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NOTES AND COMMENTS

Accessibility and Urban Growth Rates: Evidence for the Irish Urban System

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I INTRODUCTION

Urban growth is a complicated process and any quantitative analysis is unlikely to replicate growth rates very well. This paper explores one particular relationship in the context of Irish urban centres, that between growth rates and accessibility to larger centres. That this is an important relationship is noted in a recent NESC study (O'Farrell, 1979). There it is suggested that with increased urbanisation "location relative to the range of external economies available in metropolitan centres becomes more important" (O'Farrell, 1979, p. 57) as a determinant of urban growth. The study further hypothesises that

> A smaller centre close to Dublin profits from greater external economies and from overspill effects (the greater the distance from Dublin the larger a centre has to be in order to attract labour and capital) so that the minimum size for successful growth depends partly upon a town's

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> location relative to other major centres. The greater the inter-urban (and inter-regional) connections of such a town, the better are its growth prospects for a given initial size (O'Farrell, 1979, p. 57).

Such hypotheses, however, have remained largely untested. There is, nevertheless, some statistical evidence on the growth performance of certain Irish towns. For example, Curtin *et al.* (1976) classified 97 towns on a growth index, specifically scores on a principal component, and concluded that for the period of analysis 1961-1971, there was a very definite pattern of growth associated with the development and spread of the main cities.

> These towns which have grown fastest and obtained all the benefits which we have demonstrated to be associated with growth are almost exclusively concentrated in the eastern half of the country. Even more significantly, of the top twenty towns, only three can be regarded as growing autonomously: Shannon, Naas and Arklow, and even then it is questionable whether Naas falls into the sphere of influence of Dublin or not. Of the remaining seventeen, fourteen are satellites of Dublin, one is a suburb of Cork, one a satellite of Drogheda and one a satellite of Waterford. At the other end of the scale, the towns that have shared least in the fruits of development are to be found, in general, in the western half of the country (Curtin, *et al.*, p. 63).

In a more recent paper (Hourihan, 1982), dealing with in-migration to Irish cities and towns 1970-71, the author also interprets much of the growth of towns along lines similar to Curtin *et al.* He also found that the towns identified as growing fastest and having the highest growth potential by Curtin *et al.*, also had the highest rate of in-migration.

The purpose of the present paper is to examine the relationship between urban growth rates and a measure of an urban centre's accessibility to major centres. Some theoretical considerations underlying this relationship are outlined in the following section. This is then followed by an empirical analysis of growth patterns for the two time periods 1961-71 and 1971-81. Population change is used to measure urban growth in each time period. In the final section these patterns of growth are discussed.

II THEORETICAL FRAMEWORK

A number of approaches to the structure and development of urban systems can be found in the literature. They include what Hansen (1977) describes as traditional approaches such as central place theory, regional input-output analysis and export-base analysis as well as growth-centre and related hierarchical diffusion models. Recent attention has been focused on the influence

of organisation decision-making linkages on growth processes within urban systems (Pred, 1976). According to this theory, urban system development is seen as a function of contact systems and information flows. Furthermore, the growth-transmission mechanisms do not necessarily correspond to the predictions of the earlier theories of hierarchical filtering and hinterland spread. Hansen (1977) describes the likely patterns whereby economic growth and innovation are diffused through the urban system:

> Growth inducing innovation linkages run not only from large cities to smaller cities, but also from large cities to even larger cities, from smaller to larger cities, and between cities of comparable size. Moreover, the most important non-local linkages are not those between a metropolis and its hinterland, as central place theory and growth centre theory concerning spread effects would have it, but rather they are those between large metropolitan complexes (p. 24).

Within this framework the major growth impulses influencing expansion in a given town, k, are through linkages between it and other towns in the national urban system or abroad and are not those between town k and its hinterland. It can be hypothesised that a town's growth should be positively related to the extent to which that town can interface with, and absorb, diffusion impulses. A measure of this possible interaction is provided through a centre's relative accessibility. A town with a high level of accessibility within the urban system has the potential to receive stronger growth and innovation impulses than a town characterised by a low level of accessibility. The differences in potential between towns should be reflected in their respective rates of growth.

