 + \theta) \qquad (1)$$

The indirect employment in second and subsequent rounds of expenditure/...

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1. see S.J.P.E., February 1971

2. see Tables (a) and (b) of this Statistical Appendix for the modified values for the University model.

expenditure, (ΔE_b), is estimated from taking the additional income from these stages of the multiplier, ($E_d w_d (k_a - 1)(k_b - 1)$), and dividing this ty an income figure reflecting the additional income needed to create an additional job in the private (ℓ) and public (w_p) sectors[3] so that:-

$$\Delta E_b = \frac{E_d w_d (k_a - 1)(k_b - 1)}{\ell(1-\theta_1) + w_p \theta_1} \qquad (2)$$

he final model is that:-

$$\Delta E_i = \Delta E_a + \Delta E_b$$

$$\Delta E_i = E_d \theta + \frac{\Delta V}{\ell}(1 + \theta) + \frac{E_d w_d (k_a - 1)(k_b - 1)}{\ell(1-\theta_1) + w_p \theta_1} \qquad (3)$$

The lower case

To use this model to obtain a lower case estimate of indirect employment to correspond to the lower case income estimate derived from using the Brown value for k_r, then the Greig model must be modified to eliminate the link between income and employment in public services.[4] This involves discarding the ratios θ and $_1$ and also w_p, so that the model can be rewritten as:-

$$\Delta E_i = \frac{\Delta V}{\ell} + \frac{E_d w_d (k_a - 1)(k_b - 1)}{\ell}$$

Secondly, it is more convenient to use a modified formulation for ΔV, working from the Greig identities that:-

$$\Delta V = E_d w_d v, \text{ and}$$

$$v = (1 - s - t)(1 - m), \text{ so that}$$

$$\Delta V = E_d w_d (1 - s - t)(1 - m).$$

By substitution and rearrangement,

$$\Delta E_i = \frac{E_d w_d \left((1 - s - t)(1 - m) + (k_a - 1)(k_b - 1)\right)}{\ell} \qquad (3')$$

Finally, the Greig estimate for the lower value of ℓ must be reviewed. He estimated[5] that, given that employment would be mainly in/...

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3. Where θ_1 is a weighting device to estimate income per job.
4. Since the boosting effect of this relationship is not included in the Brown multiplier value.
5. See his article in the S.J.P.E., February 1971 (p 12 of draft).

mainly in the services ector and, by implication, female predominant, that an increase in L.V.A. of about £830 (1969 value) would create a job in the upper case, where capacity was already fully extended; in the lower case, if some under-capacity existed in the services sector, the relationship between turnover and employment would change. Given that, over a large part of his region, there might be some slack of this type, he selected, for the lower employment case a value for l of £1,200 per annum. In the Study Area relating to the University there is no evidence of any significant underutilisation of services capacity; however, since a lower case estimate is being sought a value for ℓ of £1,000 per annum for 1969, will be taken.

The values for the various items in the employment multiplier are given in table (a). This table also shows how the estimate of about 190 local resident construction workers on the University site by 1976 has been made.[6] Using these figures and the modified lower case Greig multiplier, it can be estimated that indirect employment generated by the University by 1976 will be 860 persons in the lower case. A very rought check on this figure can be made by taking a similar type of approach to that used by Brown[7] in his rough estimates of indirect employment from the R.E.P. Firstly, the additional income generated over and above the initial injection's L.V.A. component (i.e. $J_1 (1 - m^*) + J_2 = £2.89M$) must be /...

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6. indirect employment will be generated by local expenditure therefore the figure for total construction workers must be adjusted to exclude non residents.
7. N.I.E.R., "The Regional Employment Premium", February 1967, p.30.

must be calculated; in the lower case, this amounts to about £860,000. Secondly, if this additional income is assumed to have the same distribution between factors, as for the U.K.[8], then about 70% of it, or £607,000 will be income from employment. Thirdly, if it is assumed that the pattern of employment is the same as the pattern of expenditure as given by the Family Expenditure Survey (see Statistical Appendix 7.5 for fuller discussion) and that the average incomes for the S.I.C. orders is the same as estimated for 1966 inflated to 1969 (see Statistical Appendix 3.2 table (a)) then the average income for additional employment will be about £770. This average income figure taken with the £607,000 additional employment income provides an estimate of about 800 additional jobs in indirect employment for the lower case.

The Upper case

The upper case income estimate made earlier was based on the Greig value for k_r so that, in the context of employment, the full Greig formulation, with its additional boost from public sector employment, will be used. Here again, however, some modifications are made. Firstly, Greig estimates public sector employment as a ratio (θ) of direct employment and additional employment in the private sector. Direct employment, as defined for the University model, includes University staff, construction workers and students. This direct employment differs/...

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8. National Income and Expenditure, table 1, 1964-9.

employment differs in nature from the E_d figure used by Greig, inasmuch as a significant part of its numbers, i.e. the students, have a much lower level of expenditure and a much smaller household size background than the typical direct employee. While students do use the public service facilities of hospitals, roads, police, schools etc., and while the indirect employment generated by students' expenditure will have full normal usage of public services, the students themselves will only place a demand on these services for (per person) a reduced household level and then, for only about half of the year.[9]

If a rough, income-equivalent approach is taken to weight for these lower expenditure and household demands, and it is assumed that four students are the equivalent of one normal direct employee[10] as regards demand on public services, then the modified direct employment figure becomes, for 1975/6:-

University staff	1,276
Construction workers	192
Students: direct employee equivalent	850
	2,318

Secondly, the Greig formulation for $\Delta V = E_d w_d v$ is used. The modified multiplier for the upper case will then read:-

$$\Delta E_i = E'_d\theta + \frac{E_d w_d v}{L}(1 + \theta) + \frac{E_d w_d (k_a - 1)(k_b - 1)}{L(1 - \theta_1) + w_p \theta_1} \qquad (3'')$$

The upper case values for this multiplier are given in table (b); the value for L was taken as £850 in 1969. From these values, it/...

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9. two 14/5 week semesters; only p/grd. attend for most of year.
10. average income per student £400; average income per direct employee about £1,600.

values, it can be estimated that, in the upper case, there will be an additional 1,650 jobs in indirect employment generated by the University in 1976.[11]

Again the rough check used in the lower case can be applied here. In the upper case the additional income amounts to £1.77m., about £1.24m. of which is income from employment. Given an average income of about £770 per annum, this provides a checking estimate of over 1600 additional jobs in indirect employment in the upper case.

To summarise then, it has been estimated that the effect of the University by 1976 will be to generate between 860, say 850, in the lower case, and 1650 in the upper case, jobs in indirect employment in the Study Area, by the end of its Phase 2 growth.

