



**SWP 32/88    MANUFACTURING EMPLOYMENT CHANGE  
IN WALES, 1971 - 1981:  
A CORRELATION AND REGRESSION  
ANALYSIS**

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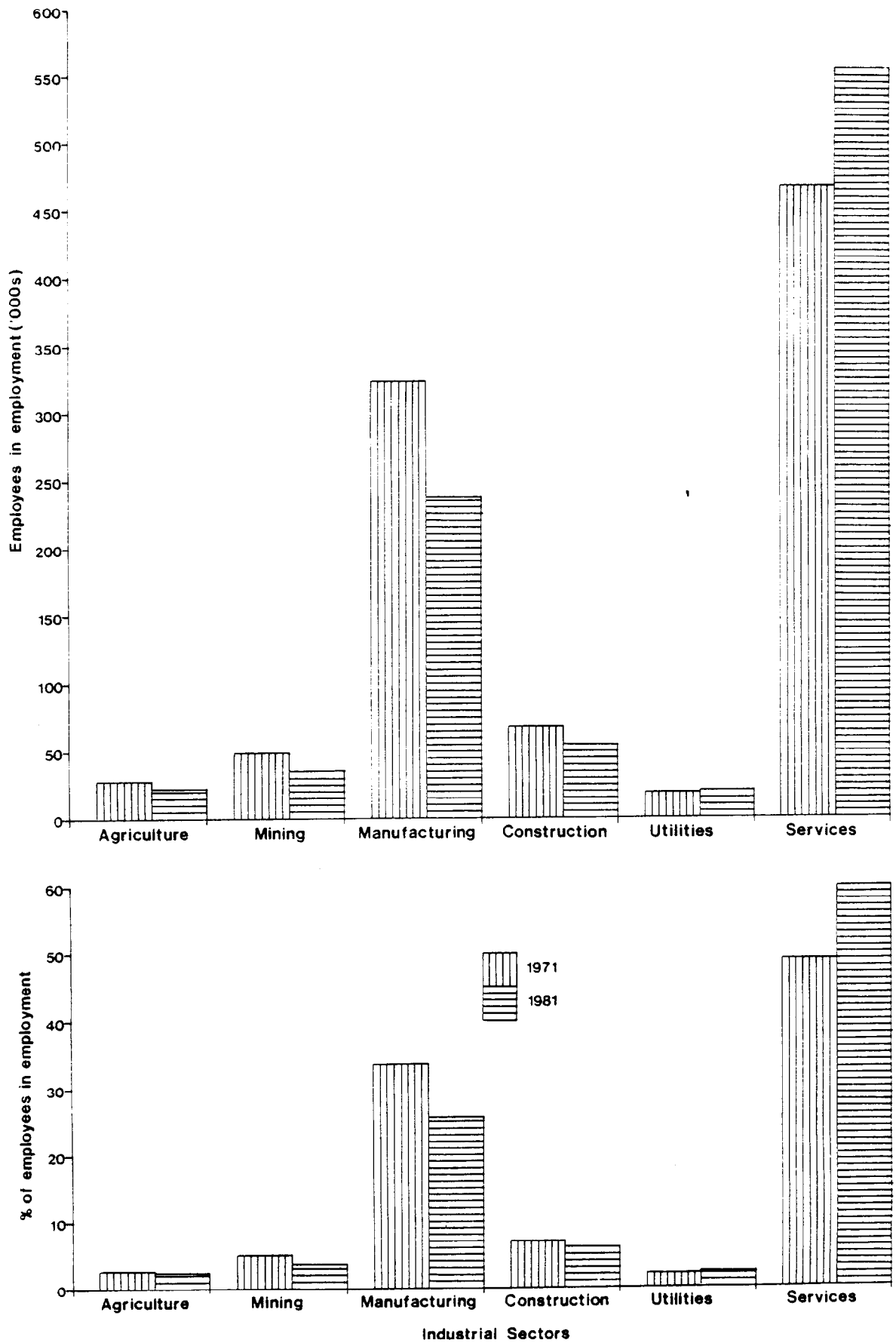
*Between 1971 and 1981 manufacturing employment change in Wales was spatially uneven. Changes in employment beg questions as to the processes behind those exposed in spatial terms. Multiple correlation and regression analysis was used to draw useful insights into the processes which were operating in contrasting labour markets.*

**VARIATIONS IN MANUFACTURING EMPLOYMENT CHANGE**

It is widely known that manufacturing growth was traditionally seen as a way of strengthening the economy of Wales, both to combat decline in mining in south Wales (and to a lesser extent in north-east Wales), and to stem depopulation from rural Wales. For much of the postwar period, strenuous efforts have been made to attract manufacturing activity into Wales from 'birthplaces' elsewhere. Progress on this was ostensibly reasonable as indicated by the proliferation of investment in manufacturing and the rising levels of industrial building.

Between 1971-1981, however, net manufacturing employment fell severely. On the basis of previously unpublished data provided by the Department of Employment, Watford (ER2 records), Figure 1 shows rises in employment in utilities and services were inadequate to affect major falls in all other employment sectors, with manufacturing losing more employment than agriculture, mining and construction combined. In fact, total employment fell by 3.1% (or 29,547 jobs) and manufacturing employment fell by 26.3% (or 85,114 jobs). Figure 2 shows that Metal Manufacture (SIC 6) accounted for 59.5% (or 50,647 jobs) of the net manufacturing employment loss. Only three manufacturing sectors (for example, Vehicles (SIC 11), Chemicals and Allied Industries (SIC 5) and Timber, Furniture, etc (SIC 17)) recorded gains in manufacturing employment. As compared with U.K. rates of change of employment in

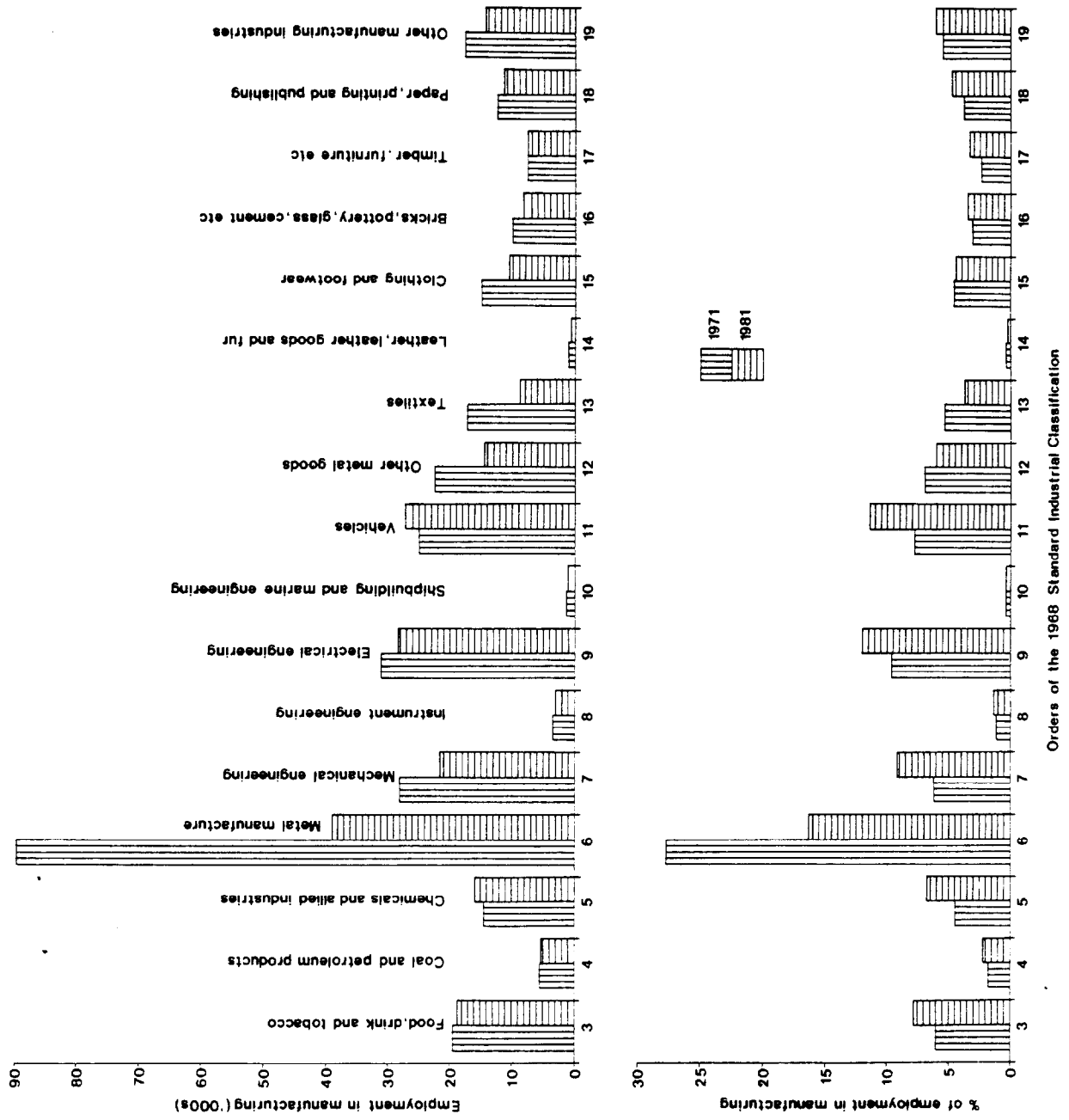
### CHANGES IN WALES'S TOTAL EMPLOYMENT STRUCTURE, 1971-1981



Source: Department of Employment ER2 Records 1971 & 1981

Figure 2

CHANGES IN WALES'S MANUFACTURING EMPLOYMENT STRUCTURE, 1971-1981



each manufacturing sector Table 1 indicates that Wales 'did better' in the thirteen minor employment sectors (in Wales), and 'worse' in the four relatively major employment sectors (in Wales).

