

the structural characteristics of the central place system of West Thessaly

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The description and explanation of the structural and behavioural characteristics of settlement systems is a topic that has been given much attention by geographers and others. Apart from its intrinsic academic interest, an understanding of the functional attributes and relative importance of towns and villages is a crucial pre-requisite to the formulation of effective regional and sub-regional planning policies. Although studies of settlement systems are commonplace (for example, see the bibliographies by Barnum et al., 1965, and Andrews 1970) the subject has received relatively little attention in Greece. Moreover, such work in the country that has been done has been hindered by an absence of detailed, spatially disaggregated data. Since the nature of the Greek system, dominated by the primacy of Athens, is a basic element in the spatial inequalities of income and welfare in the country, further investigation of the system may therefore be readily justified.

The work reported in this paper can be seen as a contribution towards a more detailed understanding of the settlement system of provincial Greece. Based largely on *ad hoc* data collecting exercises conducted in West Thessaly, it is an examination of the structural characteristics of the settlement system of the region. The study is set within the framework provided by central place theory since this places the emphasis on the service function of towns rather than the industrial ones. This is the sector which has been most neglected in economic research and policy formulation in Greece despite its importance in terms of employment and output as well as its significance as a physical land use in towns.

Following an outline of the basic precepts of central place theory, the paper will describe the technique used for the study of the West Thessaly system. The results of the analysis will then be discussed, and an assessment will be made of the potential application of central place studies to planning strategies in Greece.

1) central place systems: theoretical formulations and empirical verification

(a) *Theoretical Formulation:* The fundamental feature of the geography of tertiary economic activity is the clustering of establishments within centres. Settlements which contain such establishments act as foci of movement for consumers who visit to buy the goods and services they supply, and they are termed *central places*. Because there are differences in the frequencies and size of purchase of different goods or use of services, in the costs of providing them, and in the distances people are willing to travel to buy or use them, central place functions do not all have the same location requirements regarding access to consumers.

A variety of central places therefore exists in any area.

Central place theory is concerned with the location, size, nature and spacing of these service centres. Although its initial formulation was intended as an explanation of the hierarchical and spatial distribution of settlements, it has subsequently developed as a major theoretical framework for the study of the geography of tertiary activity at both the inter-urban and intra-urban scales of enquiry.

The work of Christaller, first published in 1933, was the starting point for modern research on the subject. He developed his model to explain the sizes, numbers and distribution of towns which he felt could not be accounted for by «their location in respect to the geographical conditions of nature» (Christaller 1966). The principal modification to the original model was by Berry and Garrison (1958) who extended the threshold concept and made the model more applicable to tertiary economic activity at both inter-urban and intra-urban levels. Although some developments of the theory, such as those by Lösch (1954) and Beavon (1977), are fairly complex, the basic features of the Christaller model are simple.

Given certain assumptions such as an isotropic plain and rational economic behaviour by entrepreneurs and consumers, it is postulated that a regularly distributed network of central places will exist to supply a surrounding rural population with goods and services. Since different goods and services have different threshold populations (that is, they require different numbers of consumers to make their supply economically viable), a number of hierarchical orders will emerge with a numerical pyramid of order membership. At the lowest level will be settlements supplying those goods and services which need frequent purchase and have correspondingly low thresholds. In order to give equal accessibility to all central places, and to eliminate the possibility of excess profits being earned, the central places are equally spaced over the isotropic plain and their hexagonally shaped trade areas are of equal size. The demand for more specialised goods and services (which have higher threshold populations) is met by a smaller number of outlets to which customers are willing to travel greater distances. Settlements providing these functions will similarly be regularly distributed, but will be fewer in number and separated from each other at greater distances than the settlements providing only low threshold functions. The larger centres contain all the low level goods and services as well as the higher order ones. Given sufficient variation in demand for different activities, the model predicts a series of centres of different sizes, with the trade areas for different levels of functions nested within each other.

Relaxation of the initial assumptions of the model, such as introducing variable purchasing power and influences on movement like transport networks and administrative boundaries, produces more complex versions of the original model. For the present purpose, however, it is sufficient to note that the essential features of the central place model remain unchanged: namely, that the basic elements of a central place system are population, functions (goods and services) and functional outlets (the establishments providing the goods and services); and, secondly, that in a perfect market economy the hierarchical and spatial distribution of tertiary activity may be explained as a result of spatial competition between suppliers and the varying threshold requirements of different goods and services.

b) *Empirical Verification:* From the large number of empirical central place studies which have been published, structural regularities in settlement systems would appear to be a widespread phenomenon. Consumer movement studies made either independently or in conjunction with them appear very generally to show close relationships between the structural character of the systems and the functional relationships of their component settlement. On the other hand, the lack of scientific rigour in many of these studies, together with the large number of different techniques that have been used, make comparisons between studies very difficult (W.K.D. Davies, 1968). Moreover, Beavon (1977) has suggested that the intellectual attraction of central place theory at the time when geography was experiencing its «quantitative revolution» led many people to identify hierarchies when their data did not indicate such a conclusion: «it was simply a case of recognising the only finding for which there was any theoretical justification». The need to develop objective common procedures that will allow effective cross-spatial and cross-temporal comparisons has therefore still to be satisfied. This applies in a wider sense to all empirical central place work but it is equally valid in the specific case of Greece where such studies that have been made (for example, Centre for Planning and Economic Research 1967, National Polytechnic 1971 and 1973, Sivignon 1975) have all used different criteria for identifying settlement rankings and they have all involved arbitrary analytical techniques to a substantial degree.