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11. If 3 students are assumed to be a direct employee equivalent, then E_d'' becomes 2601 and an additional 50 jobs are added to total indirect employment; if, on the other hand, 5 students are the direct employee equivalent, then E_d'' becomes 2148 and indirect employment falls by about 20 jobs.

Statistical Appendix 7.4

Table (a)

Values for lower case Greig multiplier

	Numbers	Income (£'000)	
University staff	1276	1,803	
Construction staff*	192	234	
Students	3400	757	
E_d	4868	2,794	($E_d w_d$)

E_d =	(direct employment)	4868
w_d =	(wages of E_d)	£574 p.a.
s =	(average prop. to save)	.06
t =	(average prop. to tax)	.18
m =	(average prop. to import)	.71
k_a =	(first round k_r)	1.35
k_b =	(second and other round k_r)	1.25
L =	(income needed to create an additional job)	£1000

* Construction expenditure £1.3m.
direct labour 30% (Statistical Appendix 6.2) = £390,000
60% of this local (Statistical Appendix 6.2) = £234,000
average earnings 1969 (D.E.P.G., 1970, table 122) = £1,220

Construction workers (local) = $\frac{£234,000}{1220}$ = 192 persons

Table (b)

Values for upper case Greig multiplier

E'_d	(modified direct employees)	2318
θ	(ratio of public service to other employees)	0.156
ΔV	($E_d w_d v$)	£614,000
L	(income needed to create additional job)	£850
$E_d w_d$	(income of direct employees)	£2.79M
k_a	(1st round multiplier)	1.4
k_b	(2nd and subsequent round multiplier)	1.35
θ_1	(ratio of public service : total employment)	0.156
w_p	(average wage in public service)	£970

Statistical Appendix 7.5

Estimated industrial structure of University generated employment

This Statistical Appendix attempts to examine in more detail the industrial structure of the additional employment given to the area from the University itself and the indirect employment it will generate.

The method chosen has been to assume that the employment pattern will follow the expenditure pattern of the additional University income. In turn, it is assumed that the expenditure pattern for this income in the Study Area will be similar to that estimated for Scotland as a whole over the period 1967-9 as given in the Family Expenditure Survey[1]. Both of these assumptions are rather sweeping. The similarity of indirect employment and expenditure patterns will only occur if further assumptions are made that capacity in all expenditure sections is already fully utilised and that the relationship between employment, productivity and expenditure is the same for all sections, i.e. £x of expenditure in any section will give rise to the employment of one additional person. Secondly, there is no reason why the expenditure pattern of the Study Area - at least as regards the expenditure of University income - should reflect the broad, average pattern for Scotland[2]. Here it can only be argued that expenditure figures for the Study Area are not available and that Scotland is the nearest comparable economic base[3]. Further, it/...

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1. see table 17, F.E.S., Regional section.
2. or, equally obviously, why the 1976 pattern should be the same as for 1969, here again it can only be argued that 1969 figures must be used in default.
3. apart from academic staff, most administration etc. staff and students will be Scottish.

Further, it is reasonable to use an average rather than a marginal expenditure pattern, on the Greig argument that the strong immigrant element in local expenditure of this income will tend to swamp the marginal pattern of local residents.

The summary pattern of Scottish weekly household expenditure is given in table (a). No detailed breakdown is available for these Scottish figures, so that a further assumption must be made that the Scottish pattern for detail within the broad expenditure groups is the same as that for the U.K.[4]. This makes possible a more detailed, if still rough, examination of expenditure categories, partly to make allowance for local industry supplies of goods and partly to allow a translation of the expenditure categories into S.I.C. Orders on the basis of M.L.H. definitions.

Table (b), column 1, gives the results of the analysis of the expenditure categories. As could have been anticipated, the bulk of expenditure items in all categories merely fall within the M.L.H. definitions of Order XX, Distributive Trades; however, the exercise does allow the indentification of expenditure on important items such as car sales, part sales and services, i.e. Order XXIII, with minor other items such as Transport, Public Utilities and Food etc. Finally, a/...

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4. Table 1, F.E.S.

Finally, a fairly high estimate for Construction (Order XVII) has been given on the grounds that the bulk of the housing for University immigrants is anticipated to be private and, where local authority housing is provided, this will tend to be in addition to local requirements; thus, both sections will tend to represent new construction rather than maintenance activity. Finally, in column 2, it is assumed that the Greig figure for public service employment of about 16% will apply to the indirect employment generated; the F.E.S. figures are then adjusted to allow for this.

Using the pattern of indirect employment, as given in table (b), the lower and upper case estimates of indirect employment are allocated into the various S.I.C. Orders. Finally, table (c) gives the breakdown of total employment, i.e. both direct and indirect. The University adds 1280 persons to S.I.C. Order XXII, Professional and Scientific services (the D.E.P. allocate this in its entirety to M.L.H. 872), with an additional boost from direct employment of 320 construction workers employed on the site.

Table (a)

Breakdown of total weekly household expenditure

Scotland	F.E.S. 1968
Housing	9.3%
Fuel	6.8
Food	28.1
Alcoholic drink	4.6
Tobacco	6.3
Clothing and footwear	10.2
Durable household goods	7.0
Other goods	6.7
Transport and vehicles	11.7
Services	9.0
Miscellaneous	0.3
	100.0

Table (b)

Estimated Breakdown of indirect employment 1975/6

		Expenditure 1967-68 %	Indirect Employment 1975-76 %	Lower case Persons	Upper case Persons
III	Food	3.2	3	26	50
XVII	Construction	9.3	8	68	132
XVIII	Gas	4.0	3	26	50
XIX	Transport	1.9	2	17	33
XX	Distributors	63.6	53	450	874
XXIII	Miscellaneous	18.0	15	127	247
XXIV	Public Administration		16	136	264
			100	850	1650

Table (c)

Total University employment effect: 1975/76

		Lower	Upper
III	Food, drink, tobacco	26	50
XVII	Construction	388	452
XVIII	Gas, electricity, water	26	50
XIX	Transport and carriers	17	33
XX	Distributors	450	874
XXII	Professional and scientific	1280	1280
XXIII	Miscellaneous	127	247
XXIV	Public Administration	136	264
		2450	3250

Statistical Appendix 7.6

Effect of University on income and employment by 1981

The effect on income

By the end of Phase 3 growth in 1981, the constructional work on the University premises and on induced investment will have been completed, thus J_1 can be eliminated from the income model, which will then read:-

$$\Delta Y = K_r J_2$$

This leaves only the computation of J_2.

