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Reprint No. 103

Reprinted from
Papers of the Regional Science Association, Vol. 31, 1973

TWELFTH EUROPEAN CONGRESS OF THE REGIONAL SCIENCE ASSOCIATION

INTRAURBAN LOCATION AND THE NEW PLANT

by Gordon C. Cameron*

1. INTRODUCTION

In a stimulating unpublished paper which reviewed recent theories of urban workplace location, Foster [3] stated: "The conclusion to be drawn from this is not simply that cities are on the march centrifugally but towards a pattern in which the idea of a city centre loses meaning . . . Modern city road systems annihilate the importance of distance within urban areas so that it really hardly matters where anything stands in relation to anything else. Hence the random pattern of new development submerges the old centripetal pattern which is becoming an irrelevant accident of history." There is no doubt that the main force behind the central clustering of manufacturing activity in cities which grew during the nineteenth and early twentieth centuries was the desire to minimize the costs of moving raw materials, semi-finished goods and finished products; see Moses and Williamson [6]. Given the then existing intraurban transport technology (mainly horse-drawn and hand-drawn carts) the costs of movement rose sharply with increased distance from the core. Accordingly, the rent gradient was very steep. However, with the introduction of motor vehicles and improved road systems these friction costs were reduced and some manufacturing plants were able to operate outside of the central cores where rental costs were lower. The implication of Foster's summary is that with the further development of road systems, and (presumably) other forms of person-to-person communication, urban land is becoming increasingly homogenous with respect to its input-output characteristics. It follows that new activities, which are unconstrained by the inertial forces which tie older plants to

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their existing locations, are certain to avoid high-rent central areas. Instead, they will disperse in a random fashion throughout the metropolitan area. The ensuing locational pattern is rather like a volcano in which the center of the core is gradually eroded and the slopes flatten into an almost featureless plain. This paper uses data and some simple statistical tests to evaluate this thesis of the locational randomness of new manufacturing development between 1958 and 1968 in one core-dominated British conurbation—Clydeside.[1]

2. THE EXISTING PATTERN

The tests used in this paper assume certain facts about the urban land, property and labor markets on Clydeside and particularly about the reasons for the existing pattern of industrial location in that conurbation. The first assumption is that the rent gradient peaks within the Central Business District (CBD) and falls with increased distance from the CBD. The gradient is not continuous but has smaller peaks in sub-centers within the conurbation. Given these conditions, and a specified level of output, each manufacturing establishment is assumed to search for a location (and a position on the rent gradient) which maximizes the difference between costs and revenues. These calculations do not include the supply price of capital or of labor which are assumed invariant with urban space. Furthermore, no individual establishment is able, on its own, to alter the supply price of a given unit of space. Accordingly, the bid price schedule[2] of each establishment is determined by its production function and the extent to which costs and revenue are influenced by access to material and service inputs and final markets.[3] Given these conditions, manufacturing establishments spread themselves throughout the conurbation and four major locational types can be identified.[4]

a) Central Cluster: in industries (and establishments) which are clustered close to the CBD, high rentals have to be paid if the advantages of the cluster are to be reaped; see Hoover [4; pp. 77–86]. Revenue is dependent

[1]The Clydeside conurbation is in West Central Scotland. It has a population of 1.7 million (1971) and a manufactoring labor force of over 300,000. The Census of Population defines it as Glasgow County of City, Dunbarton County (part), Clydebank L.B., Bearsden S.B., Kirkintilloch S.B., Milngavie S.B., Lanark County (part), Airdrie L.B., Coatbridge L.B., Hamilton L.B., Motherwell and Wishaw L.B., Rutherglen L.B., Bishopbriggs S.B., East Kilbride S.B., No. 6 D.C., No. 8 D.C., No. 9 D.C., Renfrew County (part), Paisley L.B., Barrhead S.B., Johnstone S.B., Renfrew S.B. First D.C., Second D.C. We have included the New Town of Cumbernauld in the area of the conurbation. The approximate dimensions of the area covered by the study are 50 kilometers from west to east and 30 kilometers from north to south.

[2]The notion was first introduced by Alonso [1].

[3]The best theoretical explanation of how these variables affect manufacturing location decisions is provided by Mills [5].

[4]This follows the distinction made by Chinitz [2].

upon face-to-face contact and falls off sharply outside of the cluster. Output type varies constantly so that internal economies of scale and establishment size are limited. Total costs are kept low partly because of fierce competition but also because of the intensive use of high-rent space[5] and the external economies associated with close access to specialist suppliers (cluster economies) as well as to a pool of experienced labor and other urban services (urbanization economies); see Figure 1.

b) Decentralized Cluster: in industries which buy most of their material inputs and sell most of their products outside of the conurbation, revenue