The study which is reported here in West Thessaly is the first to have been done in Greece using detailed data collected in special field surveys, and the first to use techniques to determine objectively the existence of hierarchical structure in the settlement system. Following a description of the techniques developed for the study, there is an examination of the hierarchical structure of the central place system, with a

description of the functional characteristics of each level and an estimation of the threshold population of the various goods and services. Secondly, the spatial structure of the system is analysed, and, thirdly, the aggregate relationships between the three component elements of population, functions and functional units are elucidated.

2) the measurement of settlement centrality in West Thessaly

(a) *Data Collection*: the most important set of data needed for a study of the structure of a central place system is that relating to the provision of tertiary activities in the settlements. Although there have been several censuses of commercial establishments in Greece, the published data are not sufficiently disaggregated for a detailed study down to the level of individual establishments. Neither, of course, do the censuses include data on non-commercial functions. Some information on commercial establishments can be obtained from local sources but the coverage between *nomoi* is not consistent. In order to obtain sufficiently detailed and homogeneous information on commercial activity encompassing two *nomoi*, a direct *ad hoc* field survey was therefore considered necessary. For non-commercial functions the relevant data were obtained by a combination of field survey and requests to local authorities. The survey encompassed 166 settlements in the plain region of Trikala and Kardhitsa (Fig. 1), and a catalogue was made of the number and types of functions and functional units found in each place.¹ Limits imposed by the availability of time and resources meant that it was not practical to survey the mountain villages in detail but pilot surveys indicated that there were no significant differences between these villages and those in the plain as far as tertiary activity was concerned. In the survey 88 functions were identified, 55 being retail and 33 non-retail. These represent a high (if unknown) proportion of types of tertiary activity found in provincial Greece.

(b) *The Measurement of Settlement Centrality*: Christaller (1966) defined centrality as «the relative importance of a place with regard to the region surrounding

it, or the degree to which the town exercises central functions». Expressing this in simple mathematical terms, if a town has an aggregate importance B of which B_z represents the town's population, then $(B - B_z)$ is the surplus of importance, or centrality, for the surrounding region. A settlement which possesses centrality is a central place and the first step of an empirical central place study is to attempt to measure the centrality of all the settlements in the region being studied. Unfortunately there is no widely used technique for doing this, and most of those that have been used measure in fact the nodality of settlements, their aggregate importance, rather than their centrality. Since the emphasis in this study was on centrality it was found necessary to develop a measure which could be calculated with the data collected in the field survey and which would provide an indication of relative differences in centrality between settlements. After some experimentation, an adaption of the Functional Index developed by W.K.D. Davies (1967) was found the most satisfactory.

The Functional Index takes as a basis the location coefficients used in industrial location studies. The first stage is the calculation of the location coefficient of a single outlet of any given function:

$$C = \frac{1}{T} \cdot 100$$

where C = the location coefficient of function t

T = the total number of outlets of function t in the system.

Since the coefficient reduces all functions to a common base, the degree of focality of each functional type is immediately comparable in an objective fashion. The second stage is to multiply the relevant location coefficient by the number of outlets of each functional type present in a settlement. This yields *centrality values* which are said to measure the degree of centrality imparted to each settlement by each function. The final stage is the addition of all the centrality values of a settlement to yield the functional index of the settlement.

Although the Functional Index has been used subsequently in a number of empirical central place studies (for example, Marshall 1969, Rowley 1970), it does not, in fact, measure centrality. Rather, it measures nodality, the aggregate importance of a settlement and, as R.E. Preston (1971) has noted, «we know little or nothing about how well such nodality indexes identify centrality». It was to overcome the problem in this study that the modification of Davies's index was developed. The *weighted functional index* retains the advantages of the original functional index and the only additional data needed are the

1. These terms were defined by Thomas (1969) as follows: «an *establishment* is essentially the physical manifestation of an activity and is generally the unit in which an activity is performed... In contrast, the term *function* refers to activities which are performed in the establishments. According to these definitions, it is possible for more than one function to be associated with a particular establishment. Each occurrence of a function constitutes one *functional unit*. Since central place theory is primarily concerned with goods rather than establishments *per se* the use of the concept of the functional unit is an approach which reconciles this with the scale problem inherent in empirical central place studies (W.K.D. Davies 1965).

FIGURE 1. Settlements in the Plain Area of West Thessaly Classified by Hierarchical Level



populations of the settlements. Similarly, the assumptions implicit in the functional index are retained: in particular, that the region being studied is functionally closed, that there are no spatial variations in per capita consumption within the region, and that all outlets/units of a given function are of equal economic significance.

The first step in this modification is the calculation of a *centrality ratio* for each function in each settlement of the region from the formula

$$CR_{is} = \frac{F_{is}}{P_{st}}$$

where CR_{is} = centrality ratio of function i in settlement s

F_{is} = number of functional units of function i in settlement s as a percentage of the total number of functional units of i in region r

P_{st} = population of settlement s as a percentage of the total population of region r

If the centrality ratio has a value greater than 1.0, this is taken to indicate that there are functional units of the function which are surplus to the demand for that function by the population of the settlement itself. It is therefore assumed that this surplus is supported by demand originating outside the settlement. If the centrality ratio is less than 1.0, then the demand for the function in the settlement is considered to be not fully met by the functional units (if any) in the settlement. If the ratio is equal to 1.0 then supply and demand for the function are considered to be in equilibrium.

In calculating the centrality ratio, care clearly needs to be taken to ensure that the population data correspond to the physical rather than the administrative limits of settlements. Moreover, in an area where there are settlements that have been undergoing rapid economic and/or demographic change, interpretation of the weighted functional index may need to take into account distortions produced by lags in the urban system when economic or demographic elements do not change simultaneously.