And yet the geography of employment loss was most uneven (Figure 3). There were large absolute and percentage manufacturing employment losses in the urban-industrial Revised (1978) Travel-to-Work Areas (TTWAs) with the major existing activity, and patchy employment growth in selected rural TTWAs in line with the putative urban-rural shift. The spatial pattern of total manufacturing employees is also indicated in Figure 4. Of course, it is recognised that 1971-1981 is not a homogeneous period due to the onset of national recession in the late 1970s. Figures 5 and 6 show that, again, the geography of manufacturing employment change was erratic. Most but not all rural TTWAs showed modest absolute gains, their small initial manufacturing employment giving them large percentage change (Figure 5). Most of the urban-industrial TTWAs showed severe absolute, though mainly low relative, losses of manufacturing employment, apart from Merythyr Tydfil and Bargoed TTWAs. The 1971-1981 period (Figure 6) show the urban-industrial TTWAs experiencing unmitigated major manufacturing employment loss, and most rural TTWAs losing many of their earlier gains.

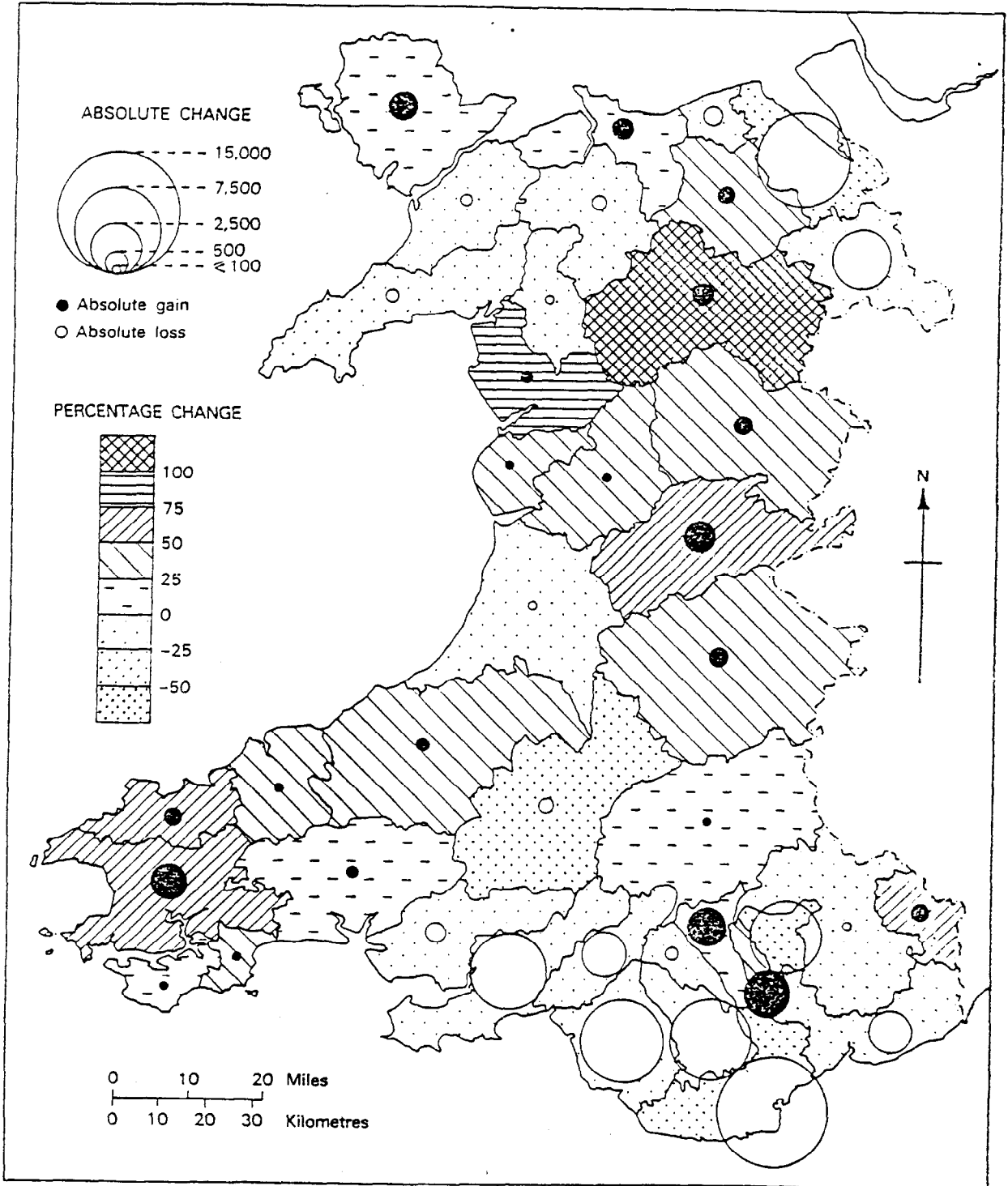
Changes in manufacturing employment beg questions as to the processes behind those exposed in map form, they hint at arguments to do with locational advantage/disadvantage, the extent to which change was simply an expression of existing industrial structures, and representing urban-rural shift, etc. Do they express or reflect shifts in consumer purchasing power, the variable presence of an enterprise culture, the spatial vagaries of investment, etc? The patterns of employment change identified above can be viewed as the outcome of a series of processes which have impacted on the forty TTWAs in distinctive ways. Given the manifested complexity of manufacturing employment change over the ten year period (Figure 3), it is important to try and identify the processes leading to these absolute (MFCHA) and percentage (MFRCHPC) spatial differences in manufacturing employment (Appendix 1).

## **PREVIOUS RESEARCH**

Fragmentary evidence from previous studies suggests that manufacturing growth and decline have not occurred uniformly throughout the U.K. (Fothergill and Gudgin, 1982), but has favoured particular locations more than others. With regard to the economy of Wales over the 1971-1981 period, two important questions have been raised. What areas have been most or least favoured in this respect? And what are the reasons for spatial variation in manufacturing employment change at the important local