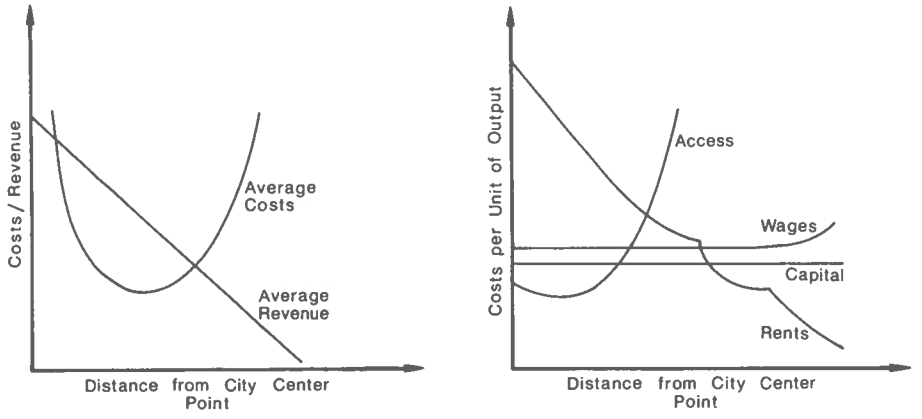


FIGURE 1

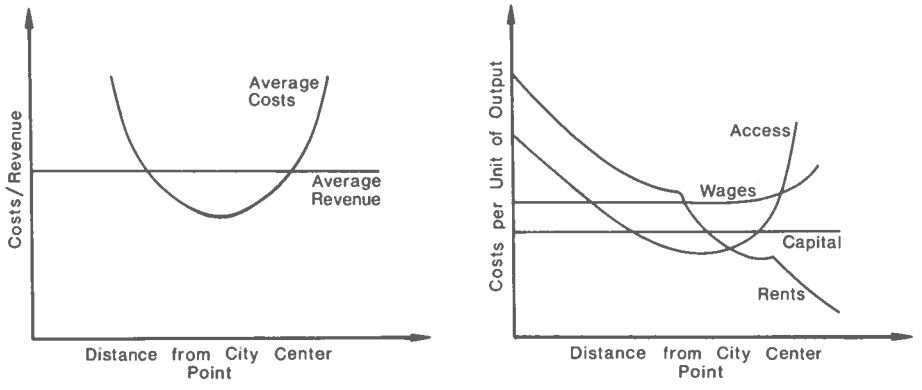


FIGURE 2

[5] In such locales, manufacturers are competing against other users such as commercial services with low land-to-output ratios.

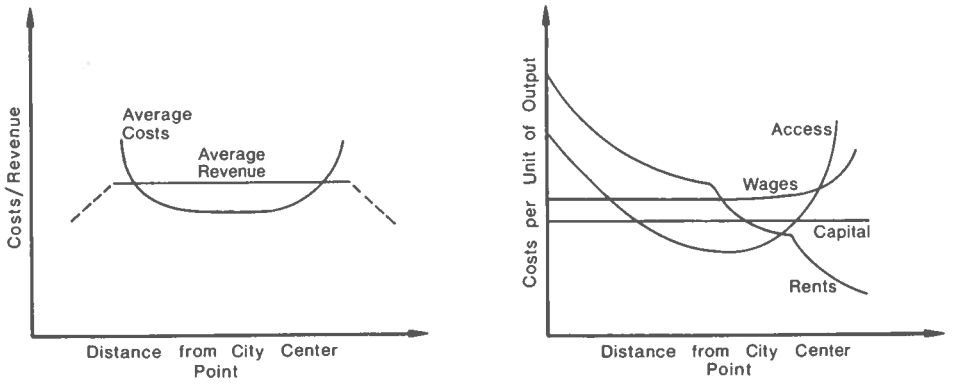


FIGURE 3

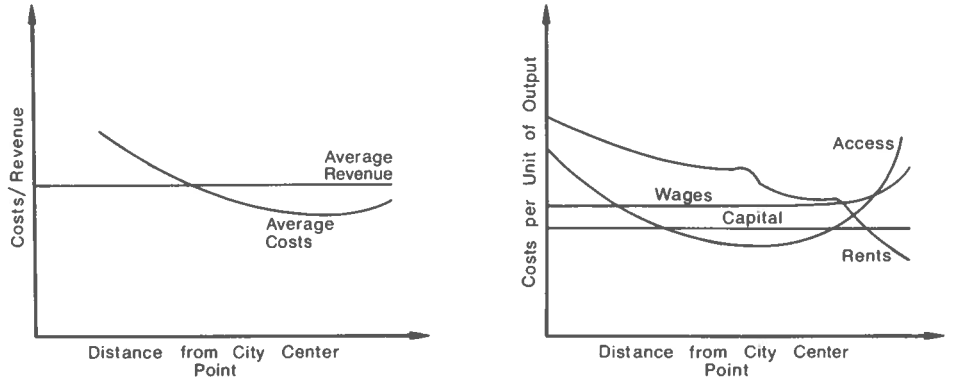


FIGURE 4

does not vary with intraurban location but transport and communication costs are minimized close to non-central transport facilities such as container terminals and interurban motorway entry points. Such plants form a decentralized sectoral cluster, not for reasons of access to each other but because of input-output access to the rest of the world; see Figure 2.

c) Random Spread: in industries with markets which extend to parts or the whole of the conurbation, but with costs of access to the dense range of central core suppliers either insignificant or invariant with space, a decentralized pattern emerges, with actual siting depending largely on considerations of access to labor and final markets; see Figure 3.

d) Peripheral: in industries with non-local markets and a production technology with a high land-output ratio, a decentralized pattern emerges with development occurring at the rural-urban margin; see Figure 4.