The second stage is to weight each of Davies's centrality values by the centrality ratio:

$$WC_{is} = C_{is} \cdot CR_{is}$$

where, WC_{is} = weighted centrality value of function i in settlement s

C_{is} = centrality value of function i in settlement s

Thus, the centrality value is increased or decreased in direct proportion to the degree to which there appears to be either a net surplus or deficit of functional

units of the function in the settlement relative to its population. For computation these first two steps may be combined in one formula:

$$WC_{is} = \frac{C_{is}^2 \cdot Pr}{P_s \cdot 100}$$

where, Pr = total population of region r

P_s = population of settlement s

The third stage is to standardize each of the arrays of weighted centrality values by expressing each weighted centrality value of a function as a percentage of the sum total of weighted centrality values of that function:

$$SWC_{is} = \frac{WC_{is}}{\sum_{j=1}^n WC_{ij}} \cdot 100$$

where, SWC_{is} = standardized weighted centrality value of function i in settlement s
 n = total number of settlements in region r

This reduces all the arrays of weighted centrality values to a common base, thus ensuring that any very high weighted centrality value which may be produced by the location of a functional unit of an infrequently occurring function in a small settlement will not lead to a gross distortion of the weighted functional index.

The final stage in the derivation of the weighted functional index is the addition of all the standardized weighted centrality values for each settlement:

$$WF_s = \sum_{i=1}^f SWC_{is}$$

where, WF_s = weighted functional index of settlement s

f = total number of functions in settlement s

Although the calculation of the weighted index involves several stages, these are straightforward and easily programmed for a computer. The input is a matrix of functional units by settlements and the population of the settlements. If data are obtained on, for instance, numbers of employees, then these could be substituted for functional units as in Davies's original functional index.

3) the hierarchical structure of the central place system

The WFIs for the first twenty settlements with the highest indices are shown in Table 1, sub-divided into retail and non-retail components. While it would be possible to proceed with the analysis of hierarchical structure using only the indices in this table, it is more satisfactory to follow Davies's (1967) example and assess the degree of similarity or dis-similarity between places in terms of the whole distribution of weighted centrality values. This can be done by calculating correlation coefficients between each settlement and every other and, through an examination of these coefficients, ensure that the series of groups are composed of units with maximum internal homogeneity and between group dissimilarity at the required level of generalization. Here the Spearman rank correlation coefficient is used because a non-parametric technique is desirable for this kind of data.

The correlation coefficients were calculated for retail and non-retail functions separately, and then using the complete matrix of weighted centrality values. In this way it can be seen whether a hierarchy based on retail functions differs from that based on non-retail, and it facilitates the interpretation of an aggregate hierarchy.

(a) *The Retail Hierarchy*: After ranking the settlements by their retail WFI, the rank correlations coefficients between adjacent pairs were calculated. A lower correlation between a pair of settlements than that between pairs of immediately higher ranking was

taken to indicate the edge of a group. The correlation coefficients between all members of the provisional group were found, and if all had higher correlations with each other than with settlements adjacent to the group this was interpreted as confirming the existence of a group which satisfied the definition of Clark (1956) used by Davies (1967). Nevertheless, an element of subjectivity is still involved in deciding when a correlation coefficient marks a break: with 151 degrees of freedom very low coefficients are statistically significant.

The most interesting feature in the list of retail WFIs is the closeness of Trikala and Kardhitsu (1451.3 and 1416.4 respectively) and of Kalambaka, Mouzakion, Sofadhes and Pili (370.2, 360.9, 364.5 and 338.7 respectively). The correlation coefficient between Trikala and Kardhitsu is 0.45, and their correlations with all other settlements are negative. With Kalambaka they have correlations of -0.40 and -0.21 respectively, and they, therefore, emerge as a distinct high-level group. Below this the next six centres form another group, although the WFIs of the last two are rather lower than the others. Sofadhes is a slight anomaly in having relatively low correlations with all the other settlements, but has even lower ones with those outside the group. The boundary of the group is pronounced with all the settlements having low correlations with Neochorion, the ninth ranked centre in retail indices (Table 2).

In contrast, the identification of a third level in the retail hierarchy is more difficult. Although Neochorion and Leondari have almost the same retail WFI, the correlation between them is only 0.18. This implies significant differences in the retail structure of these two settlements which may be related to the fact that Neochorion is a large village with a population more than twice that of Leondari. Its relatively large provision of retail outlets is supported by the indigenous inhabitants of the village while Leondari may be more of a true central place. Neochorion is only 7 kms. from Farkadon, while the closest large settlement to Leondari is Sofadhes, 18 kms. distant. The highest correlation that Neochorion has is with Itea and that is 0.42. Leondari also has low correlations with the other settlements, the highest also being with Itea (0.48). The next three settlements in rank order, Fanarion, Itea and Fiki, all have similar retail WFIs, and they are also more highly correlated with each other. Taken in isolation they satisfy the criterion for group identification (Table 3). The inclusion of Neochorion and Leondari as part of this group could be justified if a less strict approach to group identification were taken: in terms of the simple array of WFIs they form part of a distinct cluster with the other three, while they both have correlations of 0.4 with one of the other settlements. Below

TABLE 1. *Weighted Functional Indices*

	Weighted Functional Index			
	1971 Population	Retail	Non-Retail	Total
Trikala	34,794	1451.3	933.1	2384.4
Kardhitsu	25,685	1416.4	655.5	2071.9
Kalambaka	5,453	370.2	443.2	813.4
Mouzakion	2,626	360.9	122.4	483.3
Sofadhes	4,505	364.5	103.6	468.1
Pili	1,759	338.7	42.9	381.6
Palamas	5,318	186.1	85.2	271.3
Farkadon	2,175	134.3	49.8	184.1
Fanarion	1,310	45.2	90.8	136.0
Leondari	1,435	57.1	60.5	117.6
Fiki	1,057	40.6	38.4	79.0
Neochorion	3,089	57.6	17.7	75.3
Itea	1,445	41.5	32.2	73.6
Megala Kalivea	2,333	6.2	64.8	71.0
Proastion	1,971	28.4	28.3	56.7
Kedhros	1,131	24.3	27.8	52.1
Merina	1,048	1.1	32.2	33.3
Metropolis	1,504	21.6	7.7	29.4
Parapotamos	230	2.8	25.4	28.2
Anavra	1,133	22.4	2.3	24.7