Taking the j_a component of J_2 first, the projection must lose accuracy as it moves further into the future, therefore only a broad indication of income and employment effect is being sought for 1981. Thus, to estimate staff incomes, the Development Plan figures for 1981 will be taken without adjustment for any current or expected future divergencies. These are shown in table (a) column 1. Next, the estimated average income figures for 1969/70 are shown in column 2. From these, it can be estimated that total direct staff incomes by 1981 at constant 1969/70 prices will amount to about £4.03 millions per annum (j_a).

In calculating the value for students' income (j_b), again the Development Plan figures are taken for 1981, i.e. that there will be 5,950 undergraduate and 1,000 postgraduate students by this year. Next it is assumed that they will follow the same breakdown by type of residence as for 1976, the resultant figures are shown in column 1 of table (b). Next the 1969/70 net student income figures are taken, having/...

taken, having been adjusted for deductions for rent, or spending outside the Study Area. The average net income per student for the various grades is given in column 2. This allows students' income for 1981 (j_b) to be estimated at about £2.06 millions.

Next, an estimate must be made of d_a and d_b, the deductions made in respect of expenditure on University services to avoid double counting of income. For d_a, 1,871 persons in direct staff will spend £0.135 millions, at constant 1969/70 prices; in addition 814 persons will spend £0.020 millions per annum, giving a total for d_a after adjustment for LVA in 1981 of £0.150 millions. For d_b 6950 students, spending, at 1969/70 prices, £95 each, or in total £0.660M, provide, after the LVA adjustment a d_b figure of £0.640 for 1981. Given that $J_2 = (j_a + j_b) - (d_a + d_b)$, the multiplicand component of income of direct staff and students becomes £5.19 millions.

Using the same values for k_r lower and upper, it can be estimated that, in the lower case, the University will be adding about £6.44 millions per annum at constant 1969/70 prices to local income; in the upper case, the estimate is £7.99 millions. By the end of Phase 3 growth, from a direct employment and student income generation figure of £5.19M the University will generate through induced investment and the multiplier an additional £1.25 millions per annum in the lower case and £2.80 millions per annum in the upper case (at 1969/70 prices).

The effect/...

The effect on employment

Using the Greig employment multiplier and the values for the various coefficients as given in Statistical Appendix 7.4, and taking $E_d w_d$ from the statistics used in providing the income estimates for 1981, the lower case estimate for indirect employment generated by the University for that year is for 1,600 jobs. In the upper case, using the four student direct employee equivalent the estimated figure is 3,100 jobs. This range of between 1,600 and 3,100 jobs in indirect employment with, in both cases, 2,685 jobs in direct employment by 1981. The Study Area, it is estimated, will gain between 4,300 and 5,800 jobs as a result of the University.

Taking the S.I.C. order breakdown of employment (E_i) used for 1976, and applying this to the estimates for 1981 provides figures which can be amalgamated with the detailed 1981 employment projections of Chapter 4 to provide a broad breakdown of the total Study Area labour force into Primary, Manufacturing and Services sectors, as given in the Chapter itself. Any more detailed breakdown than this would be without value.

Statistical Appendix 7.6

Table (a)

Estimated total income of direct staff (1981)

	Estimated staff numbers 1980/81	Estimated average wage/salary 1969/70	Estimated total income (£M)
Academic	992	£2328	£2.309M
Departmental	630	1182	0.745
Administration	204	1372	0.280
Library	45	1435	0.065
Others	814	771	0.628
	2685		£4.027M

Table (b)

Estimated total income of students (1981)

	No. of students	Net income per student	Estimated Total income (£M)
Undergraduates			
University residences	3986	£266	£1.060M
Private lodgings	774	364	0.282
Home			
within S.A.	595	294	0.175
outside S.A.	595	221	0.131
Postgraduates			
University residences	670	360	0.241
Private lodgings	130	550	0.072
Home			
within S.A.	100	550	0.055
outside S.A.	100	413	0.041
	6950		£2.057M

THE STATISTICAL APPENDICES TO CHAPTER 8

Statistical Appendix 8.1

Estimation of age structure and sex of students

For reasons discussed in the chapter, the following estimates are based on average Scottish University patterns[1] rather than any pattern from basic students' data at Stirling. Before this pattern can be applied to the figures for Stirling[2] the latter must be adjusted to exclude any students who were previously resident in the Study Area; the impact of the University on population has to be measured in terms of additional immigrant population.[3] Taking the previously estimated local resident component[4] of 5% for all students from the projected student figures gives adjusted totals for undergraduates of 2,898 in 1976 and 5,652 in 1981; for postgraduates, the figures become 334 in 1976 and 951 in 1981. In table (a), the average Scottish pattern was applied to the immigrant students for Stirling to provide estimated age and sex structures for 1976 and 1981. It was then assumed that students aged "30 and over" were spread over the age range 30 - 44 in the proportions of ½ for 30 - 4, 1/3 for 34 - 9 and 1/6 for 40 - 4; for undergraduates, it was assumed that students aged "under 21" are students aged 20.

Having estimated the number of immigrant students and their age and sex structure for 1976, the next step was to estimate from this the number of dependents brought by them into the area. Student dependents will obviously be wives, husbands and children. Records at/...

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1. see Statistics of Education, Vol. 6, for each year.
2. Development Plan Report, 1968, Appendix C.
3. students commuting from outside the area have also been excluded.
4. Stat. Appendix 7.3, table (a)

Records at the University[5] and S.E.D. grant figures indicate that about 10% of undergraduate and 50% of postgraduate students will be married. No official statistics are available to give marriage by age or sex and age of dependents; the estimates which follow were made from assumptions based on current records of admissions and grants. In table (b) the marriage proportions in the various age groups, are broken down and applied to the immigrant undergraduate and postgraduate figures for 1976.

Many of the married students will both attend the University, so that to estimate the number of dependents, allowance must be made for this. It was assumed that students and their wives/husbands were both of the same age group.[6] Secondly, it was assumed that all female students in the 15 - 9 age group were married to male students at Stirling, as against 80% of female students in age group 20 - 4, 30% in 25 - 9 and 10% in 30 - 4; the remaining female students were all married to husbands who were not students at the University. This allows, in table (c), an estimate to be made of the number of marriages in the student populations for 1976. Next, it was assumed that the remaining married female students of table (c) had dependents, both husbands and children, who were either already resident in the Study Area or who currently live outside the Study Area.[7]

The figures of married male students already excluded students previously resident/...