3. LOCATION AND GROWTH

Given these conditions what are the likely effects on the overall spatial distribution of manufacturing activity within the conurbation of a growth on the demand for the products of existing conurbation industry? In the short run, profits will rise and output may increase *in situ* as variable factors are added to the fixed plant capacity. After a point, however, marginal and then average unit costs will rise, so that capacity extensions are contemplated. At this point the options open to the firm are likely to be: a) plant extension *in situ* vertically and/or horizontally; b) branch development at a new site; c) closure *in situ* and transfer of activities to a new site. For any given establishment the choice of one of these options will depend upon a host of factors. The most important considerations are likely to be whether revenue is invariant with urban space, and on the cost side the degree of interrelatedness of the production processes in the existing plant and in the new capacity; building costs or rental costs at the existing locale and elsewhere; the costs of managerial and supervisory control; the costs of manning up and (in the British context) the ease or otherwise of obtaining planning permission.[6]

Over any period of time an existing industry, which is growing, will expand its capacity by using all of the three options of branch development elsewhere, closure and transfer elsewhere and *in situ* extensions. In general, however, the more the existing industry location pattern is replicated by the new decisions, the more it is likely that the factors causing that pattern to emerge in the first place are still operative. In addition to expansions by existing companies, the rise in profits will induce new companies to enter the market. Here the decision is unlikely to be constrained by questions of managerial control, by the need for relating production processes and by existing supply relationships. Thus this type of location decision may be especially crucial to an understanding of any new factors affecting the locational pattern. Once again, we can assume that if the existing pattern in any given industry tends to be replicated by the new decisions, then it suggests that the same complex of factors, which originally caused that pattern to emerge, are still at work.

4. SOME HYPOTHESES

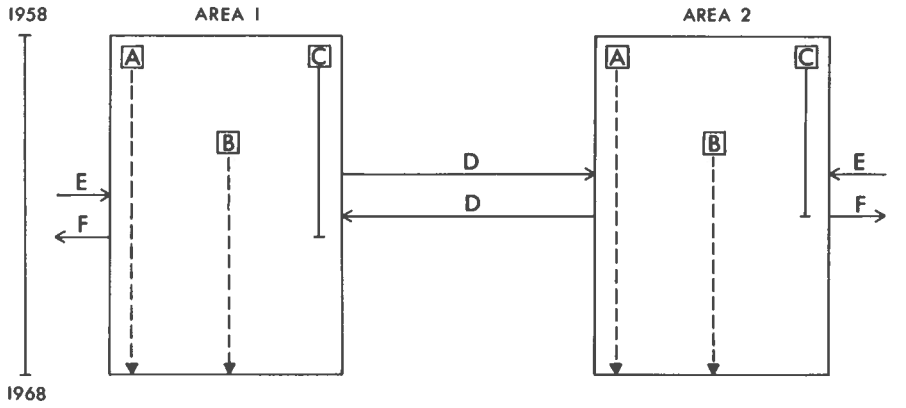
Under conditions in which intraurban distance becomes largely irrelevant to efficient operation we might expect: a) a gradual disappearance of the dense cluster of plants in high-value land surrounding the CBD, as existing plants migrate out and new plants avoid central locations; b) a random dispersal throughout the conurbation of new plants but with

[6] All plant extensions require local planning authority permission.

some sectoral clustering on the "trade" side; c) a considerable increase in the average distance between plants in any given industry and especially in those industries which were originally centrally clustered. Each of these hypotheses will be examined in subsequent sections.

5. THE DATA

As part of a study of the locational dynamics of the conurbation in the period between 1958 and 1968, data have been collected on every manufacturing[7] establishment which employed more than five employees and was in existence at some time during these years. The data register, which locates each establishment to the level of a 100 meter grid-square, records all intraurban establishment transfers,[8] all transfers out of the conurbation and all transfers into the area. It also records the initial location and subsequent locational shifts of all newly-formed companies and of branch and headquarter developments by conurbation and non-conurbation companies. All establishments which closed are recorded at the date and location



A = Non-moving establishments in business, 1958–1968
B = Births (conurbation companies, rest of world companies)
C = Deaths (closures)
D = Intra-conurbation movements (transfers and branches)
E = In-migrants with closure elsewhere
F = Out-migrants with conurbation closure

FIGURE 5

[7]The stress on manufacturing is crucial. We have deliberately excluded those offices and warehouses associated with manufacturing enterprises but locationally separate from such enterprises. Thus the data relate only to plants where manufacturing actually occurs.