TABLE 2. Rank Correlation Coefficients (retail WFIs)

	1	2	3	4	5	6	7
1. Kalambaka	1.0						
2. Sofadhes	0.31	1.0					
3. Mouzakion	0.70	0.32	1.0				
4. Pili	0.58	0.32	0.57	1.0			
5. Palamas	0.43	0.43	0.56	0.49	1.0		
6. Farkadon	0.54	0.35	0.53	0.39	0.57	1.0	
7. Neochorion	0.07	0.18	0.19	0.18	0.25	0.23	1.0

TABLE 3. Rank Correlation Coefficients (retail WFIs)

	1	2	3	4	5	6
1. Neochorion	1.0					
2. Leondari	0.18	1.0				
3. Fanarion	0.29	0.27	1.0			
4. Itea	0.42	0.48	0.58	1.0		
5. Fiki	0.36	0.32	0.51	0.60	1.0	
6. Proastion	0.23	0.43	0.38	0.63	0.37	1.0

TABLE 4. Rank Correlation Coefficients (non-retail WFIs)

	1	2	3	4	5	6	7	8	9	10
1. Kalambaka	1.0									
2. Mouzakion	0.22	1.0								
3. Sofadhes	0.16	0.67	1.0							
4. Fanarion	-0.19	0.50	0.39	1.0						
5. Palamas	0.15	0.70	0.97	0.38	1.0					
6. Meg. Kalivea	-0.07	0.23	0.12	0.25	0.15	1.0				
7. Leondari	-0.36	0.34	0.30	0.84	0.29	0.38	1.0			
8. Farkadon	0.03	0.75	0.47	0.71	0.47	0.43	0.55	1.0		
9. Pili	-0.05	0.60	0.39	0.55	0.42	0.59	0.48	0.84	1.0	
10. Fiki	-0.12	0.39	0.20	0.53	0.20	0.66	0.53	0.58	0.59	1.0

this it is not possible to define further groups. Proastion is the next settlement below Fiki, and has a WFI 12 points lower. Continuing further down the array no other large breaks in WFI values occur, and all these places must be assigned to a fourth category where a continuum of values is found which can be related directly to the population size continuum.

(b) *The Non-Retail Hierarchy*: There is a considerable contrast between the array of retail WFIs and that of non-retail WFIs. In particular, the remarkable closeness between the highest ranking values is not found while there are also differences in the rank ordering of settlements. As before, Trikala and Kardhitsa are respectively first and second rank and, although their non-retail WFIs differ by almost 300, there is a high correlation of 0.71 between them. Similarly their correlations with all other settlements are negative: with Kalambaka, the third ranking centre, -0.19 and -0.05 respectively. Consequently they again emerge as a distinct upper group. Kalambaka has a high index of 443.2, only about 200 less

than Kardhitsa, and more than 300 higher than Mouzakion, the next settlement in rank order. Moreover, it has negative correlations with all places but Farkadon, Mouzakion, Sofadhes and Palamas, and the positive correlations with these are all low (Table 4). Therefore, in terms of non-retail functions Kalambaka must be classed by itself, and this can be related to its function as the seat of an *eparchy*, the only one in West Thessaly. Below Kalambaka no clear groupings emerge, except perhaps Mouzakion, Sofadhes and Palamas which are all highly correlated with each other. Fanarion and Leondari are highly correlated, as are Pili and Farkadon. Megala Kalivea, the seventh ranked centre, has low correlations with most other settlements. This can be related directly to it being the site of one of only six social institutions in the detailed study area: this produces a high WFI, but it correlates lowly with other centres with similar WFIs which are composed of a larger number of centrality values. Further down the array a very large number of settlements are highly correlated with

TABLE 5. Rank Correlation Coefficients (total WFIs)

	1	2	3	4	5	6	7
1. Kalambaka	1.0						
2. Mouzakion	0.47	1.0					
3. Sofadhes	0.25	0.49	1.0				
4. Pili	0.30	0.62	0.43	1.0			
5. Palamas	0.31	0.63	0.67	0.51	1.0		
6. Farkadon	0.31	0.66	0.44	0.62	0.56	1.0	
7. Fanarion	-0.06	0.27	0.13	0.16	0.18	0.28	1.0

TABLE 6. Rank Correlation Coefficients (total WFIs)

	1	2	3	4	5	6	7
1. Fiki	1.0						
2. Neochorion	0.44	1.0					
3. Itea	0.63	0.45	1.0				
4. Meg. Kalivea	0.61	0.42	0.44	1.0			
5. Proastion	0.46	0.28	0.72	0.47	1.0		
6. Kedhros	0.47	0.34	0.57	0.45	0.61	1.0	
7. Merina	0.33	0.31	0.24	0.47	0.37	0.45	1.0

each other, and coefficients of 0.82, 0.85 and 1.00 are common. This indicates the basically similar non-retail functional structure of these settlements, a structure which is more homogeneous than the retail because it is more a result of governmental service provision than the essentially individualistic provision of retail services.