Figure 3

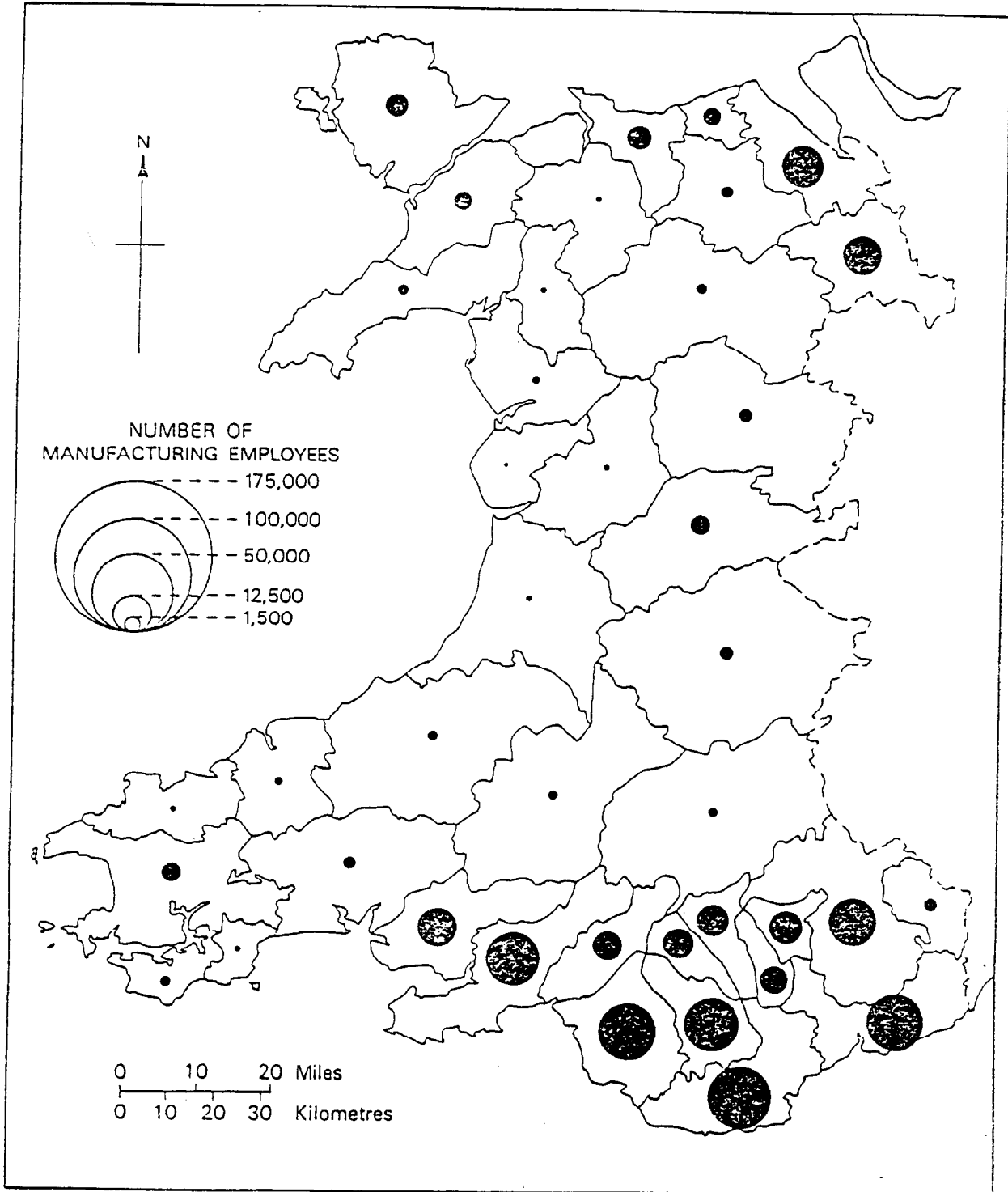
### ABSOLUTE AND PERCENTAGE CHANGE IN TOTAL MANUFACTURING EMPLOYMENT, 1971-1978



Source: Department of Employment ER2 Records 1971 & 1981

Figure 4

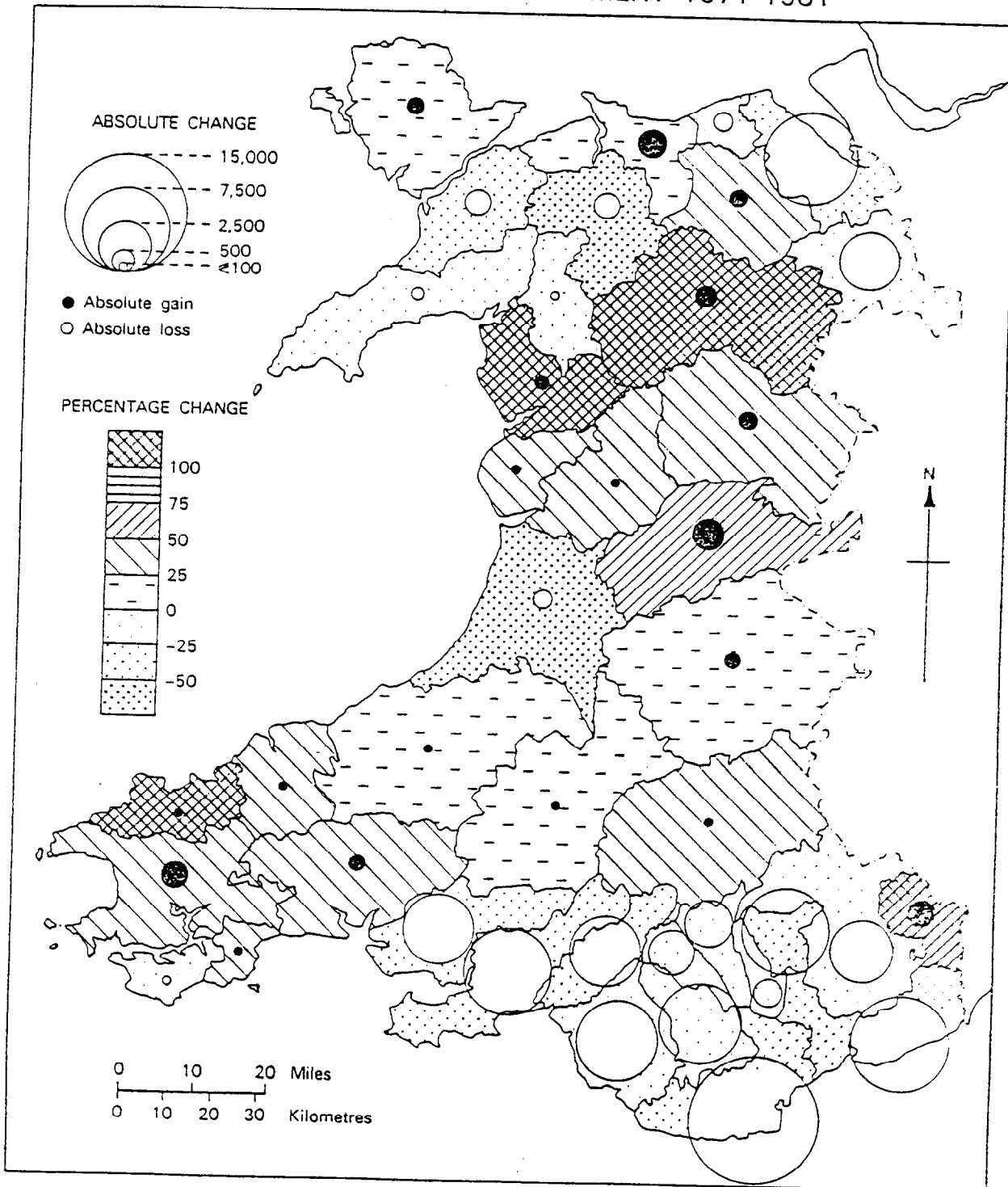
### TOTAL MANUFACTURING EMPLOYEES IN WALES, 1981