Some qualifications to the conceptual framework just outlined may be needed in the context of the Irish urban system. There is no evidence available as to the underlying structure of growth-transmission interdependencies in Ireland. O'Farrell's working hypothesis is that

> . . . in the Irish context the extra-regional (and extra-national) interdependence of the major growth nodes such as Dublin and Cork, Limerick, Shannon, Waterford and Galway is likely to be considerable. The growing complexity of inter-urban relationships and multipliers is largely synonymous with the mounting variety of intermediate goods and services required by technologically advanced production processes. The future growth of urban centres (and regions) in Ireland is inextricably tied to the future forms and spatial linkages of private and public firms in addition to the locational patterns of new grant-aided plants which will themselves generate growth (O'Farrell, 1979, p. 74).

This is undoubtedly valid, particularly when it is borne in mind that:

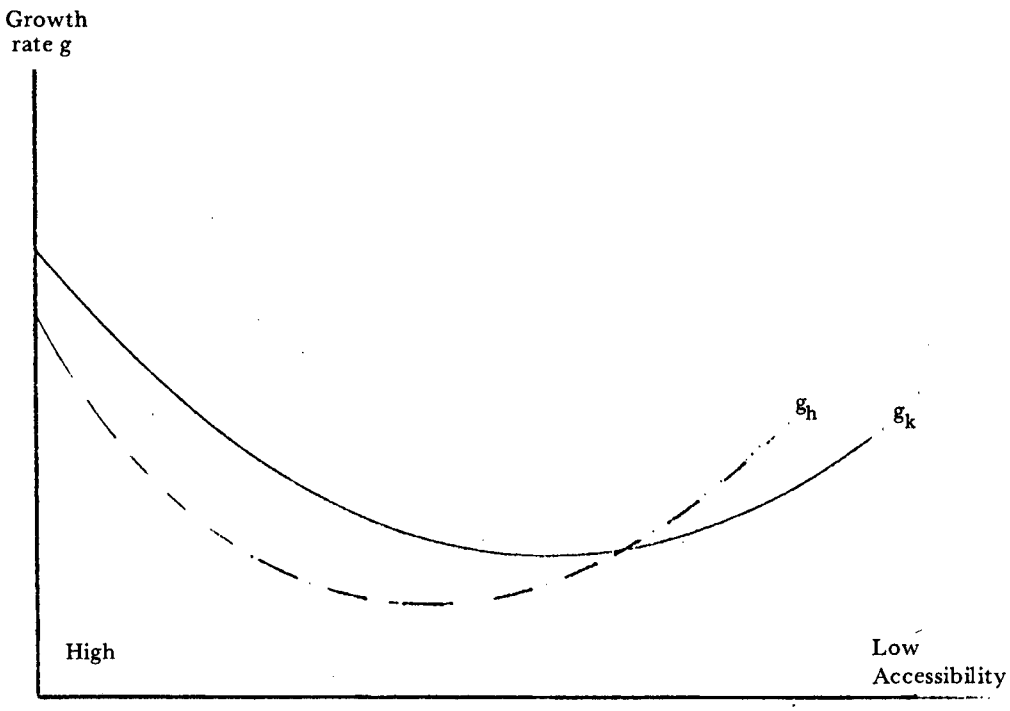
(i) much of the original empirical findings by Pred (1976) and others relate primarily to data for the amount of employment in other urban areas "controlled" by major industrial organisations from the urban areas where their respective organisational headquarters are located, and

(ii) these processes are increasingly international in character (Hansen, 1977).

For many of the smaller urban centres in Ireland where significant industrial/office growth has not taken place it is likely that the conceptual framework of central-place and growth-pole models provide important insights into the possible nature of spatial growth processes. Von Boventer (1970) presents a number of testable hypotheses which draw on a mixture of central-place theory and applied growth-pole analysis. His argument is that there are two important factors which, *ceteris paribus*, strengthen the viability and the growth potential of a given centre: agglomeration economies and the existence of an economically strong hinterland. The location of a town close to another (major) centre means that there are common agglomeration economies and positive overspill effects, but it also means that there is competition for customers and for the production factors of the areas surrounding the centres. On the other hand, at greater distances from all competing centres, there are obviously no common agglomeration economies with other centres but there is the possibility of autonomous growth through a monopoly of the hinterland and its mobile resources. The hypothesis, therefore, is that a given town has better growth prospects if it is either close by some vigorous bigger centres or far away from all competing centres and that there is some intermediate distance at which the town is "worst off". This "worst off" distance is the point where the combined effect of trickle down and hinterland advantage is weaker than at other distances so that at that point the growth potential of a town is worse than at other locations. If we define a given centre's, k's, accessibility as some function of the distance to all major centres we can describe its growth potential, g_k, as a function of its accessibility. The relationship is illustrated in Figure 1. One further refinement to this relationship is that the "worst off" distance may be smaller for a small town than for a bigger town (Von Boventer, 1970, p. 917). In the case of the smaller centre the major overspill effects are likely to occur in residential growth, the significance of which is likely to decline rapidly as distance increases. On the other hand, the competition for hinterland consumers and resources between smaller centres and major centres will not be that great so that a smaller centre can quickly (in terms of distance) encounter the necessary demand thresholds necessary to support a given range of service activities which in turn will help it grow. For bigger centres the overspill effects are likely to be more general and more widely diffused. However, the com-