(c) *The Aggregate Hierarchy*: Repeating the correlation analysis with the complete matrix of weighted centrality values, and taking into account the results of the two previous analyses, it is possible to identify a hierarchical structure in the central place system of West Thessaly which is characterized by four levels with two sub-divisions. This is as follows:

Level	Constituent Settlements
A	Trikala, Kardhitsu
B1	Kalambaka
B2	Mouzakion, Sofadhes,
	Pili, Palamas, Farkadon
C1	Fanarion, Leondari
C2	Fiki, Neochorion, Itea, Megala
	Kalivea, Proastion, Kedhros
D	Remaining settlements

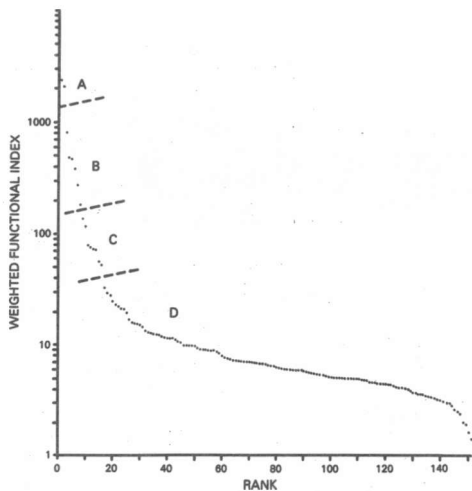
The recognition of Trikala and Kardhitsu as the only two A level centres in the study area is not open to debate. Both have WFIs of over 2,000 while Kalambaka, the third in rank order, has an index of 813. The rank correlation coefficient between them is 0.58 whereas with all other settlements they both have negative correlations: between Trikala and Kalambaka it is -0.27, and between Kardhitsu and Kalambaka -0.19. The dominant position of Trikala

and Kardhitsu applies to both the retail and non-retail sectors.

Six B level centres have been identified although the allocation of Kalambaka to a separate sub-division has been considered necessary. This is because its WFI exceeds that of Mouzakion, the fourth ranked centre, by over 300, and it has relatively low correlations with all other members of this group except Mouzakion (Table 5). The sub-division results from the higher level of non-retail functions which Kalambaka performs since it is similar to the other B level settlements in terms of retail functions. The B2 group emerge as a distinct group by all having fairly high correlations with each other. The break between these settlements and those of the C group is clear: Fanarion, the ninth centre in order, has low correlations with all the settlements above it.

The C level centres have also been divided into two subgroups, although the basis for so doing is less clear than in the B group. Fanarion and Leondari are classified as C1 because, firstly, their WFIs are considerably higher than the others and, secondly, Leondari has relatively low correlations with Fiki and Neochorion, the next two centres in rank order. This sub-division can also be related to the position of these two places in terms of non-retail functions where they were very highly correlated with each other. Most of the other settlements have relatively high correlations with each other, the only exception being between Neochorion and Proastion and Kedhros (Table 6). The division between C and D level settlements was made at Kedhros. Although the cor-

FIGURE 2. Ranked Weighted Functional Indices



relation of Kedhros with next ranked settlement, Merina, is 0.45, Merina has relatively low correlations with all but one of the other members of the group, and has a WFI value almost 20 less than that of Kedhros. Furthermore, the relatively high index of Merina is due solely to the fact that it has a small library (one of only eight recorded in the area) without which its WFI value would have been only 3.6.

The D group is the lowest if small settlements without any central functions are excluded from consideration. It is not possible to identify any significant breaks in the WFI array, and a continuum of 137 settlements must be recognised with WFI values ranging from the 33.3 of Merina down to the 0.2 of the small village of Aghioi Anarghiroi (Fig. 2).

(d) *The Functional Characteristics of Hierarchical Levels:* One of the features of the classical central place model is that each level in the hierarchy is distinguished from the level below it by a separate «basket of goods» (the marginal hierarchical functions). The characteristics of each hierarchical level and the nature of the marginal hierarchical functions can be seen in Table 7.

Firstly, it is clear that each level contains all the functions of any lower level and an incremental basket of different functions in addition, which form the marginal hierarchical functions for that level. The order of entry of functions is not, however, clear cut: a function which appears at a given hierarchical level is not generally found in all settlements of that level.

TABLE 7. Incidence Matrix of Functions in Settlements by Hierarchical Grades (% total)