Source: Department of Employment ER2 Records 1981

Figure 5

### ABSOLUTE AND PERCENTAGE CHANGE IN TOTAL MANUFACTURING EMPLOYMENT 1971-1981

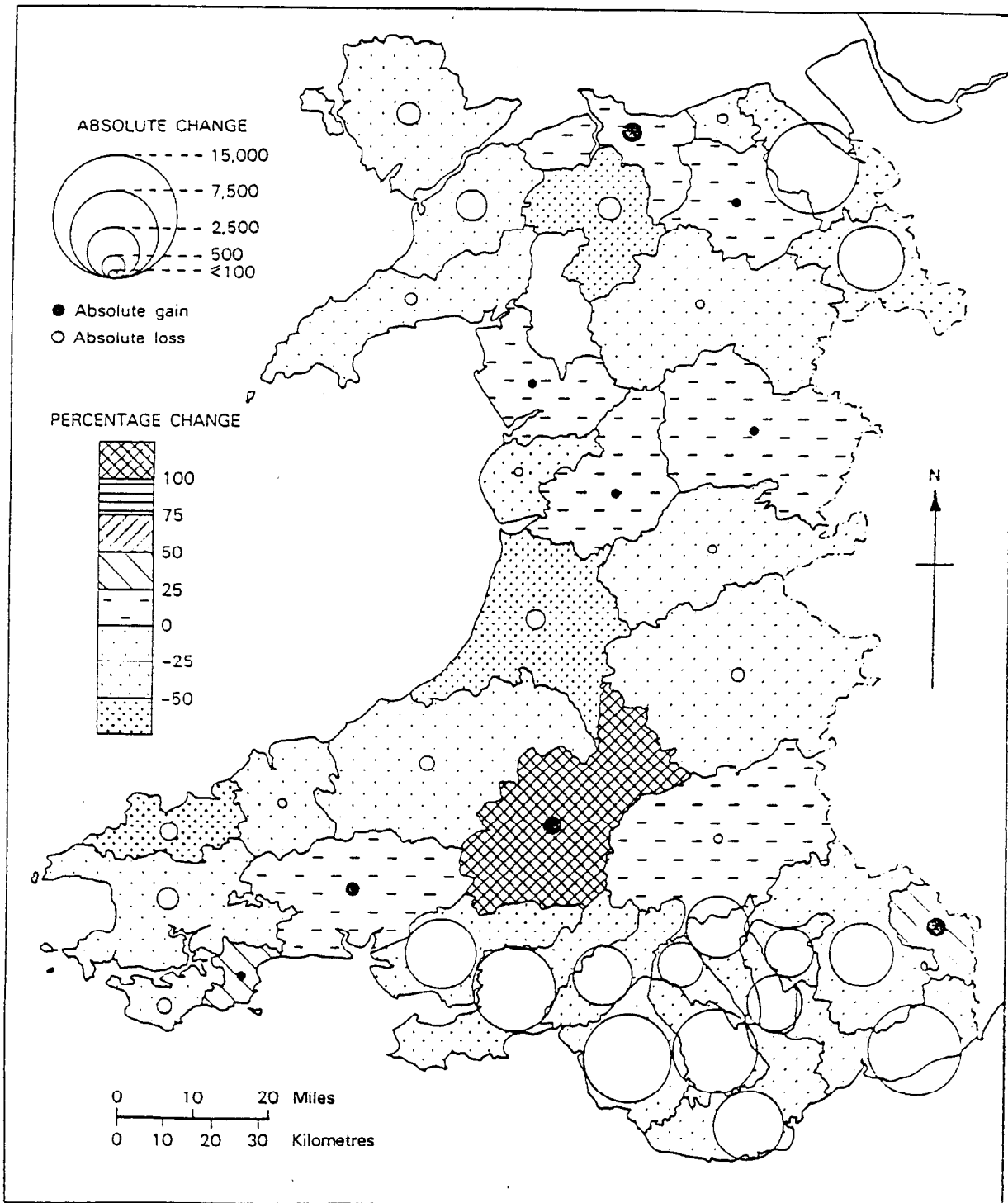


Source: Department of Employment ER2 Records 1971 & 1981



Figure 6

### ABSOLUTE AND PERCENTAGE CHANGE IN TOTAL MANUFACTURING EMPLOYMENT, 1978-1981



Source: Department of Employment ER2 Records 1971 & 1981

labour market scale? Classical industrial location analysts such as Weber (1909) and Smith (1971) developed models and theories of industrial location in terms of normative factors. In contrast, contemporary empirical research concerned with actual manufacturing employment change and location has conceived, of the problem as a function of initial economic potential, industrial structure, entrepreneurship, government planning controls and social class (Smith, 1969; Keeble and Hauser, 1971, 1972; Keeble, 1976; Owen and Green, 1984).

A detailed study of theoretical and empirical work on industrial location dynamics has suggested a wide range of hypotheses and location factors which might help to explain spatial variation in manufacturing employment change at the TTWA scale. Whilst fundamentally these variables arise from the fine-scale processes of job-creation and destruction, there are practical limits to the extent to which the minutiae behind each and every case can be grasped and distilled. Hence, it is necessary to focus the analysis on broader variables that in turn influence the job-creation and destruction process. Factors associated with manufacturing employment change in labour markets are detailed below (Table 2).

(i) Spatial Preferences

The strength of the urban-rural space preferences (Owen and Green, 1984, p.20) have been identified as influences leading to employment growth in rural areas (Keeble and Hauser, 1971, p.237; Keeble, 1976, p.104-106) (Factor 1 in Table 2). This factor in practice is filtered by a whole range of internal contradictions, such as population and household size relationships, and the influence of locationally-specific planning - particularly housing - planning policies. It may coincidentally tend to capture some characteristics of rural-versus-urban distinctions, given the tendency during the 1970s for positive population change to be inversely related to levels of urbanisation.

(ii) Industrial Structure

Areas with manufacturing employment bases dominated by industries which nationally (e.g. U.K.) have declining levels of employment will perform poorly while areas in which nationally-growing industries are well represented will display more favourable prospects for employment (Factor 2 in Table 2). A 'structural measure' might also be viewed to some extent as a surrogate for institutional and entrepreneur considerations (Keeble and Hauser, 1972, p.23; Keeble, 1976, p.107). It has been suggested that an area

with a favourable employment structure will have further potential for employment growth (Owen and Green, 1984, p.21).

It has been postulated by Storey (1982) that areas with high proportions of employment in heavy industries will have lower rates of new firm formation and employment creation. This employment tradition in heavy industries may lead to marked negative 'multiplier' and 'knock-on' effects being diffused throughout an area leading to further contraction in employment.

Keeble and Hauser (1971, p.234) have also argued that the initial level of diversification in an area may influence a resultant increase or decrease in manufacturing employment change. This is based on the view that highly specialised industrial areas are excessively vulnerable in terms of industrial stability and growth, whereas the more diversified an area's industries, the greater the probability of healthy expansion (For a dissenting view see Britton, 1967, p.75-84).

#### (iii) Agglomeration Economies and Diseconomies

It has been suggested that the operation of agglomeration economies through increasing the mass of industrial activity in a labour market may be positively associated with employment growth, whilst agglomeration diseconomies may reduce growth or even initiate decline (Smith, 1969, p.186; Keeble and Hauser, 1971, p.236-7; Keeble, 1976, p.101-102) (Factor 3 in Table 2). Also, a good deal of evidence has been advanced suggesting that the environment provided by small towns and rural areas (or perhaps the characteristics of the firms located in such areas) are more favourable for manufacturing employment growth than those in large cities and conurbations (Keeble, 1976, 1980; Fothergill and Gudgin, 1979, 1982; Moore et al, 1985).

#### (iv) Labour Force Characteristics

The availability of labour may prove an attraction to, indeed a crucial factor for, certain types of manufacturing activity (Keeble and Hauser, 1971, p.235; Keeble, 1976, p.102-103) (Factor 4 in Table 2). In the past the availability of skilled manual labour within an area would have been likely to attract certain types of manufacturing industry but in recent years technological change and the automation of many craft operations have reduced the demand for this type of labour. Recently, technical and administrative functions have assumed an increasing importance in manufacturing. Conversely, the demand for unskilled manual labour has fallen even more than for skilled workers (Owen and Green, 1984, p.23).

(v) **Market Accessibility**

It has been found that firms in remote and inaccessible areas are at a competitive disadvantage relative to firms in more accessible locations (Keeble and Hauser, 1971, p.234-35; Keeble, 1976, p.101; Keeble et al., 1981, p.37-39; Owen and Green, 1984, p.21) (Factor 5 in Table 2). Moreover, the concept of regional economic potential (Rich, 1975, 1980) is the most widely used index of market accessibility, itself the key component of the centre-periphery model.

**SURROGATE VARIABLES**

The 'surrogate' variables for the five factors stated above are detailed below. Also, the hypothesised direction between the independent 'surrogate' variable and manufacturing employment change is stated.

**Factor 1: Spatial Preferences**

It is suggested that there is a positive relationship between the rate of percentage population change in a TTWA, 1971-1981 (POPCHPC) and an increase in manufacturing employment.

**Factor 2: Industrial Structure**

It is hypothesised that a TTWA with a high positive percentage manufacturing employment structural shift component, 1971-1981 (MFRSTSHPC) has a positive relationship with an increase in manufacturing employment based on the seventeen manufacturing Standard Industrial Categories (SICs). Conversely, it is postulated that a TTWA with a high proportion of total manufacturing employment in heavy industries such as Coal and Petroleum Products (SIC 4), Chemicals and Allied Industries (SIC 5), Metal Manufacture (SIC 6) and Shipbuilding and Marine Engineering (SIC 10) will have a negative relationship with manufacturing employment change. Also, it is suggested that specialised TTWAs which have low endogenous entropy manufacturing employment diversification values (Formula 1) (D71) will have a negative relationship to manufacturing employment change.

Formula 1

$$P_i = \sum M_j / D_{ij}$$

Where:  $P_i$  = economic potential of region  $i$ ;  
 $M_j$  = measure of the volume of economic activity in a region  $j$ ;

- $D_{ij}$  = measure of the distance or cost of transport between region  $i$  and region  $j$ ;  
and  
 $\Sigma$  = summing for all  $n$  regions considered yields the potential for region  $i$ .

### Factor 3: Agglomeration Economies and Diseconomies

It is postulated that a TTWA with a high agglomeration ratio, 1971 (total manufacturing employment in a TTWA as a ratio of the land area (h.a.) of a TTWA) (AGGLOM) will have a negative relationship with manufacturing employment change.

### Factor 4: Labour Force Characteristics

It is hypothesised that TTWAs with high percentages of economically active persons being managers and professionals (MANPROFPC71) and foremen and skilled manual workers (SKILLEDPC71) in 1971 would have positive relationships with manufacturing employment change. In contrast, it is suggested that TTWAs with high percentages of unskilled manual workers in 1971 (UNSKILLEDPC) would have a negative relationship with manufacturing employment change.

### Factor 5: Market Accessibility

It is postulated that TTWAs with low regional economic potential values (Formula 2) will have a negative relationship with manufacturing employment change.