[8]A transfer means a closure of the existing plant and a movement to a new location.

of the closure. Finally, all establishments are classified in terms of ownership, employment size, male/female employment ratios and (minimum list heading) product. Figure 5 illustrates the nature of the data set. For the purpose of this paper, we have defined new development to embrace the location decisions of 526 establishments. These decisions do not include *in situ* expansions for which there is no readily available data source; nor do they include transfers. However, they cover the 110 companies which established branches within the conurbation at sites different from the location of the "parent company." These parent companies include those sited in the conurbation and also companies from the rest of the world. In addition, 353 establishments were started by entirely new companies and 19 already existing companies established headquarters plants within the conurbation. This gives a total of 526 establishment decisions;[9] see Table 1. The vast

TABLE 1. New Developments 1958–1968

Branch Developments	154
of which Conurbation Companies	(44)
other U.K. Companies	(110)
New Companies	353
Headquarter Establishments	19
Total	526

TABLE 2. Typical Employment Size of all New Establishments

Size Group (Employees)	Establishments (Number)	Establishments (Percentage)
5–9	123	23.4
10–24	196	37.3
25–49	94	17.9
50–99	53	10.1
100–249	36	6.8
250–499	14	2.7
500–999	4	0.8
1,000–4,999	6	1.1
Total	526	100.0[a]

[a] Percentage total has been rounded to 100.

majority of these plants employed a very small labor force. For example, with each establishment grouped according to its most typical employment

[9] This total varies according to whether the 1958 or 1968 Standard Industrial Classification (SIC) is used. The 1968 SIC gives a figure of 526 establishment decisions but the 1958 SIC is more restrictive in its definition of manufacturing so that the total is only 519.

size over the period of its life on the register, 60 per cent by number employed less than 25 people, and almost 80 per cent had less than 50 employees; see Table 2. Given the refined degree of the location grid (100 meters square), it is possible to present these data on establishments in a very large number of spatial units. Experiments with different areal presentations suggest, however, that the most realistic picture is as follows: the central city of Glasgow (CC) which is broken down into eight one-kilometer rings and is centered on a point where the densest cluster of establishments occurs; a grouping of old and new sub-centers (SC) outside the central city, once again broken down into three one-kilometer rings; and finally, four non-urban quadrants (NUQ)[10] at the margin of the built-up area; see Figure 6.

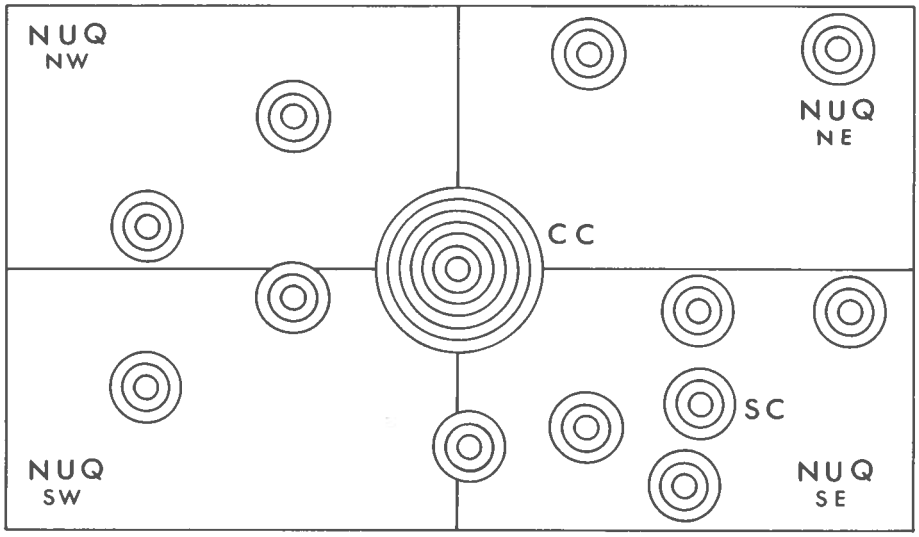


FIGURE 6

6. SOME BASIC FACTS

The starting point of the analysis is the distribution of all plants (2,492) by area as of January 1, 1958 and then again at the end of 1968, as indicated in Table 3. This highlights some critical locational features. In 1958 the most obvious fact was the heavy concentration of plants within the central city where three out of every four plants were sited. Within this area an especially dense concentration of activity occurred in and around the core. Indeed, no less than one out of every four plants in the conurbation as a whole was sited within one kilometer of the center point and two thirds

[10]The use of non-urban is perhaps misleading but no separate area with a labor force of more than 10,000 is located within these quadrants.

TABLE 3. Establishments by Rings, 1958 and 1968

Area	Stock 1958	Stock 1968	1958–1968 Change
Central City			
Ring 1	576	427	−149
Ring 2	429	314	−115
Ring 3	239	246	+7
Ring 4	180	151	−29
Ring 5	127	122	−5
Ring 6	88	91	+3
Ring 7	117	144	+27
Ring 8	98	88	−10
Sub-Total	1,854	1,583	−271
Sub-Centers			
Ring 1	244	240	−4
Ring 2	134	171	+37
Ring 3	8	9	+1
Sub-Total	386	420	+34
Non-Urban Quadrants			
N.E.	19	42	+23
N.W.	65	70	+5
S.W.	27	22	−5
S.E.	141	174	+33
Sub-Total	252	308	+56
Total	2,492	2,311	−181

were located within five kilometers.[11] Outside of the central city, the only relatively heavy concentrations of activity were in the inner cores of the sub-centers. Very little activity occurred in the non-urban quadrants; there, only one out of every ten plants was sited. By 1968, the picture had changed to a certain extent. As a whole, the number of plants had fallen by 181, or eight per cent. The most marked reduction occurred in the two most central rings (up to two kilometers) where a quarter (254) of the total disappeared. In the rest of the central city, however, some rings made gains and some made small losses, with the overall picture one of numerical stability. Elsewhere, the sub-centers and three of the non-urban quadrants increased their share both absolutely and relatively, with especially marked gains occurring in East Kilbride, one of the two New Towns within the