Function*	A	B	C	D
1. Coffee shop	100.0	100.0	100.0	99.3
2. General store	100.0	100.0	100.0	99.3
3. Kiosk	100.0	100.0	100.0	64.2
4. Barber	100.0	100.0	87.5	70.1
5. Tailor	100.0	100.0	87.5	43.1
6. Butcher	100.0	100.0	100.0	31.4
7. Primary school	100.0	100.0	100.0	97.8
8. Vehicle repairs	100.0	100.0	100.0	24.8
9. Clothing (women)	100.0	100.0	62.5	2.9
10. Groceries	100.0	100.0	25.0	—
11. Clothing (men)	100.0	100.0	62.5	2.9
12. Clothing (children)	100.0	100.0	62.5	2.9
13. Co-operative	100.0	100.0	100.0	91.2
14. Commune office	100.0	100.0	100.0	89.1
15. Lawyer	100.0	66.7	—	—
16. Hardware	100.0	100.0	50.0	—
17. Shoes	100.0	100.0	75.0	5.8
18. Textile goods	100.0	100.0	50.0	2.9
19. Doctor	100.0	100.0	87.5	4.4
20. Wines/Drinks	100.0	100.0	12.5	—
21. Furniture	100.0	100.0	50.0	1.5
22. Electrical goods	100.0	100.0	50.0	1.5
23. Household appl.	100.0	100.0	25.0	1.5
24. Hairdresser	100.0	100.0	75.0	15.3
25. Baker	100.0	100.0	75.0	13.1
26. Kindergarten	100.0	100.0	100.0	37.9
27. Fruit and veg.	100.0	83.3	50.0	3.7
28. Accountant	100.0	16.7	—	—
29. Radio/TV	100.0	100.0	12.5	—
30. Vehicle accessories	100.0	83.3	25.0	0.7
31. Dentist	100.0	100.0	—	—
32. Confectionery	100.0	100.0	62.5	0.7
33. Bicycles	100.0	83.3	50.0	—
34. Restaurant	100.0	100.0	37.5	1.5
35. Cleaning	100.0	100.0	37.5	2.2
36. Glassware	100.0	100.0	25.0	0.7
37. Clocks/Watches	100.0	100.0	—	—
38. Jewellery	100.0	100.0	—	—
39. Chinaware	100.0	100.0	25.0	0.7
40. Chemist	100.0	100.0	12.5	—
41. Dairy produce	100.0	100.0	25.0	—
42. Vet	100.0	100.0	25.0	2.9
43. Books	100.0	100.0	—	—
44. Private college	100.0	83.3	25.0	—
45. Cinema	100.0	100.0	37.5	2.2
46. Agric. machines	100.0	33.3	12.5	—
47. Secondary school	100.0	100.0	37.5	0.7
48. Photography	100.0	100.0	12.5	—
49. Stationery	100.0	100.0	—	—
50. Bridal wear	100.0	66.7	—	—
51. Taverna	100.0	50.0	50.0	—
52. Police station	100.0	100.0	100.0	3.7
53. Cars	100.0	—	—	—
54. Toys	100.0	100.0	12.5	—
55. Fish	100.0	100.0	25.0	13.9
56. Printer	100.0	50.0	—	—
57. Gifts/Souvenirs	100.0	33.3	—	—
58. Post office	100.0	100.0	75.0	0.7
59. Court	100.0	100.0	12.5	—
60. Insurance agency	100.0	—	—	—
61. Candles	100.0	33.3	—	—
62. Clinic	100.0	—	—	—
63. Bank	100.0	66.7	—	—

(continued)

TABLE 7. Incidence Matrix of Functions in Settlements by Hierarchical Grades (% total)

Function*	A	B	C	D
64. Telegraph office	100.0	100.0	62.5	—
65. Trucking	100.0	50.0	—	—
66. Newspapers	100.0	66.7	—	—
67. Religious goods	100.0	33.3	12.5	—
68. Travel agent	100.0	16.7	—	—
69. Leather/Skins	100.0	—	—	—
70. Handbags	100.0	—	—	—
71. Undertakers	100.0	16.7	—	—
72. Library	100.0	33.3	37.5	0.7
73. Driving school	100.0	16.7	—	—
74. Social institution	100.0	16.7	12.5	—
75. Agric. Bank	100.0	66.7	—	—
76. Sweets	100.0	—	—	—
77. Music	100.0	—	—	—
78. Perfume	100.0	—	—	—
79. Optician	100.0	—	—	—
80. Sports clothes/equip.	100.0	—	—	—
81. Art	100.0	16.7	—	—
82. Hospital	100.0	16.7	—	—
83. Electricity office	100.0	16.7	—	—
84. Flowers	100.0	—	—	—
85. Office supplies	100.0	—	—	—
86. Nomos office	100.0	—	—	—
87. Police H.Q.	100.0	—	—	—
88. Agric. college	50.0	16.7	—	—

*Functions are ranked in ascending order by location coefficient.

In the case of *B* level settlements a lot of the marginal hierarchical functions are found only in Kalambaka: of the functions which are found in 16.7 per cent of *B* settlements (that is, in one only), all but Art are found in Kalambaka. All of the *B* level marginal hierarchical functions are found in both of the *A* centres, with the exception of «Agricultural College» which is found only in Kardhitsa. Similarly, most of the *C* level marginal hierarchical functions are found in all of the *B* level settlements, but the same relationship does not occur with the *D* level marginal hierarchical functions and *C* level settlements. Ten of the functions are found in all of the *C* level settlements, including six of the first eight functions ranked in ascending order of location coefficient. With other functions the proportion of *C* settlements containing them varies considerably, being lowest where the marginal hierarchical function is found in only a small number of *D* level settlements.

It will be seen that *A* level centres are not distinguished from *B* level so much by the range of functions which they possess as by the number of functional units of the various functions which they contain (the main exception is administrative functions). Many of the *A* level marginal hierarchical goods subsumed under general function headings can be obtained in *B* centres, although demand is not sufficient to warrant specialisation by any particular outlet to a degree where it would have been identified in the field survey (for example, sweets, music, perfume, handbags).

In reality, very few functions are confined solely to Trikala and Kardhitsa although the range widens if Kalambaka is excluded from consideration. On the other hand, it should be remembered that the field survey could not be completely comprehensive and that functions omitted from the study are usually those more characteristic of higher rather than lower hierarchical levels.

The main distinction between *B* and *C* level settlements is in the provision of non-retail services: only 40 per cent of the *B* level marginal hierarchical functions are retail (cf. 62.5 per cent of all functions identified in the study), whereas with *C* and *D* level settlements the proportion is 75 per cent and 72 per cent respectively. This may be interpreted as reflecting primarily the different locational influences on retail and non-retail service provision, including the random decisions of individual entrepreneurs within a satisfaction maximisation rather than profit maximisation frame of reference and, secondly, the limitations on the size of retail functional outlets imposed by various social and economic factors. In comparison the location of non-retail functions, particularly those associated directly or indirectly with government, is more subject to rational objective decisions, and the size of the units of some functions such as schools can vary considerably.