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5. Admissions and Welfare data from the University.
6. mean age calculations for Scotland indicate an 18 month gap between married person, see Annual Report of the Registrar General, 1969, table Q.1.5.
7. If husbands have moved into the area to employment as direct or indirect staff, then they and the family will be counted elsewhere in the Chapter.

previously resident in the area, but not those resident outside the area and commuting to the University. It was estimated earlier that 10% of the students would fall into this category[8] in 1976; thus the figures for immigrant male students were adjusted as shown in the final column of table (c). Having completed these adjustments, it can then be estimated that the number of adult dependents to be added to the immigrant students figures will be 326 wives, these having the same age structure as their husbands.[9]

Having estimated the number of immigrant wives/marriages, the final steps were to estimate the numbers of dependent children and the age structure of these. Again there is a complete absence of official statistics on family size, age and sex for students. The approach taken was to use the Sample Census information on household composition by socio-economic group to allow an estimate to be made of the number of child dependents; obviously, the normal family size figures given by the Registrar General would not be particularly relevant here, since student families will tend to have rather different characteristics to the population as a whole. In table (d), the 326 student households were assumed to have similar characteristics to the sample census data for all Scottish students, and from this it was estimated that there would be a child dependent population of 313 by 1976.
To estimate the age structure of child dependents, it was assumed that the age of children relative to male parents[10] would be the same for students as for the Scottish population as a/...

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8. see Statistical Appendix 7.2, in particular table (c) and comments.
9. this is, of course, based on the assumption that the married immigrant students will have brought their wives and families into the Study Area with them.
10. see the Sample Census for Scotland, 1966, Household Composition tables, table 23, p.80; the proportions used here have been derived from the appropriate age group sections of this table.

as a whole, in the absence of socio-economic data on this set of statistics. The resulting age structure proportions are shown in table (e). Finally, to breakdown by sex, it was assumed that the child dependents will have similar characteristics to the Scottish pattern and each age group is giving the same male/female balance as for Scotland as a whole.[11]

The final aggregation of students and dependent figures, to show that the additional population to the Study Area by 1976 from this source has been estimated to amount to 3,871 persons, with age and sex structure as given in table (f) of this Statistical Appendix.

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11. Annual Report of the Registrar General for Scotland, No. 115, Part II, table N.2.1., p.28.

Statistical Appendix 8.1

Table (a)

Undergraduate students : breakdown by age/sex

	Men			Women		
	%	Numbers		%	Numbers	
		1976	1981		1976	1981
Under 18	12.0	348	678	8.6	249	486
19	13.7	397	774	8.2	238	464
20	13.3	385	752	7.2	209	407
21	10.8	313	611	4.2	122	237
22	6.5	188	367	1.8	52	102
23	3.7	107	209	0.8	23	45
24	2.0	58	113	0.3	9	17
25-29	3.4	99	192	0.5	14	28
30 and over	2.3	67	130	0.7	20	40
		1962	3826		936	1826

Postgraduate students : breakdown by sex/age

	Men			Women		
	%	Numbers		%	Numbers	
		1976	1981		1976	1981
Under 21	0.3	1	3	0.6	2	6
21 - 24	35.6	119	338	14.9	50	142
25 - 29	24.9	83	237	4.0	13	38
30 and over	16.7	56	159	2.9	10	28
		259	737		75	214

Statistical Appendix 8.1

Table (b)

Estimated number of married students for 1976

Undergraduates

Age	Estimated proportion married	Men	Women	Total
15-9	2%	15	10	25
20-4	8	84	33	117
25-9	60	59	8	67
30-4	90	31	9	40
35-9	100	22	7	29
40-4	100	11	3	14
		222	70	292

Postgraduates

Age	Estimated proportion married	Men	Women	Total
20-4	25%	30	13	43
25-9	70	58	9	67
30-4	90	25	5	30
35-9	100	19	3	22
40-4	100	9	1	10
		141	31	172

Statistical Appendix 8.1

Table (c)

Estimated number of marriages for 1976

Undergraduates

Age	Men	Women	Total	Estimated No. of wives of male students
15-9	15	-	15	13
20-4	84	7	91	76
25-9	59	6	65	53
30-4	31	8	39	28
35-9	22	7	29	20
40-4	11	3	14	10
	222	31	253	200

Postgraduates

Age	Men	Women	Total	Estimated No. of wives of male students
20-4	30	3	33	27
28-9	58	6	64	52
30-4	25	4	29	22
35-9	19	3	22	17
40-4	9	1	10	8
	141	17	158	126

Statistical Appendix 8.1

Table (d)

Estimated number of children in students' households 1976

Number of children	% of + households	No. of * households	Total children
With no child	45%	147	0
With one child	24	78	78
With two children	24	78	156
With three children	4	13	39
With four children	3	10	40
	100	326	313

Source: + Sample Census 1966. Household Composition table 9, p.36.

* table (c), Statistical Appendix 8.1

Table (e)

Estimated age and sex structure of students' children

Age	Proportion of+ total child dependents	Estimated No. of children	Male*	Female*
0-4	41.6%	130	67	63
5-9	39.7	124	63	61
10-5	17.6	55	28	27
15-19	1.1	4	2	2
	100.0	313	160	153

Source : + derived from data on table 23, p.80 of Sample Census 1966. Household Composition.

* Annual Report of Registrar General for September 1969, Part II table N.2.1.

Statistical Appendix 8.1

Estimated total of students and dependents 1976

Age	Male	Female	Total
0-4	67	63	130
5-9	63	61	124
10-4	28	27	55
15-9	747	502	1249
20-4	1171	570	1741
25-9	182	132	314
30-4	62	66	128
35-9	41	47	88
40-4	20	22	42
	2381	1490	3871

Statistical Appendix 8.2

Estimation of numbers and age/sex structure of academic staff and dependents

The numbers of academic staff employed by the University were taken from the Development Plan, as adjusted[1] in the light of current experience as 453 persons for 1976 and 902 for 1981. A breakdown by age structure does exist[2] but this indicates that the usual problems of recruitment for a new institution have resulted in an age structure which is badly distorted towards the younger age groups.[3] On the grounds that the present staff will age towards a more average type of pattern and that recruitment for the more senior posts to be advertised in the future, will also tend to help this, it has been assumed that for 1976 and 1981, the age structure of the University's academic staff will be the same as the average pattern for Scotland as a whole; this assumption is obviously more defensible for the latter year than for the former one.

Table (a) to this Appendix applies the average proportions in each age group for Scottish universities (1966-69) to the 1976 academic staff estimates for Stirling. No statistics are available for Stirling or Scottish universities on the male/female breakdown by age group or by total. This time it has been assumed that the sex proportions of Stirling academic staff will be the same as for all academic staff for the U.K.;[4] these averaged out over 1966-69 at 89% male and 11% female, but/..