petition for customers and resources with major centres is likely to be more intense with the result that greater distances are necessary before the drawing power of the major centres is weakened sufficiently. The relationship between growth rates and accessibility for a smaller town, $h < k$, is illustrated by the dotted line in Figure 1.

Figure 1: *Growth as a function of accessibility*



From the various conceptual frameworks discussed in this section, a generalised relationship between growth and accessibility, as depicted in Figure 1, is hypothesised and tested in the following section of the paper.

III EMPIRICAL ANALYSIS

The function relationship to be examined is

$$g_k = f(A_k) \qquad (1)$$

where g_k = the rate of growth of centre k
A_k = the accessibility of k to major centres.

The centres used in the analysis consist of the 114 cities and towns which had a population of 1,500 or more in 1971. These centres are divided into major centres, defined as all centres with a population of 10,000 or more, and ordinary centres which are in turn further sub-divided into three size categories. There were 17 major centres and their names and population in 1971 are given in Table 1. The size categories used to classify ordinary centres and the number of centres in each size category are summarised in Table 2.

The seventeen centres in Table 1 include all the national and regional growth centres identified in Buchanan (1969). This growth centre strategy has never been fully accepted in policies related to the spatial distribution of economic activity in Ireland (see Ross (1978) and Walsh (1976)). The

Table 1: *Major urban centres in order of their 1971 population*

Centre and rank	*Population*	*Centre and rank*	*Population*
1. Dublin City Borough*	660,617	10. Sligo*	14,011
2. Cork*	129,893	11. Wexford	12,892
3. Dun Laoghaire	94,763	12. Kilkenny	12,738
4. Limerick*	60,908	13. Tralee*	12,729
5. Waterford*	32,598	14. Clonmel	11,914
6. Galway*	27,513	15. Athlone*	11,387
7. Dundalk*	23,175	16. Ennis	10,577
8. Drogheda*	19,407	17. Carlow	10,164
9. Bray	15,391		

*Designated as a growth centre, Buchanan (1969).
Source: Census of Population of Ireland, Volume I.

Table 2: *Size categories of ordinary centres and number of centres in each category*

Size (Population)	*Number of centres*
5,000-10,000	24
3,000- 5,000	28*
1,500- 3,000	43**
Total	95

*One centre in this size category, Shannon, is excluded because of the "planned" nature of growth.
**One centre, Templemore, is excluded because of possible distortions in its growth performance due to the presence of a major police training facility in that town.

choice of centres to which accessibility is measured is based on a simple definition of major centres based on size without any attempt to discuss whether they are growth centres or not. There is obviously a certain degree of arbitrariness in relating the growth rate of a given lower order centre to its accessibility to a selected number of large centres. Perhaps the most satisfactory analysis would be to investigate the relationship between the growth rate of a given centre and its accessibility to all higher ordered centres (Fotheringham, 1979), or maybe in the Irish context, accessibility to Dublin only, given its dominant position within the Irish urban system.