The kind of retail functions which characterizes the *B* settlements are those which might be considered as luxuries rather than necessities—jewellery, books, gifts, art—whereas the non-retail functions are mainly professional activities (lawyer, dentist) or financial (banks). In contrast, the retail functions which characterize the third hierarchical level tend to be those which could be classified as necessities, but those not supplying goods requiring frequent purchase (for example hardware, chemist). Finally, the *D* group has a large number of marginal hierarchical functions but very few of these are found in more than 50 per cent of these settlements. Indeed, only the coffee shop, general store, kiosk, barber, primary school, co-operative and commune office functions are found in more than 60 per cent of the total, although it should be remembered that the range of goods available within a village general store can be very wide. Most of the other functions are found only in the larger villages such as Mataranga and Kardhitsomagoula, although there is also a certain random element involved which classical deterministic central place theory cannot adequately explain: the existence of a small library in Merina and a secondary school in Magoula are examples of this.

(e) *Threshold Populations*: The concept of threshold is basic to central place theory and any central place study should therefore include an estimate of the threshold population of the various functions it con-

siders. Moreover, there is a potential practical application of threshold populations in the planning of future retail provision. While the concept itself is not complex, however, the empirical assessment of the values is not without complication. Although the classical theory predicts a smooth order of entry of functions at increasingly higher hierarchical levels, a number of factors operate in the real world to produce a rather more variable pattern of entry. In the first place, there are variations in consumer behaviour over space produced by variations in real disposable income, tastes and buying habits. Secondly, there are variations in the size and quality levels of establishments providing any particular good or service. Although establishment size variations are not very significant in retail trade in Greece, they are certainly of relevance when considering some non-retail functions such as administration, education and health. Although it would be possible to overcome this problem by using floorspace or employment data, these are not available at the appropriate scale of analysis. Variations in the quality level of establishments is a less tangible influence on threshold values but it has been considered a vital element in some theoretical formulations of retail land use (Garner 1966). In addition, random influences on entrepreneurial behaviour also complicate the picture, particularly social factors and the operation of businesses on a part-time basis.

To accommodate this operational problem of assessing threshold populations, Haggett and Gunawardena (1964) suggested that the concept of an entry level should be replaced by one of an entry zone. At the lower limits of the zone all settlements lack the function being considered while at the upper limits of the zone all settlements possess it. In simplified form, what they suggest is that the threshold population of a function should be the median population between the population of the settlement below which no others possess the function and the population of the settlement above which all settlements possess it. This is a straightforward technique although it does have one major theoretical drawback: in considering only the population of the central places it is excluding the population of the hinterlands they serve. Nevertheless, given the necessary crudities of any attempt at calculating thresholds, the values which this method provides are sufficient for the present purpose. Furthermore, for the specific case of West Thessaly, the nucleated nature of rural settlement reduces the importance of this drawback.

The median population thresholds for the 88 functions identified are shown in Table 8. They range from 109 for Coffee Shop and General Store up to 15,569 for those functions found only in Kardhitsu and Trikala. Generally, the values confirm the pic-

TABLE 8. *Median Population Thresholds*

1. Baker	974
2. Butcher	673
3. Coffee shop	109
4. Confectionary	1,419
5. Dairy produce	1,724
6. Fish	814
7. Fruit and veg.	1,306
8. Groceries	1,832
9. Restaurant	699
10. Sweets	15,569
11. Taverna	1,429
12. Wines/Drinks	1,860
13. Bridal wear	2,219
14. Clothing (children)	1,251
15. Clothing (men)	1,251
16. Clothing (women)	1,251
17. Leather/Skins	15,569
18. Shoes	1,132
19. Sports clothes/equipment	15,569
20. Tailor	677
21. Textile goods	1,268
22. Clocks/Watches	2,219
23. Chinaware	1,796
24. Electrical goods	1,631
25. Furniture	1,796
26. Glassware	1,796
27. Hardware	1,429
28. Household appliances	1,796
29. Radio/TV	1,846
30. Agric. machines	4,912
31. Bicycles	1,394
32. Cars	15,569
33. Vehicle accessories	1,440
34. Vehicle repairs	707
35. Barber	636
36. Cleaning	1,846
37. Hairdresser	808
38. Art	5,318
39. Books	2,219
40. Chemist	1,419
41. Flowers	15,569
42. Jewellery	2,219
43. Music	15,569
44. Newspapers	2,263
45. Office supplies	15,569
46. Photography	1,724
47. Religious goods	2,333
48. Stationery	2,219
49. Gifts/Souvenirs	2,298
50. Toys	2,073
51. Candles	4,912
52. Handbags/Luggage	15,569
53. Perfume	15,569
54. Kiosk	658
55. General store	109
56. Commune office	490
57. Nomos offices	15,569
58. Court	1,724
59. Police H.O.	15,569
60. Police station	1,053
61. Accountant	5,386
62. Dentist	2,219
63. Doctor	1,045
64. Lawyer	2,858
65. Optician	15,569
66. Printer	3,797

(continued)

TABLE 8. Median Population Thresholds

67. Vet	695
68. Clinic	15,569
69. Hospital	5,386
70. Library	1,429
71. Post office	1,419
72. Telegraph office (OTE)	1,440
73. Social institution	2,858
74. Kindergarten	635
75. Primary school	197
76. Secondary school	1,435
77. Private college	1,419
78. Agricultural college	25,685
79. Bank	2,858
80. Agricultural Bank	2,858
81. Insurance agency	15,569
82. Cinema	1,394
83. Driving school	5,386
84. Electrical office (DEH)	5,386
85. Travel agent	5,386
86. Trucking Co.	3,797
87. Agricultural Co-op.	4,374
88. Undertaker	5,386

ture revealed in the previous analysis of the existence of many functions in at least some of the smaller settlements in the region, but some qualifications need to be made. This technique has probably over-estimated the threshold population of some retail functions which do form components of the mix of General Store or other shops or are available from market traders, and underestimated others such as *Nomos* offices and Hospitals which clearly are supported by a much wider population than that of the towns in which they are located. In general, however, the threshold values do accord well with intuitive impressions gained during the collection of the data in the field.