[11] It is obvious that this analysis does not refer to the *density* of plants per square kilometer, since the surface area of each kilometer ring increases with distance from the center.

conurbation,[12] and in the N.E. and S.E. quadrants. In particular, the S.E. quadrant, which is on the main trading axis between Glasgow and the south, showed particularly strong absolute and relative gains.

The overall picture, then, is of a fairly sharp reduction in the peak of the core, and of a gradual heightening of the slopes. The components of these overall changes in the areal distribution of plants are complex, involving the births, deaths and inter-area migrations of establishments. However, the pattern of "new" locations was particularly interesting and significant. Table 4 shows that whereas an average of seven out of every

TABLE 4. Percentage Distribution by Area of Stock 1958, Stock 1968 and New Establishments

	Stock 1958		Stock 1968		New[a]	
Area	Number	Percentage	Number	Percentage	Number	Percentage
Central City						
Ring 1	576	23.1	427	18.5	82	15.6
Ring 2	429	17.2	314	13.5	52	9.9
Ring 3	239	9.6	246	10.7	40	7.6
Ring 4	180	7.2	151	6.6	22	4.2
Ring 5	127	5.1	122	5.3	21	4.0
Ring 6	88	3.5	91	4.0	19	3.6
Ring 7	117	4.7	144	6.2	34	6.4
Ring 8	98	3.9	88	3.8	19	3.8
Sub-Total	1,854	74.3	1,583	68.5	289	54.9
Sub-centers						
Ring 1	244	9.8	240	10.4	56	10.9
Ring 2	134	5.3	171	7.1	64	12.0
Ring 3	8	0.3	9	0.4	2	0.4
Sub-Total	386	15.4	420	17.9	122	23.3
Non-Urban Quadrants						
N.E.	19	0.8	42	1.8	25	4.8
N.W.	65	2.6	70	3.0	17	3.2
S.W.	27	1.1	22	1.0	8	1.5
S.E.	141	5.7	174	7.5	65	12.4
Sub-Total	252	10.2	308	13.3	115	21.9
Total	2,492	100.0[b]	2,311	99.7	526	100.0[b]

[a] Initial location of new establishments.
[b] Percentage total has been rounded to 100.

[12] The other New Town is Cumbernauld.

ten establishments was sited in the central city between 1958 and 1968, just over half of the new plants set up within this area (columns 2, 3, 7). This comparative "deficiency" of new plants was especially marked in the most densely clustered part of the city, that is, up to five kilometers from the center point. Throughout the rest of the central city, the number of new plants was very much in line with the average proportional stock so that the relative losses of the core and immediately adjacent areas were clearly not offset in the outer parts of the central city. In the rest of the conurbation it is clear that the sub-centers picked up more than their "expected" share of new plants and this comparative gain was particularly strong in the second ring of the sub-centers. Comparative gains were also made in all of the non-urban quadrants. Thus the general picture is of a low birth rate in the dense core of the central city, an average birth rate in the outer parts of the central city and the cores of the sub-centers, and a very high birth rate in the outer parts of the sub-centers and in the non-urban quadrants.[13] Of course, as we have already noted, the birth rate is only one factor affecting the changing spatial distribution of plants within the conurbations. Table 5 also depicts the effects of plant deaths and inter-area migration between 1958 and 1968. It shows that the spatial variation in death rates was significantly less than the variation in birth rates. Indeed, if we exclude data from the S.W. quadrant on the grounds that these are not significant, the range of death rate over space had a high of 37.4 per cent in Ring 2 of the sub-centers and a low of 22.2 per cent in Ring 7 of the central city. In contrast, the range of birth rates was much greater at 42 per cent and 13 per cent.[14] The other interesting point is that only the two innermost rings of the central city "exported" substantially more plants through transfers than they "imported" through transfers, and it was this factor together with the relatively low birth rate which caused the large reduction in the relative share of these areas.

From this brief review certain critical facts emerge. We have shown that in 1958 the Clydeside conurbation had a very heavy concentration of plants within the central city with a marked peak in the core and immediately adjacent areas up to four kilometers from the center. By 1968, the two innermost rings had lost a substantial number of plants, both because of a low birth rate and a heavy net loss of transferred plants. Elsewhere, nearly every other area gained plants absolutely and relatively. In the outer parts of the central city these gains tended to be the result of the net inflow of transferred plants, but in the sub-centers and quadrants both a high birth rate and net inward transfers were the root causes. Two areas,

[13] An analysis using one-kilometer rings based on the center point of the conurbation yielded the same general result.