The generally accepted measure with which to approximate growth is percentage population change. Burns (1982) in a review of two recent studies (Van den Berg *et al*, 1982; Hall and Hay, 1980), of urban growth describes the use of population data by the authors as being less than satisfactory. He considers migration data as a much more suitable proxy measure arguing that [migration] "acts as a proxy for perceived inter-regional welfare differences and changes. Thus population movements are assumed to reflect perception of regional welfare levels and the opportunities for betterment" (p. 1,619). Irish migration data suffer from several shortcomings. The most recent published data on migration are found in the 1971 Census of Population, Vol. XI. The Census provides information on migration patterns by tabulating the one year moves within Ireland for 1970-71. These migration data are available for each of the 114 cities and towns in the analysis. Four separate moves are distinguished in the data: those who migrated to a given centre in 1970-71 from (a) a different address in the same centre, (b) elsewhere in the county, (c) another county and (d) from outside the state. There are no data on out-migration from each centre so it is not possible to measure net migration. Furthermore, the published data are for a very short time span – one year moves – and may not be representative of trends over longer time periods. It can also be argued that some in-migration may have been due to the movement of retirement-age people. These movements will have had little to do with employment growth in a given centre. These shortcomings, which would also apply to the 1981 Census data, make the use of published migration data less than satisfactory. Population change is, as one user states, "useful as a composite index of growth because it takes into account changes in other possible indices such as employment growth, retail sales growth and services industry growth" (Fotheringham, 1979). The percentage change in population for each centre is used here to represent growth in each centre.

Accessibility of a centre k has been defined earlier as some function of ks distance from all major centres. The measure of accessibility adopted is that found in Fotheringham (1979).

$$A_k = \sum_{j=1}^{m} P_j d_{kj}^{-n} \qquad (2)$$

where A_k is the accessibility measure of centre k
P_j is the population of the major centre j
m is the number of major centres
n is a spatial polarisation parameter
d_{kj} is the distance between k and j calculated as the straight line distance between k and j.

In Equation (2) distances are weighted by the population of the major centres, the P_js. The rationale for this is that if an ordinary centre happens to be equidistant from, say, Dublin and Limerick, then its growth would be influenced more by growth effects from Dublin than from Limerick. Without the population weights this phenomenon would not be captured within the accessibility term.

One further problem in the measurement of accessibility is the estimation of the distance exponent in (2). This is an empirical problem, as there is no particular theoretical justification for using one particular value for the exponent over another (Keeble *et al.*, 1982, Love and Moryadas, 1975). The objective is to seek a value which will provide the best fit between, in this instance, growth rates and distance from a set of major centres. Fotheringham (1979) suggests a range of eight possible values for the distance exponent giving eight different accessibility terms, $A_{0.3}$, $A_{0.5}$, $A_{1.0}$, $A_{1.5}$, $A_{2.0}$, $A_{2.5}$, $A_{3.0}$ and $A_{3.5}$ where the subscripts on the As represent the value given to the exponent on distance. Ascribing any particular value for the exponent amounts to magnifying or lessening the impact of distance in the calculation of accessibility. A low value, i.e., 0.5, defines an accessibility term which implies that as distance from major centres increases accessibility declines slowly (because of the low weighting on distances). A much higher value for the distance exponent, i.e., 3.5, gives a pattern where accessibility decreases very rapidly as distance from major centres increases. Here we follow Fotheringham's example by computing eight different accessibility terms.

Prior to any regression analysis the accessibility terms are transformed via Equation (3)

$$D_i^k = \frac{\max A_i}{A_i^k} - 1 \qquad (3)$$

where A_i^k is the value of the accessibility term, calculated with distance exponent i, for the kth ordinary centre, and max A_i is the maximum value which the accessibility term has in the entire urban system. All major centres

are included for the purposes of deriving max A_i. This creates a problem in that for any major centre the accessibility terms would theoretically be infinity since distance, d_{jj}, j = 1 . . . . . 17, would be zero. In practical terms distances never become zero, and d_{jj} is given a value of one. There are eight different values for max A_i reflecting the eight different distance exponents. Similarly, eight D_i^k values are derived via Equation 3. The purpose of transforming the accessibility terms was simply to facilitate the presentation or interpretation of the regression results. The D_i^k values lie in the range $0 \leqslant D_i^k \leqslant \alpha$ and thus provide a framework whereby high accessibility implies small distance and so on.