#### Formula 2

$$D71 = - \sum_{j=1}^m P_{ij} \ln P_{ij}$$

- Where:
- $P_{ij}$  = the proportions associated with a particular employment category  $j$  within region  $i$ ;
  - $\ln$  = natural logarithm;
  - $m$  = number of categories;
  - $\Sigma$  = summation

Most economic potential analyses have measured the volume of economic activity in different regions by values of regional Gross Domestic Product (GDP), as the best available summary index of the economic activity which is present. In this study a detailed breakdown of GDP by TTWA was unavailable and total population in a TTWA in 1971 was used as the best available mass factor. Formula 2 was used to work out potential values for each TTWA in Wales, in respect of both the remaining TTWAs in Wales and the mean centres of population of each of the other Standard Regions of England and Scotland. Resultant

potential values were expressed in units of activity (e.g. population) per road transport distance (e.g. per mile).

## **RESEARCH QUESTIONS**

In this paper an attempt will be made to disentangle some of the complexity associated with absolute as well as percentage manufacturing employment change in Wales over the 1971-1981 period (Figure 3). Using previously unpublished data at the Revised (1978) TTWA scale a range of hypotheses presumed to be either positively or negatively associated with manufacturing employment change will be explored. Also, the applicability of a series of surrogate variables postulated to be associated with employment change will be tested.

## **DATA TO BE COLLECTED**

In order to answer the research questions stated above data had to be assembled from a variety of data sources including the Department of Employment, Watford and the Office of Population Censuses and Surveys (OPCS), Fareham. The definition of the selected dependent and independent variables is indicated in Appendix 1. From Appendix 1 it is apparent that nine independent variables were selected and measured. A description of each of the variables and their theoretical basis has been discussed above. It can therefore be claimed that variable selection was based on firm theoretical and deductive considerations. However, a major limitation on independent variable selection was that any data should relate to the 1971-1981 time period and not to parts of it: certainly not post-1981. This prevented the use of a number of promising but incomplete data sources and data sets.

## **RESEARCH METHODOLOGY**

The methodology adopted to disentangle the complexity of manufacturing change was multiple correlation and regression analysis. Multiple correlation and regression analysis is concerned with a particular kind of statistical relationship between a dependent variable and a selected set of independent variables (Johnston, 1978). However, a strong statistical relationship, as indicated by a high correlation coefficient, does not necessarily prove a strong cause-and-effect relationship.

In the following analyses the backward elimination method was adopted using the SPSSX regression package (Norusis, 1983). The backward elimination method starts with all independent

variables in the equation and subsequently removes them based on specified removal criteria. The criterion of maximum probability of 'F' (POUT) which an independent variable can have is used and the default value is 0.10. In order to satisfy the assumptions of the general linear model (Poole and O'Farrell, 1971) in the percentage manufacturing employment change model, the raw data for the level of agglomeration (AGGLOM) was arithmetically transformed in order to improve the level of linearity with the dependent variable absolute manufacturing employment change (MFRCHA).

## RESULTS

Irrespective of whether the dependent variable is in an absolute or percentage form, the independent variables are the same in both analyses that follow. Descriptive statistics for the nine independent variables are illustrated in Table 3. The pattern of the simple intercorrelations between them is shown in Table 4. This table indicates a fairly close picture of the important interconnections between the independent variables.

### (i) Absolute Manufacturing Employment Change, 1971-1981

Table 5 lists the initial and 'best-fit' regression results associated with absolute manufacturing employment change (MFRCHA). Moreover, Table 5 shows the independent variables selected as being significantly related to absolute manufacturing change together with their regression coefficients. The final model indicates that the three most powerful explanatory variables (as indicated by the Beta and the t-values) are the level of agglomeration (AGGLOM), the percentage level of people being foremen and skilled manual workers (SKILLEDPC71) and the level of employment in heavy industries (HIMFRPC71). Together they account for 75% of the systematic spatial variation in absolute manufacturing employment change. The results of this final model are virtually in accordance with the findings of previous research. The high loading on the negative characteristics of TTWAs appear to take on relatively greater significance than the positive attribute of the percentage level of people being foremen and skilled manual workers (SKILLEDPC71). This is in part due to the fact that absolute manufacturing employment change, 1971-1981 was dominated by massive job losses over the 1978-1981 period (Figure 6). Within this context of rapid decline, TTWAs containing the larger cities and older industrial centres with relatively high proportions of manual unskilled workers have suffered disproportionate employment loss (Owen and Green, 1984, p.24). Moreover, when the residuals from the final regression model were calculated (in

Figure 7 more than predicted means better than predicted and less than predicted means worse than predicted) a complex spatial pattern emerged illustrating the need to widen the range of independent variables in a subsequent analysis. For example, the relative stock and cost of premises as well as the level of financial assistance granted by central government through regional development grants, selective assistance schemes and the financing of development agencies to a TTWA could be included in a future model.

The following important conclusions emerge from the analysis disclosed in Table 5. First, one TTWA associated with new town designation - Newtown - experienced modest growth whilst quite substantial decline was recorded in the other Pontypool (viz. Cwmbran). Second, the greater than predicted absolute growth of employment in rural TTWAs highlights the strength of the urban-rural differential change over the period. Rural TTWAs have benefited from the attraction of numerous branch plants, in part due to the prompting work of the Welsh Development Agency (WDA) and Mid Wales Development (MWD). In contrast, urban TTWAs witnessed massive employment loss in major corporations and, in fact, the vast majority of the employment was lost in externally-controlled branch plants. Third, the replication of actual manufacturing employment change in the TTWA with marked employment loss confirms the negative role of a traditional heavy industrial inheritance and agglomeration diseconomies. However, in respect to the last point a note of caution must be added because a small number of TTWAs in south Wales did not fit the general trend (Figure 7). This is in part a result of the fact that these TTWAs had not yet fully experienced the impact of employment loss during the study period.

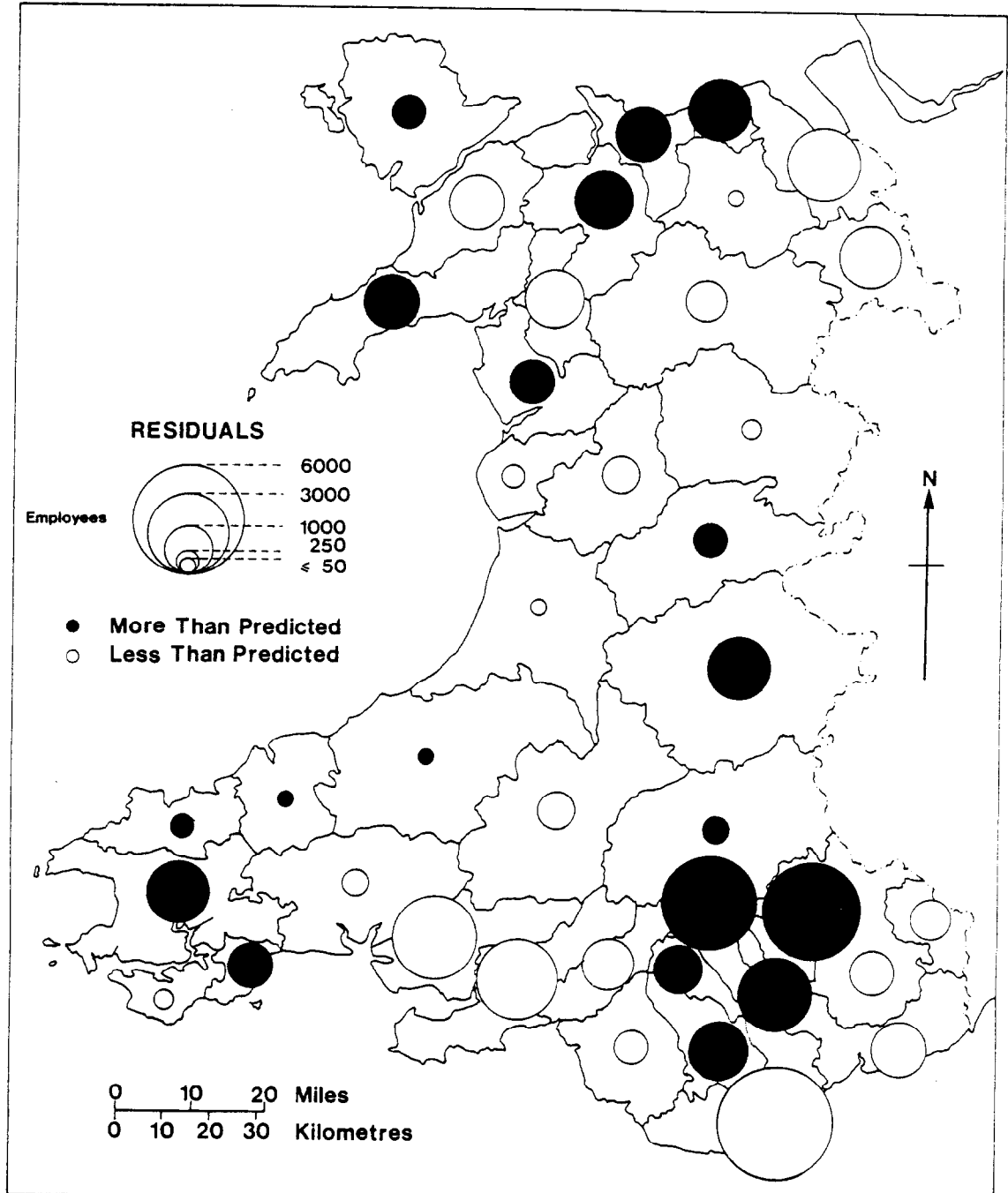
(ii) Percentage Manufacturing Employment Change, 1971-1981