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1. Statistical Appendix 7.1, table (a)
2. Court papers for session 1970-71.
3. In some departments 75% of staff are under 30 years of age.
4. Statistics of Education - see table (a) for source details.

female, but this has been rounded to 90% and 10% respectively. In table (a) these proportions have been applied to all age groups for Stirling. Analysis of current records[5] indicates that all staff[6] are immigrant to the area, so that no correction is needed for the figures of table (a) when estimating the addition to population in the Study Area by academic staff.

To calculate dependents, a similar type of assumption was applied to female staff as, previously, to female students. It was assumed that female academic staff were either married to male academic or other staff or were single and without dependents; figures of 30% married to staff members and 70% single were taken.[7] Married female staff will be registered as dependents elsewhere and, were deducted from the female staff figures. To estimate the number of adult dependents, given the assumptions made above, now involves only the calculation of the number of male staff married. If this follows the pattern by age of Scotland as a whole, then allowing for these average rates of divorce and widowhood, the proportions[8] of each age group of male staff who are married, are given in table (b). From these it can be calculated that, for 1976, the male academic staff will have 331 wives;[9] there will be no other adult dependents, given the assumptions made above for female staff.[10]

The same method was used to estimate the number and age/sex structure of/...

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5. See Statistical Appendix 7.3, table (a)
6. Rather less than 1% are non-immigrant and housing developments locally should allow this pattern to continue with larger numbers.
7. Based on current staff.
8. Annual Report of Registrar General for Scotland, 1969, table N.2.2, p.29.
9. Again it is assumed that these will belong to the same age age groups as their husbands.
10. This will cause some minor undercounting by not allowing for parents etc who are dependents.

structure of children of academic staff as for child dependents of students. Given that unmarried female staff will have no child dependents and that married female staff will be included in married households for academic or other staff, there are 331 households which may or may not have children. From this, it was estimated in table (c) that there will be 621 child dependents. In table (d), on the assumption that these child dependents would have the same age structure as for Scotland as a whole, relative to the age of male parents, the number[11] of children in the various age groups was estimated. Finally, the Scottish proportions[11] for male:female over the various age groups were applied to allocate the estimated numbers by sex.

The final step was to aggregate the figures for staff, staff wives, and child dependents, to produce the estimated addition to the local population from academic staff and dependents of 1,391 persons, as shown in table (e).

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11. See table (d) for statistical sources.

Statistical Appendix 8.2

Table (a)

Estimated age and sex structure of full-time academic and research staff, 1976

Age	Scottish* proportions (1966-69)	Academic+ staff estimates	Estimated sex structure‡ Male	Female	Single female staff
20 - 24	3.5	16	14	2	1
25 - 29	21.8	99	89	10	7
30 - 34	19.8	90	81	9	6
35 - 39	15.4	70	63	7	5
40 - 44	14.1	64	58	6	4
45 - 49	9.4	42	38	4	3
50 - 54	6.6	30	27	3	2
55 and over	9.4	42	38	4	3
	100.0	453	408	45	31

Sources : * Statistics of Education, Vol. 6, 1966-67 table 60
1968-69 table 39

+ Development Plan Report, 1968, adjusted: Statistical Appendix 7.1, table (a)

‡ Statistics of Education, Vol. 6, 1966-67 table 61
1968-69 table 38

Table (b)

Estimated age and sex of adult dependents of academic staff

Age	No. of male staff	Proportion Married*	Estimated number of wives
20 - 24	14	36%	5
25 - 29	89	74	66
30 - 34	81	83	67
35 - 39	63	87	55
40 - 44	58	86	50
45 - 49	38	86	33
50 - 54	27	86	23
55 and over	38	83	32
	408		331

Sources : * Annual Report of Registrar General for Scotland, 1969, table N.2.2., p.29.

Statistical Appendix 8.2

Table (c)

Estimated number of child dependents of academic staff (1976)

Child dependents	Proportion of total	HOUSEHOLDS Number of households	Number of children
With no child	40%	132	-
With one child	21	70	70
With two children	25	83	166
With three children	10	33	330
With four children	3	10	40
With five children	1	3	15
	100	331	621

Source : Sample Census 1966, Household composition, table 9, p.33

Table (d)

Estimated age and sex structure of child dependents of academic staff (1976)

Age	Proportion* of total children	Estimated Number of Children	Male+	Female+
0 - 4	34%	211	108	103
5 - 9	37	230	118	112
10 - 14	24	149	76	73
15 - 19	4	25	13	12
20 - 24	1	6	3	3
		621	318	303

Sources : * Derived from Sample Census 1966, Household composition, table 23, p.80

+ Annual Report of Registrar General, 1969, Part II, table N.2.1.

Statistical Appendix 8.2

Table (e)

Estimated total numbers of academic staff and dependents, by age and sex, for 1976

Age	Male	Female	Total
0 - 4	108	103	211
5 - 9	118	112	230
10 - 14	76	73	149
15 - 19	13	12	25
20 - 24	17	9	26
25 - 29	89	73	162
30 - 34	81	73	154
35 - 39	63	60	123
40 - 44	58	54	112
45 - 49	38	36	74
50 - 54	27	25	52
55 and over	38	35	73
	726	665	1,391

Statistical Appendix 8.3

Estimation of population attributable to other staff and dependents (1976)

The number of departmental (technical, clerical and secretarial staff for academic services), administration and library staff has been estimated[1] as totalling 345 by 1976. In the absence of any national average structure for these grades of staff, the current breakdown by age and sex at Stirling for 1970-71 was taken[2] and this "aged" to 1976, on the basis of the assumptions that recruitment over the period would follow the current pattern and that resignations would affect mainly the younger female grades. As can be seen from table (a), only 19% of employment in these grades is male, and 81% is female.

The next step was to estimate the breakdown of this group of staff into persons who were previously resident in the Study Area and persons who would be immigrants to the area. In table (b) the number of immigrants were estimated by staff grade; the broader groups of Departmental and "Others" were weighted by their composition and the immigrant proportions of their sub-groups to give the estimated local components of 47% and 88% respectively. This table indicates that of the original 345 departmental, administration and library staff of table (a), only 225 are relevant to the calculation as immigrant population. Obviously, staff already resident in the Study Area will tend to be biased heavily towards the junior grades, with most of the senior staff being immigrants. No figures/...

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1. Statistical Appendix 7.3
2. Accounts department records.

No figures are available at the University to give local/migrant breakdown by age; the only guidance is that it has been estimated by the Administration that only 5% of senior appointments have been filled by local residents. It is suggested therefore that, while senior posts are not associated directly with age, for the purposes of the estimates, all males aged 30 and over and all females aged 35 and over should have a local component of only 5% of their numbers. Of the remaining males, it has been assumed that 20% of the group 20 - 24 and 10% of the group 25 - 29 were previously local residents. Of the remaining female staff it has been assumed that the local proportions are 100% of staff aged 15 - 19, 60% of those aged 20 - 24, 40% of those aged 25 - 29, and 20% of those aged 30 - 34.[3] Table (c) gives the adjusted breakdown by age of male and female immigrants in the categories of staff.