IV REGRESSION RESULTS

Stepwise multiple regressions between population growth rates and the eight distance measures were run for each size category of urban centre in each of the two time periods, 1961-71 and 1971-81. This was done to identify which particular distance measure would provide the best fit for urban growth rates. Having identified the most suitable distance measure, second and third degree polynomials in the distance measure were estimated. These latter results are summarised in Table 3. In all the regressions, and for both time periods, the computed distance variable D_1, i.e., using the first distance exponent 0.3, provides the best fit. The superiority of the D_1 measure indicates that, for the urban system, accessibility declines slowly as distance from major centres increases. This distance variable enters all equations with a negative sign implying that as distance from major centres increases growth decreases at a fairly rapid rate. For small and middle-sized centres, 1,500-3,000 and 3,000-5,000 population range respectively, the distance terms in a second degree polynomial proved significant in the 1961-71 period regression equation. In the 1961-71 regression equation for large centres, 5,000-10,000 population range, all the distance terms in a third degree polynomial are significant. The relationship between growth rate and accessibility 1961-71 is shown in Figure 2a. Figure 2a illustrates the existence of some "worst off" distances but contrary to the hypothesis this "worst off" distance is shown to be largest for the small-sized centres. The presence of a significant third term in the regression equation for large centres, while not hypothesised *a priori*, can be interpreted along the lines suggested by Von Boventer (1970). Beyond the "worst off" distance it was hypothesised that a centre had the possibility of achieving autonomous growth through its potential monopoly of the hinterland and its mobile resources. However, as Von Boventer suggests "if the centre is too small, it may not be able to develop as a viable centre in spite of a large hinterland" (p. 917). Therefore, one might expect that the function depicted in

Table 3: *Regression results*

Size of centre	*Dependent variable*	*Estimated equation*	
Small Centres (1,500-3,000 pop.) n = 44	Percentage Population change 1961-71	$655.53 - 631.95D_1 + 152.09D_1^2$ (- 3.59) (2.88)	$R^2 = .44$
Middle Centres (3,000-5,000 pop.) n = 28	Percentage Population change 1961-71	$240.30 - 240.68D_1 + 61.20D_1^2$ (-5.83) (4.53)	$R^2 = .73$
Large Centres (5,000-10,000 pop.) n = 24	Percentage Population change 1961-71	$802.58 - 1271.56D_1 + 672.74D_1^2 - 116.88D_1^3$ (-2.82) (2.16) (-1.76)*	$R^2 = .70$
Small Centres n = 44	Percentage Population change 1971-81	$1431.07 - 2420.78D_1 + 1355.48D_1^2 - 247.55D_1^3$ (-3.87) (3.41) (-3.19)	$R^2 = .53$
Middle Centres n = 27**	Percentage Population change 1971-81	$745.54 - 1163.17D_1 + 611.34D_1^2 - 105.64D_1^3$ (-5.48) (4.43) (-3.73)	$R^2 = .88$
Large Centres n = 22**	Percentage Population change 1971-81	$369.42 - 365.25D_1 + 93.01D_1^2$ (-7.44) (6.92)	$R^2 = .78$

t values in parentheses are all significant at the .005 level, ( ) significant at the .05 level.

**One middle-size centre and two large centres were enumerated as part of the Greater Dublin Area in the 1981 Census of Population.