In contrast to the above results, a wide ranging mix of significant influences were associated with percentage manufacturing employment change (MFRCHPC). That there were differences between the two models was not unexpected, absolute and percentage data for the forty TTWAs were rather different. And, as Keeble (1976, p.109) warned, "This illustrates the great importance of looking separately at absolute changes and rates of change in quantitative analyses of this kind". The results of this second analysis are in many ways strikingly different from the ones stated in the previous model. The final model in Table 6 yields a lower adjusted  $R^2$  value of 58% and it includes five independent variables associated with percentage manufacturing employment change. The final model indicates that the level of agglomeration (AGGLOM - log transformed), the percentage of people being unskilled manual workers



Figure 7

### ABSOLUTE CHANGE IN MANUFACTURING EMPLOYMENT, 1971-1981: REGRESSION RESIDUALS



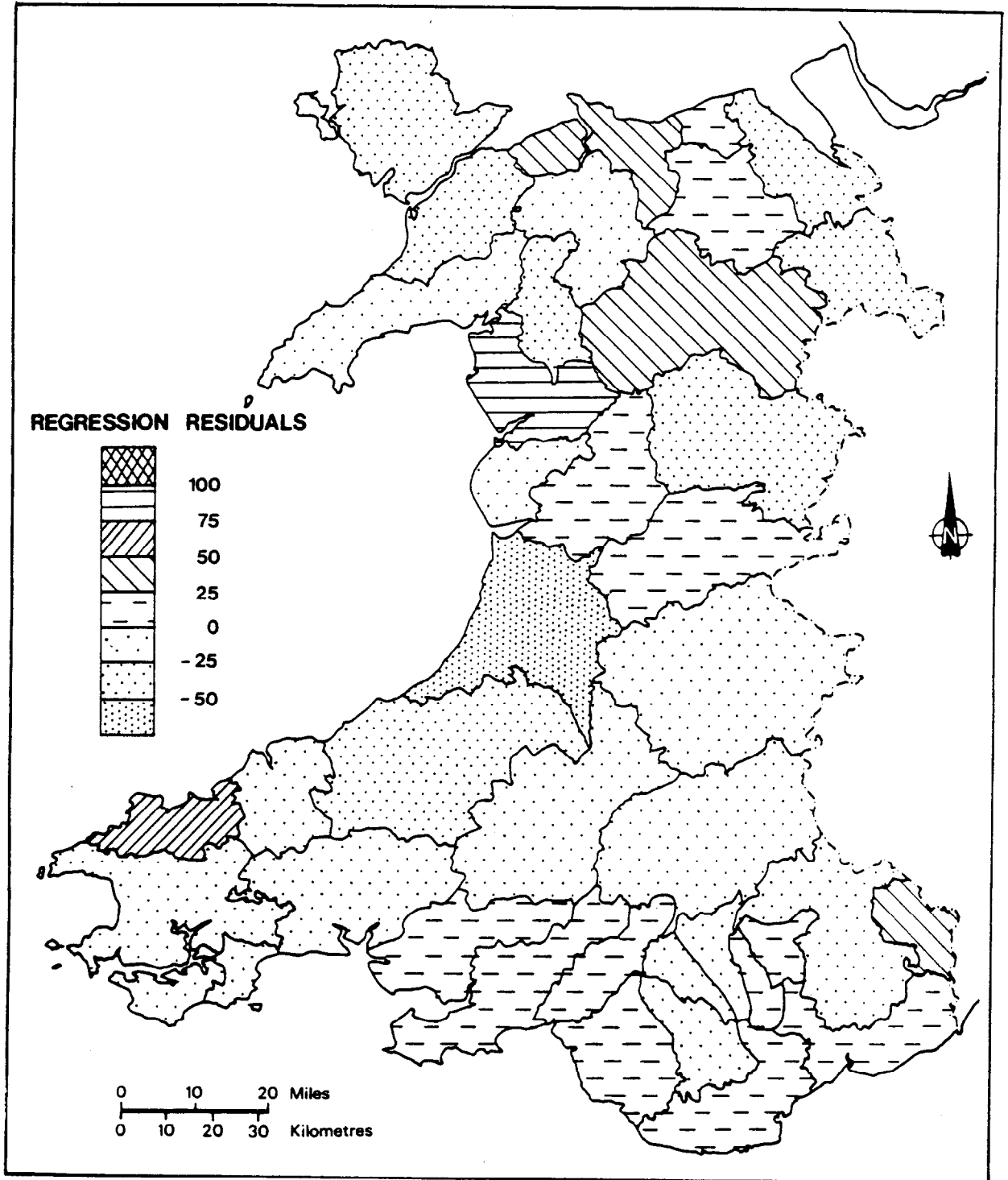
(UNSKILLEDPC71), the percentage population change in a TTWA (POPCH), the percentage of employees in heavy industries (HIMFRPC71) and the percentage manufacturing employment structural shift coefficients (MFRSTSHPC) were the most explanatory for percentage manufacturing employment change (MFRCHPC). As in the previous model, it appears that the negative characteristics of TTWAs take on relatively greater significance than positive attributes. Again, this is because percentage manufacturing employment change was so dominantly negative over the 1978 to 1981 period (Figure 6). Like the work presented by Owen and Green (1984, p.24) the results in Table 6 appear to question the findings of previous research undertaken on sub-regional employment change in Britain. For example, industrial structure mix emerged from the analysis as a reasonable determinant of manufacturing employment change, whereas Fothergill and Gudgin (1979, 1982) have emphasised the diminishing influence of industrial structure during the post-war period and Keeble (1980) dismissed it as unimportant during the period 1971-1976. Again, the residuals from the regression model were calculated and the complexity of the residuals (Figure 8) does point to the need to widen the range of independent variables in a subsequent analysis such as the level of premises availability, the relative cost of premises and the relative amount of financial assistance received by a TTWA.

Nevertheless, these findings from the model are of interest and a number of conclusions can be drawn from it. Whilst large percentage increases in a number of TTWAs should not be over interpreted, there does appear to be a significant trend towards greater relative growth in more rural locations. Second, the assistance provided by the WDA, MWD, New Town status and Assisted Area status seem to have benefited a number of TTWAs. Third, a variety of TTWAs have suffered more than others from large-scale manufacturing employment loss in a small number of establishments, particularly in TTWAs which have traditionally been dominated by metal manufacturing. Fourth, it does appear that several traditional urban TTWAs in south Wales have declined less rapidly than that predicted by the model (Figure 8). It suggests that the lowland coastal TTWAs in south Wales have done relatively better (in part, possibly due to attraction of branch plants and increased indigenous new firm formation, added to the fact that a number of these TTWAs suffered increased employment loss after 1981 rather than before 1981) than TTWAs associated with traditional mining valley communities.

## **SUMMARY AND CONCLUSION**

Figure 8

**PERCENTAGE CHANGE IN MANUFACTURING EMPLOYMENT, 1971-1981. MODEL: REGRESSION RESIDUALS.**



The above analyses have identified a number of interesting, intuitively logical, and sometimes unexpected spatial relationships between the variations associated with absolute and percentage manufacturing employment change in the forty labour markets in Wales over the period 1971 to 1981. It can be claimed that the two presented models have thrown some new light on the types of locational influences at work upon manufacturing employment change in the Principality and the models have provided some measure of their spatial incidence. This paper has sought to delimit a number of the characteristics associated with the spatial changes in the pattern of manufacturing employment in Wales since 1970. In order to unravel some of the complexity associated with this transformation of the manufacturing economy of Wales by the early 1980s a range of processes associated with this change have been identified and measured. The models presented have indicated that local processes have been at work but the economy of Wales has also been strongly influenced by the changing fortunes of the U.K. economy relative to the world economy. From the above analyses, at times, the picture appears to be of broad areally-cohesive responses to the processes of economic change: at others it is localised distinctiveness. Whilst a limited number of processes can be identified as being associated with manufacturing employment change, the subtlety of interactions of processes must lead to a persistence of differences in 'environmental' conditions at the TTWA level.