To estimate figures for adult and child dependents it is again assumed that, as for academic staff, the proportion of males married in each age group will be similar to the pattern of professional workers for Scotland as a whole[4] and that wives will belong to the same age group as their husbands; results are given in table (d). For the female immigrant staff of 163 persons, it can no longer be assumed that all will be single. Some will obviously be married to non-University husbands who have moved into the area for other reasons. Few, if any, will have moved their husbands and children into the area to/...

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3. While the proportions are quite arbitrary, they appear to be "not unreasonable" to the administration.
4. Annual Report of Registrar General, 1969, table N.2.2., p.29.

area to take employment at the University. Some, however, may have been widowed or divorced and have child dependents;[5] allowance can be made for these[4] and it has been estimated that this will account for only a further six households with child dependents, given the estimated age structure of female staff.

Child dependents are estimated as in previous Statistical Appendices[6] and come to a total of 66. In table (e) these are allocated by age and sex.

Having estimated the numbers of administrative, departmental and library staff and their dependents, the remaining direct immigrant population stems from University work staff, maintenance staff, groundsmen, porters etc., cleaners and catering staff. Some of these grades[7] are entirely local resident, and in no case is there any great dependence on immigrants to the area. From current recruitment records it has been estimated that about 42 persons, all male, in the maintenance, porters, work staff groups, will be immigrants to the area and about 15 persons, all female, from catering staff. If current age patterns apply to these 57 immigrants, they will have the age and sex structure shown in table (f). Using similar assumptions as before, it has been estimated that there will be 34 married male workers. Using Sample Census figures for manual workers,[8] it has been estimated that there will be 31 child dependents, allocated by sex in the normal/...

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4. Annual Report of Registrar General, 1969, table N.22., p.29.
5. In the absence of a questionnaire there is no satisfactory way of estimating older dependents, e.g. parents.
6. In particular see Statistical Appendix 8.2, tables (c) and (d).
7. Statistical Appendix 7.3
8. Household composition tables, table 11, p.43.

the normal manner. The total of "other staff" and their dependents are given in the final column of table (f).

This allows, in table (g) the final aggregate of non-academic staff and dependents to be estimated.[9]

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9. Tables (c), (d), (e) and (f). The age group "50 and over" for Administrative, Library and Departmental has been split on current proportions.

Statistical Appendix 8.3

Table (a)

Estimated age and sex structure of Administrative, Departmental and Library grades (1976)

Age	Male		Female		Total Numbers
	Percentage of total	Number	Percentage of total	Number	
15 - 19	0.0	-	13.0	45	45
20 - 24	1.3	4	25.2	87	91
25 - 29	2.5	9	8.2	28	37
30 - 34	1.3	4	5.7	20	24
35 - 39	1.9	7	8.2	28	35
40 - 44	3.8	13	12.6	43	56
45 - 49	1.9	7	3.1	11	18
50 and over	6.3	22	5.0	17	39
	19.0	66	81.0	279	345

Table (b)

Estimates of immigrant persons in "other staff"

Staff	Estimated number as at 1976*	Estimated % local resident+	Immigrant Staff
Departmental	178	47	94
Administrative	114	65	40
Library	53	35	34
Others	478	88	57
	823		225

Sources : * Statistical Appendix 7.1, table (a)

+ Statistical Appendix 7.3, table (a), adjusted

Statistical Appendix 8.3

Table (c)

Estimated age and sex structure of Administrative, Library and Departmental staff immigrants, 1976

Age	Male	Female	Total
20 - 24	3	35	38
25 - 29	8	17	25
30 - 34	4	16	20
35 - 39	7	27	34
40 - 44	12	41	53
45 - 49	7	11	18
50 and over	21	16	37
	62	163	225

Table (d)

Estimated number and age of wives

Age	Males	Proportion married	Number of wives
20 - 24	3	36%	1
25 - 29	8	74	6
30 - 34	4	83	3
35 - 39	7	97	6
40 - 44	12	86	10
45 - 49	7	86	6
50 and over	21	86	18
	62		50

Statistical Appendix 8.3

Table (e)

Estimated age and sex structure of child dependents of Departmental, Administrative and Library staff

Age	Proportion of total	Estimated number of children	Male	Female
0 - 4	34%	22	11	11
5 - 9	37	24	12	12
10 - 14	24	16	8	8
15 - 19	4	3	2	1
20 - 24	1	1	1	-
		66	34	32

Table (f)

"Other staff" and dependents (1976)

Age	Staff		Adult dependents (wives)	Child dependents		Total	
	Male	Female		Male	Female	Male	Female
0 - 4				6	5	6	5
5 - 9				6	6	6	6
10 - 14				3	3	3	3
15 - 19				1	1	1	1
20 - 24				-	-	-	-
25 - 29	6	3	4			6	7
30 - 34	4	3	3			4	6
35 - 39	6	1	5			6	6
40 - 44	8	4	7			8	11
45 - 49	5	2	4			5	6
50 - 54	8	1	7			8	8
55 and over	5	1	4			5	5
	42	15	34	16	15	58	64

Statistical Appendix 8.3

Table (g)

Estimates of non-academic staff and dependents (1976)

Age	Male	Female	Total
0 - 4	17	16	33
5 - 9	18	18	36
10 - 14	11	11	22
15 - 19	3	2	5
20 - 24	4	36	40
25 - 29	14	30	44
30 - 34	8	25	33
35 - 39	13	39	52
40 - 44	20	62	82
45 - 49	12	23	35
50 - 54	19	27	46
55 and over	15	20	35
	154	309	463

Statistical Appendix 8.4

Estimates of immigrants to secondary employment and dependents, (1976)

It has been estimated previously[1] that, excluding the workers employed on the construction of the University campus, secondary employment of between 850 in the lower and 1,650 in the upper case will have been generated by the University by 1976.[2] The effect of this secondary employment on the Study Area will depend upon the immigrant component of these workers. It is argued here that this will depend on the type of employment generated. Additional employment in, say, the services sector for females is likely to be met mainly, if not entirely, by females already resident in the Study Area;[3] immigration is more probable to male employment in secondary jobs created (or to replace males who have transferred from within the Study Area to this work).