Figure 2a: *Patterns of growth 1961-71*

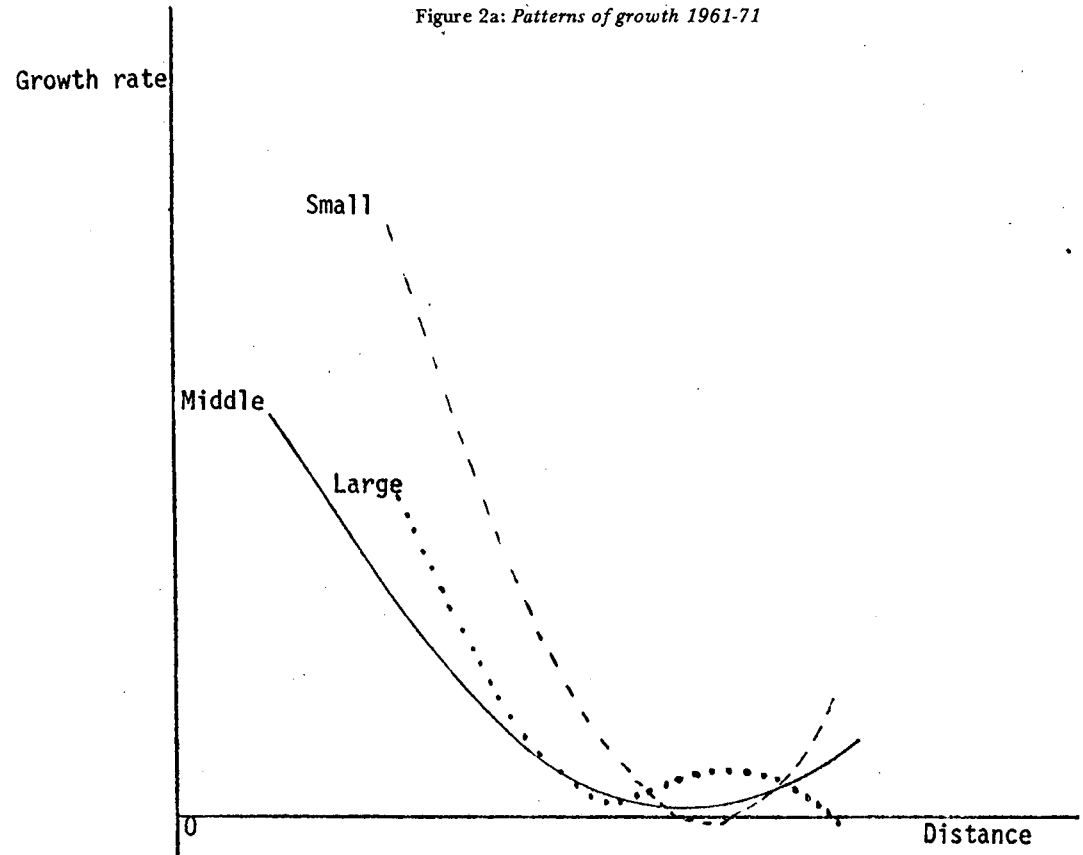


Figure 2b: *Patterns of growth 1971-81*

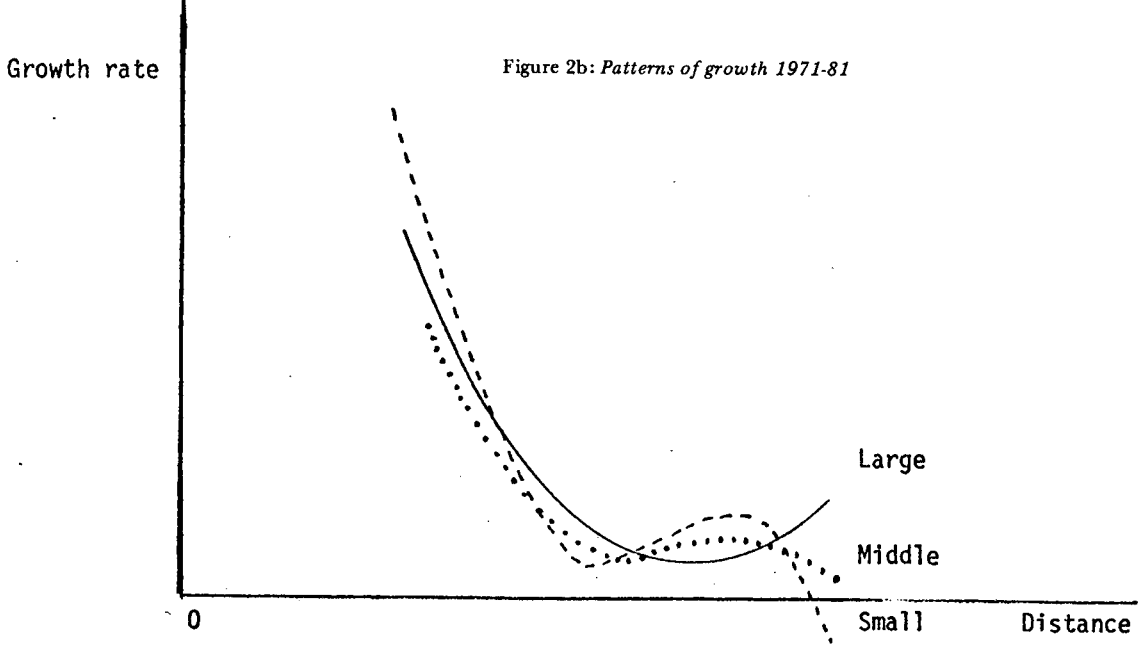


Figure 1 bends down again after a certain distance has been surpassed. This pattern of growth is reflected on the regression results for the large-sized centres. In general, the 1961-71 patterns indicate that growth rates are sensitive to proximity to major centres with middle size centres being the least subjected to this strong polarisation influence.