On the basis of the presented models it can be suggested that the traditional centres of heavy industry will experience further declines in manufacturing employment, whilst the more rural TTWAs will record further modest increase in manufacturing employment. In order to stem the decline of manufacturing employment in TTWAs in Wales a number of options are open to policy-makers. First, to provide assistance (financial, managerial and marketing) to existing businesses in Wales to grow, or even to just retain their existing levels of manufacturing employment. Second, the attraction of mobile investment in terms of branch plants from the remainder of the U.K. and from overseas could be further continued in order to diversify the manufacturing bases of TTWAs as well as to create new manufacturing jobs. Third, there needs to be a further development of an 'enterprise culture' in Wales which will lead to the formation of successful new indigenous manufacturing firms. As the above analyses have indicated, a variety of TTWAs (especially in traditional urban and industrial south Wales) may have environmental conditions associated with them which are not conducive to entrepreneurship. Therefore, there is the continued need for agencies such as the WDA, MWD, British Steel (Industries) and NCB Enterprises Ltd and local authorities to remove some of the constraints on new firm formation and development in local

labour markets. For example, the situation could be improved by the provision of a wide range of premises (in terms of size) at low rental costs. Moreover, these agencies could be further encouraged to provide financial, managerial and marketing assistance and to promote the development of local 'networks' between entrepreneurs. Finally, this study of absolute and percentage manufacturing employment change has demonstrated the need for further detailed studies which would ultimately lead to a thorough understanding of all potential influences on the growth and decline of manufacturing employment in Wales.

### *Acknowledgements*

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**Table 1 Shift-Share Analysis of Employment Change in Wales by 1968 SIC, 1971-1981**

| SIC (1968) | Actual change | %      | Expected Change | %      | Differential Change | %      |
|------------|---------------|--------|-----------------|--------|---------------------|--------|
| 1          | -5,170        | -18.79 | -5,261          | -19.12 | 91                  | 0.33   |
| 2          | -13,977       | -28.32 | -7,229          | -14.65 | -6,748              | -13.67 |
| 3          | -677          | -3.47  | -3,144          | -16.11 | 2,467               | 12.64  |
| 4          | -177          | -3.17  | -1,904          | -34.09 | 1,727               | 30.92  |
| 5          | 1,375         | 9.40   | -1,068          | -7.30  | 2,443               | 16.70  |
| 6          | -50,647       | -56.54 | -37,635         | -42.01 | -13,012             | -14.53 |
| 7          | -6,336        | -22.51 | -7,286          | -25.88 | 950                 | 3.37   |
| 8          | -495          | -13.73 | -695            | -19.27 | 200                 | 5.54   |
| 9          | -2,534        | -8.16  | -4,748          | -15.29 | 2,214               | 7.13   |
| 10         | -217          | -16.63 | -304            | -23.30 | 87                  | 6.67   |
| 11         | 2,228         | 8.90   | -6,078          | -24.26 | 8,306               | 33.16  |
| 12         | -8,123        | -35.98 | -5,017          | -22.22 | -3,106              | -13.76 |
| 13         | -8,454        | -48.77 | -7,915          | -45.66 | -539                | -3.11  |
| 14         | -512          | -42.99 | -431            | -36.19 | -81                 | -6.80  |
| 15         | -4,459        | -29.59 | -5,597          | -37.14 | 1,138               | 7.55   |
| 16         | -1,792        | -17.68 | -2,872          | -28.34 | 1,080               | 10.66  |
| 17         | 221           | 2.84   | -1,387          | -17.85 | 1,606               | 20.69  |
| 18         | -1,061        | -8.44  | -1,687          | -13.42 | 626                 | 4.98   |
| 19         | -3,454        | -19.23 | -4,239          | -23.60 | 785                 | 4.37   |
| 20         | -12,792       | -18.75 | -6,383          | -9.36  | -6,409              | -9.39  |
| 21         | 329           | 1.65   | -1,582          | -7.96  | 1,911               | 9.61   |
| 22         | -7,675        | -12.20 | -5,014          | -7.97  | -2,661              | -4.23  |
| 23         | 3,418         | 3.58   | 5,741           | 6.01   | -2,323              | -2.43  |
| 24         | 9,025         | 38.83  | 8,096           | 34.84  | 929                 | 3.99   |
| 25         | 44,419        | 33.28  | 34,350          | 25.74  | 10,069              | 7.54   |
| 26         | 31,830        | 41.39  | 25,017          | 32.53  | 6,813               | 8.86   |
| 27         | 6,110         | 8.00   | 3,240           | 4.24   | 2,870               | 3.76   |
| Total      | -29,597       | -3.09  | -18,172         | -1.90  | -11,425             | -1.19  |

Source: Department of Employment, Watford, 1971 & 1981.

**Table 2** Factors Associated with Manufacturing Employment Change

| Factors   | Strength of Loading | Presumed Direction of Loading    |
|---|---------------------|----------------------------------|
| 1. Regional Space Preferences                           | High                | Positive                         |
| 2. Industrial Structure<br>Industrial Specialisation    | Favourable<br>High  | Positive<br>Positive or Negative |
| 3. Agglomeration Economies of<br>Manufacturing Activity | High                | Positive                         |
| Agglomeration Diseconomies of<br>Manufacturing activity | High                | Negative                         |
| 4. Labour Availability and Type:                        |                     |                                  |
| Managers and Professionals                              | High                | Positive                         |
| Foremen and Skilled Manua Workers                       | High                | Positive or Negative             |
| Unskilled Manual Workers                                | High                | Positive or Negative             |
| 5. Market Potential / Accessibility                     | High                | Positive                         |

Sources: Keeble (1976), Keeble and Hauser (1971, 1972) and Owen and Green (1984).



**Table 3 Descriptive Statistics**

| Surrogate Variables                              | Minimum | Maximum | Mean      | Standard Deviation | Coefficient of Variation |
|--|---------|---------|-----------|--------------------|--------------------------|
| Population Change (POPCHPC)                      | -10.18  | 21.33   | 4.33      | 6.83               | 157.91                   |
| Manufacturing Structural Shift (MFRSTSHPC)       | -16.09  | 8.14    | -1.93     | 6.00               | 311.64                   |
| Heavy Industry (HIMFRPC71)                       | 0.00    | 78.69   | 20.22     | 22.78              | 112.70                   |
| Specialisation (D71)                             | 0.51    | 2.41    | 1.69      | 0.45               | 26.52                    |
| Agglomeration (AGGLOM)                           | 0.00    | 1.10    | 0.25      | 0.34               | 137.14                   |
| Managers and Professionals (MANPROFPC71)         | 5.57    | 18.76   | 12.63     | 3.81               | 30.14                    |
| Foremen and Skilled Manual Workers (SKILLEDPC71) | 11.19   | 33.43   | 19.64     | 7.14               | 36.35                    |
| Unskilled Manual Workers (UNSKILLEDPC71)         | 3.56    | 11.74   | 7.30      | 1.91               | 26.21                    |
| Market Accessibility (ECONPOT)                   | 235766  | 384763  | 309891.90 | 49699.72           | 16.04                    |

**Table 4 Independent Variables: Intercorrelations**

| Independent Variables                                     | POPCHPC     | MFRSTSH<br>-PC | HIMFRPC<br>-71 | D71       | AGGLOM       | MANPRO<br>-F71 | SKILLED<br>-PC71 | UNSKILL<br>-EDPC71 | ECON-<br>-POT |
|---|-------------|----------------|----------------|-----------|--------------|----------------|------------------|--------------------|---------------|
| Population Change<br>(POPCHPC)                            | 1.00        |                |                |           |              |                |                  |                    |               |
| Manufacturing<br>Structural Shift<br>(MFRSTSHPC)          | 0.02        | 1.00           |                |           |              |                |                  |                    |               |
| Heavy Industry<br>(HIMFRPC71)                             | -0.11       | -0.54<br>***   | 1.00           |           |              |                |                  |                    |               |
| Specialisation<br>(D71)                                   | -0.01       | 0.06           | 0.07           | 1.00      |              |                |                  |                    |               |
| Agglomeration<br>(AGGLOM)                                 | -0.44<br>** | -0.24          | 0.39           | 0.38<br>* | 1.00         |                |                  |                    |               |
| Managers and<br>Professionals<br>(MANPROFPC71)            | 0.44<br>**  | 0.25           | -0.22          | -0.28     | -0.72<br>*** | 1.00           |                  |                    |               |
| Foremen and<br>Skilled Manual<br>Workers<br>(SKILLEDPC71) | -0.38<br>*  | -0.26          | 0.38<br>*      | 0.31      | 0.84<br>***  | -0.87<br>***   | 1.00             |                    |               |
| Unskilled Manual<br>Workers<br>(UNSKILLEDPC71)            | -0.28       | -0.47<br>***   | 0.50<br>***    | 0.24      | 0.64<br>***  | -0.64<br>***   | 0.68<br>***      | 1.00               |               |
| Market Accessibility<br>(ECONPOT)                         | -0.09       | -0.05          | 0.11           | 0.21      | 0.56<br>***  | -0.40<br>*     | 0.50<br>***      | 0.28               | 1.00          |

Notes:

- \* Significant at  $p < 0.05$ ;
- \*\* Significant at  $p < 0.01$ ;
- \*\*\* Significant at  $p < 0.001$ .