The first step is therefore to estimate the male and female proportions of the additional jobs generated by 1976. In table (a), earlier figures for the breakdown of employment by expenditure pattern[4] were used to allocate the secondary employment by S.I.C. Order; using U.K. average male/female proportions for these Orders, it was estimated that about 55% of the secondary employment in both lower and upper cases would be for males and 45% for females. Taking the previous assumption that all female employment would be recruited from residents, or/...

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1. Statistical Appendix 7.4.
2. Table 7.6
3. or whose husbands have moved into employment at the University or elsewhere in the Study Area, i.e. these females have already been counted elsewhere as immigrant dependents.
4. Statistical Appendix 7.5.

residents, or from families who have migrated into the area for male employment, then it was estimated that only 465 male workers in the lower case and 900 male workers in the upper case would be immigrants to the area.[5]

Secondly, estimates of the age structure of male immigrants were made to allow further estimates of adult and child dependents. It was assumed that the male immigrants to employment would be aged between 20 - 64[6] and that their age structure within this range comformed to the Scottish migration pattern.[7] In table (b) the lower and upper case male immigrants were allocated by age group and it was estimated from this that there would be 341 wives in the lower case and 659 wives in the upper case.[8] Using the same approach as in previous Statistical Appendices, it was estimated[9] that there would be 227 children in the lower and 443 children in the upper case. In table (c) these are shown by age group, again using the method taken previously.[10]

Finally, in table (d) the estimated total immigrant population of workers and dependents associated with the secondary growth from the University, are given for both lower and upper cases.

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5. see footnotes 14 and 20 in the chapter.
6. the 15 - 9 group will contain dependents rather than workers and these will be counted as immigrant population elsewhere.
7. see Statistical Appendix 4.1 (table c)
8. some of whom will obviously take jobs in the secondary employment female section.
9. Family size for junior non manual workers, i.e. clerical, sales etc., Sample Census, 1966, Household Composition, table 11, p.43.
10. Sample Census, 1966, table 23, p.80.

Statistical Appendix 8.4

Table (a)

Estimates of male:female proportions in employment generated (1976)

S.I.C. order		Estimated indirect* employment	National proportion males+	No. of males	No. of females
III	Food	26	57.2%	15	11
XVII	Construction	68	93.5	64	4
XVIII	Gas, electricity	26	86.1	22	4
XIX	Transport	17	83.0	14	3
XX	Distributive	450	44.6	201	249
XXIII	Misc. services	127	43.5	55	72
XXIV	Public Admin.	136	69.0	94	42
		850	55%	465	385

Sources : * Table 7.6 and 7.7

+ D.E.P. Gazette, June figures 1967-9

Table (b)

Estimates of adult dependents of secondary workers

Age	Proportion of total*	Lower case		Upper case	
		No. of males	No. of wives+	No. of males	No. of wives+
20 - 4	19	88	32	171	62
25 - 9	21	98	73	189	140
30 - 4	22	102	85	198	164
35 - 9	13	60	52	117	101
40 - 4	11	51	44	99	85
45 - 9	7	33	28	63	54
50 - 4	4	19	16	36	31
55 - 9	2	9	7	18	15
60 - 4	1	5	4	9	7
	100	465	341	900	659

Sources : * Statistical Appendix 4.1

+ Annual Report Registrar General for Scotland 1969 table N.2.2.

Statistical Appendix 8.4

Table (c)

Estimated age and sex structure of child dependents

Age	Lower case		Upper case	
	Male	Female	Male	Female
0 - 4	40	37	78	73
5 - 9	43	41	84	80
10 - 4	28	26	54	52
15 - 9	5	5	9	9
20 - 4	1	1	2	2
	117	110	227	216

Table (d)

Estimated total immigrant population from secondary employment by age and sex (1976)

Age	Lower case			Upper case		
	Male	Female	Total	Male	Female	Total
0 - 4	40	37	77	78	73	151
5 - 9	43	41	84	84	80	164
10 - 4	28	26	54	54	52	106
15 - 9	5	5	10	9	9	18
20 - 4	89	33	122	173	64	237
25 - 9	98	73	171	189	140	329
30 - 4	102	85	187	198	164	362
35 - 9	60	52	112	117	101	218
40 - 4	51	44	95	99	85	184
45 - 9	33	28	61	63	54	117
50 - 4	19	16	35	36	31	67
55 - 9	9	7	16	18	15	33
60 - 4	5	4	9	9	7	16
	582	451	1,033	1,127	875	2,002

Statistical Appendix 8.5

Estimation of population impact by 1981

While the students counted at 1976 and their dependents will have left and been replaced by other students by 1981, the original immigrant staff for the University and secondary growth will remain in the Study Area over the period[1]. These latter immigrants will have to be aged for 1981 and adjusted for births and deaths over the period. The final aggregate figures for 1981 will be gained from adding to the 1976 immigrant population the new 1981 figures for students and dependents and the figures for additional employees immigrating to the area over the period 1976-81 and their dependents.

The 1976 immigrant population, excluding the students and their dependents have been processed through the population projection model[2] for the quinquennium, with deaths by age group estimated from the survival factors and births from the fertility factors used for the Study Area projections[3]. The resultant male and female populations from this cource by 1981 are given in columns (1) and (5) of table (a) for the lower case and table (b) for the upper case. From these, it can be seen that the population total of those earlier immigrants will be between 3,208 and 4,291 by 1981.

The student population and its dependents by 1981 has been estimated as follows. The overall number has been taken from the Development Plan figures as 5,950 undergraduate and 1,000 postgraduates. It has/...

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1. this assumes no turnover from existing immigrants- where replacement has occurred, there will obviously be a source of error from this in the age structure and possibly dependent numbers.
2. Statistical Appendix 4.4, Projection 2 type model, with zero migration.
3. see Chapter 4 and Statistical Appendix 4.1 and 4.2 for these values and an account of their operation.

It has then been assumed that a similar proportion of these will be immigrant to the Study Area as in 1976 and a similar proportion commutors into the Study Area. Given similar age and sex patterns as for 1976, with similar proportions married and similar family size, age and sex structure,[4] it has been estimated that the total population from this source by 1981 will amount to 7,925 persons. The breakdown by age and sex appears in columns (2) and (6) of table (a) and (b).

The third step in the overall calculation is to estimate the additional members of staff at the University who will immigrate to employment over the period 1976-81. The difference between the estimates for 1976[5] and 1981[6] amounts to 539 academic staff and 878 additional non-academic staff. If the same migration patterns apply within these two staff categories as for 1976 and if similar assumptions are made[7] concerning age and sex distribution of staff, proportions married, family size age and sex structures of dependents, then it can be estimated that 522 immigrant academic staff[8] will have 1,133 dependents and that 301 immigrant non-academic staff will have 193 dependents, overall, for directly employed immigrant staff of 823, there will be 1,326 dependents. These figures are shown by age structure in table (c) for male staff and male dependents and table (d) for female staff and dependents, column 1 in each table.