[14] The coefficient of variation for death rates was 19.1230 and for birth rates 63.1906.

TABLE 5. Zonal Change 1958–1968

(1) Area	(2) Average Number of Establishments[a]	(3) New Establishments	(4) Deaths	(5) In-migrants	(6) Out-migrants	(7) Birth Rate: (3)/(2) Per Cent	(8) Death Rate: (4)/(2) Per Cent
Central City							
Ring 1	501.5	82	136	28	123	16.3	27.1
Ring 2	371.5	52	120	65	112	14.0	32.3
Ring 3	242.5	40	62	69	40	16.5	25.6
Ring 4	165.5	22	61	41	31	13.3	36.9
Ring 5	124.5	21	30	22	18	16.9	24.1
Ring 6	89.5	19	23	18	11	21.2	25.7
Ring 7	130.5	34	29	35	13	26.1	22.2
Ring 8	93.0	19	24	10	15	20.4	25.8
Sub-Total	1,718.5	289	485	288	363	16.8	28.2
Sub-Centers							
Ring 1	242.0	56	79	34	15	23.1	32.6
Ring 2	152.5	64	57	36	6	42.0	37.4
Ring 3	8.5	2	3	3	1	23.5	35.3
Sub-Total	403.0	122	139	73	22	30.3	34.5
Non-Urban Quadrants							
N.E.	30.5	25	8	6	0	82.0	26.2
N.W.	67.5	17	17	11	6	25.2	25.2
S.W.	24.5	8	10	3	6	32.7	40.8
S.E.	157.5	65	48	21	5	41.3	30.5
Sub-Total	280.0	115	83	41	17	41.1	29.6
Total	2,401.5	526	707	402	402	21.9	29.4

[a] Average number of establishments = (stock 1958 + stock 1968)/2.

Ring 2 of the sub-centers and the S.E. quadrant, had especially heavy gains. Three more general conclusions are also relevant: a) the birth rate of plants tended to increase with increased distance from the center point; b) the variation in the death rate over space was small; c) there is some support for the notion that many new plants would locate on the trade side i.e., the S.E. The New Town in the S.E. (East Kilbride) and the S.E. quadrant together picked up almost one out of every five new plants.

7. SOME SIMPLE TESTS

Up to this stage we have pointed out some changes in the spatial distribution of new plants as compared to the 1958 and 1968 stock of all

plants. However, in order to test the hypotheses of Section 4, we require more rigorous statistical measures. Foster's contention was that the distribution of new developments over space would be significantly different from that of the existing stock of plants. We can extend this hypothesis to reach the inference that plants in any given industry would be distributed randomly and therefore differently from their parent industry. We will test these two hypotheses separately.

Hypothesis 1

Our first hypothesis is that new plants as a whole locate differently from all plants. The following two tests confirm that this is indeed the case. Table 6 indicates that the average distance at which all new plants initially located was further from the center of the conurbation than was the case with the total stock of industry. Table 6 further shows that plants

TABLE 6. Average Distance of Plants from the Center

Industry Grouping	Average Distance from Center in Kilometers
All Plants	
1948	5.27
1958	5.55
1968	6.35
New Plants	
Initial Location	7.88
1968	8.08

as a whole have been decentralizing throughout the period 1948 to 1968 and especially in the 1958–1968 period.[15] However, for our purposes the critical finding is that the average new plant located further out than all new plants. For the second test all establishments in existence at January 1, 1958 were located in their relevant kilometer ring in the central city or within a subcenter ring or in a quadrant, as shown in Figure 6. The same procedure was followed with all new plants which were allocated according to their initial location. The null hypothesis to be tested was that there was no significant difference between the frequency distribution of all plants in 1958 and the frequency distribution of new plants. A chi-square test with 14 degrees of freedom yielded a chi-square value of 145.9050.[16] Thus we can reject the null hypothesis that there was no significant difference

[15]The increasing distance of decentralization after 1958 requires further scrutiny, since our data for 1948 are not directly comparable with those for 1958 and 1959.

[16]It is almost certain that the chi-square test is inappropriate in this instance. We are presently investigating a number of more suitable alternatives.

between the two frequency distributions.

It could, of course, be argued that the aggregation of establishment data into central city rings, sub-centers and quadrants is invalid since there is no single common variable used in the determination of spatial units. In order to overcome this problem, we have also divided the conurbation into annular rings at one, two, three and so on up to a 25-kilometer distance from the conurbation center. Once again, we have noted the number of plants in 1958 in each of these rings and the number of new plants which initially located in these rings. With 24 degrees of freedom, the chi-square value was 166.9784, so that once again we can reject the null hypothesis. Thus while this test does not allow us to prove that the distribution of new plants was significantly different from the distribution of the 1958 stock, it does allow us to refute the hypothesis that the distributions were the same.