**Table 5 Regression Analysis of Absolute Change in Manufacturing Employment in TTWAs in Wales, 1971-1981**

| Independent Variables                            | Initial Model |         |       |         |
|--|---------------|---------|-------|---------|
|  | b             | SEb     | Beta  | t-Value |
| Population Change (POPCHPC)                      | 7.84          | 60.49   | 0.01  | 0.13    |
| Manufacturing Structural Shift (MFRSTSHPC)       | 26.85         | 73.26   | 0.04  | 0.37    |
| Heavy Industry (HIMFRPC71)                       | -37.48        | 20.21   | -0.22 | -1.86   |
| Specialisation (D71)                             | -547.00       | 854.92  | -0.06 | -0.64   |
| Agglomeration (AGGLOM)                           | -12151.08     | 2212.45 | -1.04 | -5.49   |
| Managers and Professionals (MFRSTSHPC)           | 88.24         | 196.65  | 0.09  | 0.45    |
| Foremen and Skilled Manual Workers (SKILLEDPC71) | 299.33        | 129.95  | 0.54  | 2.30    |
| Unskilled Manual Workers (UNSKILLEDPC71)         | -83.10        | 282.34  | -0.04 | -0.29   |
| Market Accessibility (ECONPOT)                   | -0.00         | 0.00    | -0.06 |         |
| (Constant)                                       | -2463.45      | 5587.68 |       | -0.44   |
| Multiple R                                       | 0.88          |         |       |         |
| R Squared  | 0.77          |         |       |         |
| Adjusted R Squared                               | 0.71          |         |       |         |
| F  | 11.46         |         |       |         |
| Standard Error                                   | 2127.07       |         |       |         |

| Independent Variables                            | Final Model |         |       |         |
|--|-------------|---------|-------|---------|
|  | b           | SEb     | Beta  | t-Value |
| Population Change (POPCHPC)                      |             |         |       |         |
| Manufacturing Structural Shift (MFRSTSHPC)       |             |         |       |         |
| Heavy Industry (HIMFRPC71)                       | -38.66      | 15.22   | -0.22 | -2.54   |
| Specialisation (D71)                             |             |         |       |         |
| Agglomeration (AGGLOM)                           | -12896.92   | 1770.83 | -1.10 | -7.28   |
| Managers and Professionals (MFRSTSHPC)           |             |         |       |         |
| Foremen and Skilled Manual Workers (SKILLEDPC71) | 239.87      | 82.81   | 0.44  | 2.90    |
| Unskilled Manual Workers (UNSKILLEDPC71)         |             |         |       |         |
| Market Accessibility (ECONPOT)                   |             |         |       |         |
| (Constant)                                       | -2877.86    | 1318.43 |       | -2.18   |
| Multiple R                                       | 0.87        |         |       |         |
| R Squared  | 0.77        |         |       |         |
| Adjusted R Squared                               | 0.75        |         |       |         |
| F  | 39.13       |         |       |         |
| Standard Error                                   | 1981.52     |         |       |         |

**Table 6 Regression Analysis of Percentage Change In Manufacturing Employment In TTWAs In Wales, 1971-1981**

| Independent Variables                            | Initial Model |        |       |         |
|--|---------------|--------|-------|---------|
|  | b             | SEb    | Beta  | t-Value |
| Population Change (POPCHPC)                      | 2.15          | 0.91   | 0.28  | 2.37    |
| Manufacturing Structural Shift (MFRSTSHPC)       | 2.11          | 1.17   | 0.24  | 1.81    |
| Heavy Industry (HIMFRPC71)                       | -0.66         | 0.32   | -0.29 | -2.06   |
| Specialisation (D71)                             | -1.04         | 14.93  | -0.00 | -0.07   |
| Agglomeration (AGGLOM)                           | -54.56        | 14.01  | -0.98 | -3.90   |
| Managers and Professionals (MFRSTSHPC)           | 4.84          | 3.22   | 0.35  | 1.50    |
| Foremen and Skilled Manual Workers (SKILLEDPC71) | 3.96          | 2.40   | 0.54  | 1.65    |
| Unskilled Manual Workers (UNSKILLEDPC71)         | 13.51         | 4.48   | 0.49  | 3.02    |
| Market Accessibility (ECONPOT)                   | 0.00          | 0.00   | 0.10  | 0.80    |
| (Constant)                                       | -323.25       | 115.50 |       | -2.80   |
| Multiple R                                       | 0.83          |        |       |         |
| R Squared  | 0.68          |        |       |         |
| Adjusted R Squared                               | 0.59          |        |       |         |
| F  | 7.17          |        |       |         |
| Standard Error                                   | 33.67         |        |       |         |

| Independent Variables                            | Final Model |       |       |         |
|--|-------------|-------|-------|---------|
|  | b           | SEb   | Beta  | t-Value |
| Population Change (POPCHPC)                      | 2.34        | 0.85  | 0.30  | 2.76    |
| Manufacturing Structural Shift (MFRSTSHPC)       | 2.16        | 1.15  | 0.25  | 1.88    |
| Heavy Industry (HIMFRPC71)                       | -0.58       | 0.31  | -0.25 | -1.88   |
| Specialisation (D71)                             |             |       |       |         |
| Agglomeration (AGGLOM)                           | -39.69      | 7.86  | -0.71 | -5.05   |
| Managers and Professionals (MFRSTSHPC)           |             |       |       |         |
| Foremen and Skilled Manual Workers (SKILLEDPC71) |             |       |       |         |
| Unskilled Manual Workers (UNSKILLEDPC71)         | 13.27       | 4.23  | 0.48  | 3.14    |
| Market Accessibility (ECONPOT)                   |             |       |       |         |
| (Constant)                                       | -135.06     | 37.73 |       | -3.58   |
| Multiple R                                       | 0.80        |       |       |         |
| R Squared  | 0.64        |       |       |         |
| Adjusted R Squared                               | 0.58        |       |       |         |
| F  | 11.96       |       |       |         |
| Standard Error                                   | 33.80       |       |       |         |

## Appendix 1 Study Variables, Title, Definition, Data Source and Initial Spatial Scale

### Dependent Variables:

|                |  |   |          |
|----------------|--|---|----------|
| <i>MFRCHA</i>  | Absolute Change in Employment in Manufacturing Industry, 1971-1981   | Department of Employment ERII, 1971 & 1981  | 40 TTWAs |
| <i>MFRCHPC</i> | Percentage Change in Employment in Manufacturing Industry, 1971-1981 | Department of Employment, ERII, 1971 & 1981 | 40 TTWAs |

### Independent Variables:

|                      |  |  |             |
|----------------------|--|--|-------------|
| <i>POPCHPC</i>       | Percentage Population Change, 1971-1981  | 1981 Census County Monitors                                      | 800 Wards   |
| <i>MFRSTSHPC</i>     | Percentage Manufacturing Employment Structural Shift, 1971-1981  | Department of Employment, ERII, 1971 & 1981                      | 40 TTWAs    |
| <i>HIMFRPC71</i>     | Percentage of Local Area Manufacturing Employees in 1971 in Heavy Industries (SIC's 4, 5, 6 & 10)                                  | Department of Employment, ERII, 1971                             | 40 TTWAs    |
| <i>D71</i>           | Manufacturing Employment Diversification Index, 1971   | Department of Employment, ERII, 1971                             | 40 TTWAs    |
| <i>AGGLOM</i>        | Agglomeration Economies and Diseconomies - Total 1971 Manufacturing Employment as a Proportion of Local Labour Market Area (h.a.)  | Department of Employment ERII, 1971; 1981 Census County Monitors | 800 Wards   |
| <i>MANPROFPC71</i>   | Total Number of Managers and Professionals, 1971 (SEGs 1, 2, 3, 4 & 13) as a Percentage of Total Persons Economically Active, 1971 | OPCS, 1971   | 1,342 Wards |
| <i>SKILLEDPC71</i>   | Total Number of Foremen and Skilled Manual Workers (SEG's 8 & 9) as a Percentage of Total Persons Economically Active, 1971        | OPCS, 1971   | 1,342 Wards |
| <i>UNSKILLEDPC71</i> | Total Number of Unskilled Manual Workers (SEG 11) as a Percentage of Total Persons Economically Active, 1971                       | OPCS, 1971   | 1,342 Wards |
| <i>ECONPOT</i>       | Economic Potential of a Local Area Based on 1971 Total Population  | OPCS, 1981   | 800 Wards   |