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4. see Statistical Appendix 8.1 for these proportions.
5. see Statistical Appendix 7.1.
6. Development Plan Report, Appendix C.
7. see Statistical Appendix 8.2 and 8.3 for these proportions.
8. the lower academic staff figure shows that in some cases husband and wife will work at the University; female academic staff have therefore been taken out, if in this category and will appear in the dependent figures.

Fourthly, an estimate must be made of the new immigrants to secondary employment generated by the University over the period 1976-81. The number of indirect jobs has been estimated[9] earlier as 1,600 in the lower and 3,100 in the upper case, i.e. an additional 750 to 1,550 over the period. A problem arises as to whether similar immigrant/resident patterns can be assumed for 1981 as for 1976, mainly on the grounds that growth up to 1976, or even in non academic employment over the later period, could well deplete badly any remaining slack in the labour market[10]. However, current house construction developments in the area suggest[11] that population growth from other immigration sources is probable, so that additional labour reserves should become available to some extent[12]. To take some account of this, the immigration components for secondary growth have been increased a little, from 55% to 65% of total jobs. Then, assuming the same patterns of age, sex distribution, marriage and family size etc., it has been estimated that the additional migrants (of 500 to 1,000) will add about 610 to 1,220 dependents to the population of the Study Area by 1981. In tables (c) and (d) the total immigrant population from secondary growth employment increase over the period, is added to direct employment, for both lower and upper cases, (columns (2) and (4) in each table). This provides an estimate of new immigrants, excluding students, of between 3,259 and 4,369 by 1981 (columns (3) and (5) in each table). These figures are then taken from tables (c) and (d) and placed in columns (3) and (7) of tables (a) and (b).

This allows an estimate to be made that, by 1981, the impact of the University on the local population will be to add between about 14,500 and 16,500 persons to that population.

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9. see tables 7.10 (a) and (b).
10. see Chapter 4.
11. see Statistical Appendix 4.1.
12. but some of these may well be absorbed in response to other growth forces within the Study Area.

Statistical Appendix 8.5

Table (a)

Estimates of total population generated by University by 1981

Lower case

age	Males				Females			
	original migrants less students	students by 1981	new migrants 1976-81	Total	original migrants less students	students by 1981	new migrants 1976-81	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0- 4	186	135	186	507	173	127	178	478
5- 9	164	127	204	495	155	127	194	476
10-4	178	55	131	364	171	55	126	352
15-9	115	1530	25	1670	110	1030	23	1163
20-4	21	2401	119	2541	19	1165	88	1272
25-9	109	372	225	706	78	269	199	546
30-4	200	127	213	540	175	135	205	515
35-9	189	87	153	429	182	95	172	449
40-4	134	40	146	320	150	48	180	378
45-9	126		92	218	158		99	257
50-4	80		74	154	85		77	162
55-9	61		57	118	65		55	120
60-4	56		19	75	60		19	79
65-9	4			4	4			4
	1623	4874	1644	8141	1585	3051	1615	6251

Statistical Appendix 8.5

Table (b)

Estimates of total population from the University by 1981

Upper case

age	Males				Females			
	original migrants less students	students by 1981	new migrants 1976-81	Total	original migrants less students	students by 1981	new migrants 1976-81	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0- 4	250	135	228	613	234	127	218	579
5- 9	202	127	251	580	191	127	238	556
10-4	219	55	161	435	210	55	154	419
15-9	141	1530	31	1702	136	1030	29	1195
20-4	25	2401	214	2640	23	1165	124	1312
25-9	193	372	330	895	109	269	278	656
30-4	290	127	323	740	242	135	296	673
35-9	284	87	216	587	261	95	228	584
40-4	190	40	200	430	198	48	227	473
45-9	173		128	301	198		129	327
50-4	109		94	203	110		94	204
55-9	77		67	144	80		63	143
60-4	64		25	89	68		23	91
65-9	8			8	6			6
	2225	4874	2268	9367	2066	3051	2101	7218

Statistical Appendix 8.5

Table (c)

Estimated population of immigrant staff and dependents (1981)

Males

Age	Direct Staff	Secondary lower	"Lower" Total	Secondary upper	"Upper" Total
	(1)	(2)	(3)	(4)	(5)
0 - 4	144	42	186	84	228
5 - 9	157	47	204	94	251
10 - 4	101	30	131	60	161
15 - 9	19	6	25	12	31
20 - 4	24	95	119	190	214
25 - 9	120	105	225	210	330
30 - 4	103	110	213	220	323
35 - 9	90	63	153	126	216
40 - 4	92	54	146	108	200
45 - 5	56	36	92	72	128
50 - 4	54	20	74	40	94
55 - 9	47	10	57	20	67
60 - 4	13	6	19	12	25
	1,020	624	1,644	1,248	2,268

Table (d)

Females

Age	Direct Staff	Secondary lower	"Lower" Total	Secondary upper	"Upper" Total
	(1)	(2)	(3)	(4)	(5)
0 - 4	138	40	178	80	218
5 - 9	150	44	194	88	238
10 - 4	98	28	126	56	154
15 - 9	17	6	23	12	29
20 - 4	52	36	88	72	124
25 - 9	120	79	199	158	278
30 - 4	114	91	205	182	296
35 - 9	116	56	172	112	228
40 - 4	133	47	180	94	227
45 - 9	69	30	99	60	129
50 - 4	60	17	77	34	94
55 - 9	47	8	55	16	63
60 - 4	15	4	19	8	23
	1,129	486	1,615	972	2,101

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This bibliography contains references to the works cited in the text of the thesis. Apart from these works, considerable use has been made of the statistics contained in various publications, such as the Census Returns for 1951, 1961 and 1966 for Scotland, the United Kingdom, the Scotland, County Reports and special volumes on Economic Activity, Household Composition, Migration, and Workplace; apart from these Census publications, extensive use has also been made of various issues of the Department of Employment Gazette (formerly the D.E.P. Gazette and the M.O.L. Gazette) and the Annual Reports of the Registrar General for Scotland, both over the period 1951-1970. In addition to these main sources of statistical data, further references have been made to the data contained in the various issues during this period of the Abstract of Regional Statistics, the Digest of Scottish Statistics, the Family Expenditure Survey, National Income and Expenditure, Statistics of Education, and Statistics on Prices, Incomes and Productivity. Finally, use has been made of unpublished statistical data from the Accounts Department of the University of Stirling, the Census Office, the Department of Employment, and the Registrar General for Scotland.

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