For the period 1971-81 the growth patterns are different. The "worst-off" distances are as hypothesised (see Figure 2b). For both small and middle--sized centres all the terms in a third degree polynomial are significant. Growth rates are still strongly influenced by accessibility to major centres but beyond the "worst off" distances both small and middle-sized centres do exhibit increasing rates of growth. However, this autonomous growth is weak and as distance continues to increase growth rates begin to decline. Large centres, on the other hand, are capable of achieving this autonomous growth once the "worst off" distance has been surpassed. The patterns for the period 1971-81, compared to 1961-71, suggest that all categories of centre have succeeded in achieving some autonomous growth in spite of the continued polarisation in the proximity of the major centres. This spreading of growth presumably reflects, to some extent, the type of spatial investment strategies pursued during the 1971-81 period. These spatial policies are identified and discussed in the concluding section.

V CONCLUSIONS

The growth centre idea was dominant in Irish regional policy during the 1960s as indeed it was in most capitalist economies where strategies for the development of depressed regions were being discussed. The idea as it was used in Ireland conceived the growth centre as a geographical clustering of economic activities in an urban area. The policy implication of such a definition is that some spatial concentration of economic activities is favoured on the grounds that such a strategy is more efficient and also more conducive to growth than a strategy of dispersal (O'Farrell, 1979, and Richardson, 1978). A further assumption is that growth impulses are diffused outwards from one or more of the growth centres to all of the smaller centres. The policy debate reached a critical stage in Ireland in 1969 with the publication of what has become known as the Buchanan Report (1969). This report, commissioned by the national government, proposed a regional planning policy that was to be based on a hierarchy of growth centres. These recommendations were endorsed by many bodies and by the government's own advisory agency of that time, the National Industrial Economic Council (Walsh, 1976). The government, however, decided against taking any action and by default continued with a policy aimed at "an overall regional strategy" (Industrial Development Authority, 1972). Irish regional policy since 1970

has tended to follow what Ross (1978) describes as "an evolutionary incremental and experimental approach in an area where there has been little conclusive evidence of the most appropriate strategy" (p. 301).

Apart from the obvious political criticisms, Buchanan also came under a good deal of criticism from planners and academics on the grounds that the proposed strategy lacked a theoretical and empirical justification. This paper has sought to throw some light on one critical issue, the extent to which growth is affected by distance from major urban centres in the Irish economy. The major centres included in the analysis embrace all of those designated as growth centres by Buchanan with the exception of three local growth centres. The evidence indicates that growth impulses weaken very rapidly as distance from major centres increases. This result suggests that a regional planning strategy based on growth centres and anticipated spread effects is unlikely to be successful. It supports O'Farrell's conclusion that "spectacular results are unlikely beyond the journey-to-work zone of the growth centre" (O'Farrell, 1979, p. 74). On the other hand, the 1971-81 patterns of growth do provide some support for the type of spatial policies pursued during this period. The policies, reflected primarily in Industrial Development Authority industrial plans, have sought to promote a more even spread of economic growth through essentially a dispersal of new industry. The 1971-81 patterns indicate that some autonomous growth has taken place particularly in small and middle-sized centres. This spread of growth has taken place despite the polarisation influence of the major centres.

The processes of growth and change in the urban/regional system are obviously very complex and at best only partially understood. The relationships discussed in this paper do no more than model one aspect of the pattern of population change which is the outcome of a complex set of processes. They are important relationships in the context of growth transmission mechanisms in the Irish urban system. O'Farrell (1979) in his policy study elaborates on what he calls the fundamental relationship between regional growth and modern growth centre concepts as one where it is the linkages within and between urban centres and not relationships between growth centre and hinterland which are key processes underlying the spatial structure of the economy. This so-called fundamental relationship was only partially tested in this paper which only considered the relationship between the growth of ordinary centres (measured by population change) and their proximity to a set of major centres. As such, the relationship tested was more than simply that of growth centre and hinterland. A complete test would presumably consider the accessibility of a given centre of order n to all higher ordered centres. Thus, the growth rate of a small centre would be influenced by proximity to all middle-sized, large and major centres and so on up to large centres where growth would be influenced by proximity to

major centres only. The high R^2 value obtained for middle-sized centres over small centres in Table 3 is one indication of this more complete relationship. High R^2 values were also obtained for large centres. The role of autonomous factors in explaining growth, in addition to its location in the urban system, is presumably more significant in the case of such large centres than is the case for middle-sized centres.

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