Hypothesis 2

Our second hypothesis is that the spatial distribution of new establishments in each industry is likely to be significantly different from the spatial distribution of the stock in the same industry. Thus we would expect that if new plants are locating differently from their parent industry, then the ranks of average distance from the center of new plants and stock plants would be substantially different. Accordingly, we have ranked 84 Minimum List Heading (MLH) industries by their 1958 average distance from the center and all new plants in each industry by the average distance of their initial location from the center. A Spearman rank correlation between the two rankings with $n = 84$ yielded a ρ-value of 0.3948 and a t-value of 3.8909. This was significant at the one per cent level. An alternative test which regressed x, the average distances of the set of 1958 industries, against y, the average distances of the new plant industries, was also significant. With $n = 89$, the r-value was 0.4600, the t-value was 4.8346 and the regression equation was $y = 4.1884 + 0.7917x$. Therefore, both the rank correlation and the distance regression suggest that there was a very strong similarity between the manner in which new plants in any given industry located themselves with regard to distance from the center point and the manner in which existing plants within the same industry were located. However, before we investigate the implications of this finding, we must be certain that the data are not misleading. It is obvious that we are dealing with the average distance from the center of plants in any industry and the average may hide a wide dispersion. We have therefore calculated the standard deviation and the co-efficient of variation; see Table 7. The marginally small increase in the standard deviation and the lower co-efficient of variation (new initial and new 1968 as compared to stock 1958 and stock 1968) suggest that the average figures used in the rank correlation

TABLE 7. Standard Deviation, Co-efficient of Variation and Average Distance from Center

Industry Grouping	Average Distance in Kilometers	Standard Deviation in Kilometers	Co-efficient of Variation
All Plants			
1948	5.27	5.73	1.1
1958	5.55	5.73	1.0
1968	6.35	5.88	0.9
New Plants			
Initial	7.88	6.34	0.8
1968	8.08	6.39	0.8

and distance regression are not likely to be misleading.

Up to this point we have measured locational change in only one dimension, namely average distance from the conurbation center point. This seems a reasonable procedure since the central area can be regarded as the locale in which the external economies of cluster and/or urbanization are maximized. However, it is conceivable that for some industries a changed average distance from the center may not adequately reflect the precise nature of the changed spatial distribution. For example, an industry which was originally centrally clustered and showed a modest tendency to decentralize over time (as measured by the criterion of average distance from center) may nonetheless have become much more scattered. Similarly, a decentralized (but closely clustered industry) may show no tendency to decentralize but may, in fact, have become markedly less clustered. Accordingly, we have selected twenty-one (MLH) industries and have calculated the average distance from each other of all new plants within each industry at 1968, and have made the same calculation for all remaining plants within each industry at 1968. In fifteen of the twenty-one selected industries, the new plants were farther away from each other than was the case with their parent industry, and in six the plants were, on average, closer together. However, even though the range of increases in the fifteen industries was very large, the typical increase was small, both in percentage terms and in kilometers; see Table 8. This was also confirmed by a simple map analysis. All of this suggests that most new plants tend to replicate the locational pattern of their parent industry, both with regard to access to the center point and with regard to access to other plants within this same industry. This also confirms the fact that new plant location is in no sense a random process and that there are important reasons why intraurban space is not regarded by all manufacturers as homogeneous with respect to its input-output characteristics.

TABLE 8. Increase or Decrease in Average Kilometer Distance between Plants in the Same Industry (New Plants 1968 and Stock 1968)

Increased Average Distance			Decreased Average Distance		
MLH	Kilometers	Percentage	MLH	Kilometers	Percentage
333	+0.033	+0.3	399	−0.267	−2.7
349	+0.470	+4.3	471	−1.016	−6.1
214	+0.411	+4.5	417	−0.902	−9.6
339	+0.843	+8.8	496	−1.732	−12.3
341	+1.234	+9.7	364	−3.080	−25.5
313	+2.003	+13.1	443	−1.860	−57.5
337	+1.852	+16.1			
381	+2.323	+17.2			
469	+2.127	+19.2			
474	+1.597	+26.8			
441	+2.692	+44.9			
472	+3.788	+55.0			
475	+3.127	+58.9			
489	+3.155	+59.9			
445	+8.526	+285.3			

8. LOCATION AND EMPLOYMENT

Up to this point, the analysis has related to the location of establishments and has taken no account of establishment size. Thus the importance of the incidence of one plant in one location was equivalent to the incidence of another plant in another location. Accordingly, the ranking procedures took no account of variations in the size of plants. Clearly, this approach is legitimate for a study of location decisions. However, it makes less sense if we are trying to indicate the manner in which location decisions affect the intraurban distribution of employment opportunities. Moreover, the previous tests, which have shown that new plants in a given industry tend to replicate the locational pattern of their present industry, may not be so robust when employment is taken into account. Table 9 compares the proportion of new plants which located in the central city, sub-centers and non-urban quadrants, both in terms of initial locational incidence and in terms of 1968 employment. This is obviously not a strictly accurate comparison, but the degree of error is liable to be small, since the movement of new plants subsequent to their initial location was not great over this short period. Table 9 shows that although the central city picked up more than one out of every two new plants, it only attained one quarter of all the employment. The same was true in the first ring of the sub-centers. Elsewhere, however, and especially in the second ring of the sub-centers and in the non-urban quadrants the employment share greatly exceeded the share of

TABLE 9. Initial Locational Incidence of New Plants and 1968 Employment of New Plants by Central City, Sub-Centers and Quadrants

Area	Initial Location		Employment (1968)	
	Number	Percentage of Total	Number	Percentage of Total
Central City				
Ring 1	82	15.6	1,815	5.4
Ring 2	52	9.9	1,403	4.2
Ring 3	40	7.6	1,538	4.6
Ring 4	22	4.2	444	1.3
Ring 5	21	4.0	643	1.9
Ring 6	19	3.6	313	1.0
Ring 7	34	6.4	1,358	4.1
Ring 8	19	3.8	707	2.1
Sub-Total	289	54.9	8,221	24.6
Sub-Centers				
Ring 1	56	10.9	1,767	5.1
Ring 2	64	12.0	6,627	20.0
Ring 3	2	0.4	129	0.3
Sub-Total	122	23.2	8,523	25.4
Non-Urban Quadrants				
N.E.	25	4.8	1,945	5.8
N.W.	17	3.2	2,285	6.8
S.W.	8	1.5	6,602	19.7
S.E.	65	12.4	5,876	17.6
Sub-Total	115	21.9	16,708	49.9
Total	526	100.0[a]	33,452	100.0[a]

[a] Percentage total has been rounded to 100.

establishments. The obvious inference is that the small plants are at the center of the conurbation and the large on the periphery. This is indeed the case, as Table 10 clearly shows. Though care should be taken in interpretating the results from the two largest size categories (since both of these had a very small number of plants, see Table 2), the data do suggest that small new plants require closer access to the externalities of the urban core than do larger new plants, possibly because the latter can exploit internal economies of scale and are thereby less dependent upon externalities.

For our purposes, however, the real question is whether the ranking tests, which were employed on the individual industries using "unweighted" establishments, will generate the same results when employment weighting

TABLE 10. Average Distance of New Plants from Glasgow Center in 1968

Size (Employees)	Average Distance in Kilometers
5–24	7.496
25–99	8.973
100–499	11.910
500–999	10.858
1,000 and over	12.130

is taken into account. For this calculation the number of new establishments in each MLH was multiplied by establishment employment and establishment distance from the center. This sum was divided by the total number of new establishments, and the resulting scores were ranked. The same procedure was followed for the stock of all establishments excluding new establishments. Two separate Spearman rank correlation tests were attempted. In the first test, the rank distances of new plants starting up between 1958 and 1963 were compared with the rank distances of all establishments first in 1958 and then in 1963. In the former case with $n = 63$, the ρ-value was 0.3657 and the t-value was 3.0688. In the latter case with $n = 63$, the ρ-value was 0.5066 and the t-value was 4.5981. In both cases the results were significant at the one per cent level. The same procedure was followed using new establishments starting up between 1964 and 1968. In this second test the comparison was between the new rank distances of new plants and the 1963 and 1968 rank distances of all other plants. Once again, the correlations were significant at the one per cent level. The comparison of new plants with the 1963 stock yielded a ρ-value of 0.4133 and a t-value of 3.7702 with $n = 71$. The comparison of new plants with the 1968 stock generated a ρ-value of 0.4952 and a t-value of 4.7347 with $n = 71$. All of this suggests that the tests in Section 7, which used unweighted establishment data, have not led to misleading results.

9. SOME TENTATIVE INFERENCES

While it has been shown that in this one conurbation, the intraurban distribution of new plants was different from that of existing plants and that new plants as a whole tended to settle farther away from the core of the central city, it has also been shown that for any given industry, there was a strong likelihood that the new plants would replicate the pattern of their parent industries with regard to access to the center. The most plausible explanation of these findings is that the average new establishment in a centrally located industry is unable to compete for the highly limited supply of available space against the average existing user of space within the same industry and against other users of centralized space. However,

the economic advantages of the locale of the parent industry are such that new plants, on average, seek to be as close to this locale as possible. The corollary also follows. New establishments in industries which are already decentralized and/or scattered repeat this pattern and avoid the high rent cluster in and around the central core. We are therefore forced to reject the conclusion that new activity locates in a random fashion. Similarly, we are forced to reject the crude notions that all new plants locate in low cost decentralized locations, or that all new plants require the external economies of a central cluster. This means that for a better understanding of why some plants cluster in or near to the core, we are obliged to explore the complex of input-output access advantages, information pools and access to general urbanization economies, a complex which is associated with such clusters and which more than compensates for high rentals. It also means that the factors which cause some industries not to have such access requirements must be carefully delineated. And finally, it means that the few industries which have drastically and rapidly changed their typical locale from a centralized pattern to a decentralized pattern (or possibly in the reverse fashion) are especially strong candidates for the investigation of whether it is competitive forces, production technology changes or changes in access technology which are at the root of shifting locational preferences. This is clearly one further stage of the exploration. A second conclusion is that any public policy which aims to make sure that sites for manufacturing activity are provided in sufficient volume and in appropriate locales must assume that while the bulk of new plant employment will be generated outside of the central city, there will be sizeable demands for space, especially from small establishments, which is highly accessible to the dense urban core.

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