4) the spatial structure of the central place system of West Thessaly

One of the important features of Christaller's central place model is that the central places are distributed regularly over the isotropic plain, and centres of a given hierarchical level serve the same numbers of consumers. Perfect spatial competition means that the centres are located on a triangular lattice with hexagonal trade areas. The model thus provides a useful basis for examining the spatial structure of a settlement system since in reality the tendencies to spatial uniformity are combined with forces such as variations in resource availability and the efficiency of communications which lead to spatial heterogeneity. It is therefore interesting to see to what extent tendencies towards regular distribution can be discerned.

The most common technique that has been used to do this is nearest neighbour analysis, originally developed to analyse point patterns in ecological

studies (Clark and Evans 1954). The nearest neighbour statistic, R , is derived from comparing the actual mean distance between points and their nearest neighbour, \bar{r}_a with the mean distance to be expected if the points were distributed in a completely random fashion, \bar{r}_e .

$$R = \bar{r}_a / \bar{r}_e$$

A value of 1.0 for R indicates a random distribution of points. When R is less than 1.0 the pattern will tend towards aggregation or clustering, and a value of zero for R would mean all points have the same location. When R is more than 1.0 the pattern will tend toward uniformity or dispersion, and the maximum value of R is 2.1491, which indicates that the points conform to Christaller's triangular pattern (that is, maximum uniformity).

The nearest neighbour statistic was calculated for *B*, *C* and *D* level settlements (Fig. 1). Where a settlement of a given level was located close to a settlement of a higher level than to one of the same, then the former distance was measured since every central place performs all the functions of lower order ones. For *D*-level settlements distances were measured to the second, third and fourth nearest neighbours as well as the first.

The values of \bar{r}_a and \bar{r}_e , R and the 95 per cent confidence limits on \bar{r}_e were calculated (Table 9).

The results show a tendency towards uniformity at all hierarchical levels but one which is greatest at the *B*-level and lowest at the *D*. While all the results are significant at the 95 per cent level, the values of R are somewhat less than the maximum of 2.1491, and so there is obviously a considerable random element in the distribution. That this is strongest in the *D*-level settlements is not surprising since these are agricultural villages with only minor central place functions, if any, and their distribution should not therefore be interpreted in terms of the spatial competition between service centres. This is emphasized by the values of R for second, third, and fourth nearest neighbours which increasingly approach a value of 1.0,

TABLE 9. The Nearest Neighbour Statistic (R) for *B*, *C* and *D* Level Settlements

	R	\bar{r}_a	\bar{r}_e	95% limits on \bar{r}_e
B-level	1.590	65.87	41.43	15.01
C-level	1.551	45.43	29.30	7.51
D-level (1st)	1.225	11.65	9.51	0.79
(2nd)	1.136	16.20	14.26	0.82
(3rd)	1.116	19.87	17.82	0.83
(4th)	1.097	22.82	20.79	0.84

indicating a random distribution. However, at the two higher levels where central place functions are performed, spatial competition between centres must be considered as an influence on their distribution, and hence the greater regularity in their distribution.

5) aggregate relationships in the central place system of West Thessaly

The attributes of the settlements which form the elements of the central place system are population, numbers of central functions and numbers of functional units. In examining the relationships between these variables, the aim is to confirm the expected hypothesis that increases in one variable will be reflected in constant increases in the others.

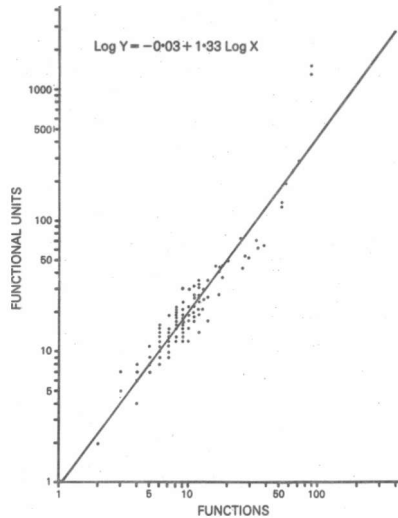
(a) *Functions and Functional Units*: Some workers have plotted these variables on a semi-logarithmic graph in order to show whether or not the number of functional units increases by a constant percentage of the previous total for each new central function which is added. However, since data on settlement populations and functional attributes tend to have a frequency distribution which is highly skewed and leptokurtic any attempt to measure the relationship between variables by the parametric techniques of linear regression and correlation analysis cannot properly proceed until both data sets have been transformed. When this is done a log-log distribution is found (Fig.3). The regression equation is

$$\text{Log} = -0.03 + 1.33 \text{ Log } C, \text{ and } r = 0.96$$

It is interesting to note that the centres of the *B* hierarchical level lie almost exactly on the regression line, while those of the *C* level have negative residuals; that is, they have less functional units than their number of functions might suggest, which might imply a declining role as true central places. In contrast, Trikala and Kardhitsa have high positive residuals. This can partly be explained by the fact that data were collected for 88 functions and, for various reasons, some functions were not included. Since these were primarily high order functions occupying relatively few establishments, it means that the total number of functions performed by Trikala and Kardhitsa is underestimated to a greater degree than the number of functional units.

(b) *Population and Functions*: These variables have also been thought to reflect a log-linear relationship, with population as the dependent variable. The distribution which Berry and Barnum (1966) found in SW Iowa certainly conformed more to this relationship than the previous one, and was similar to that found by Stafford (1963) in southern Illinois and O'Farrell (1967) in Co. Tipperary. However, other

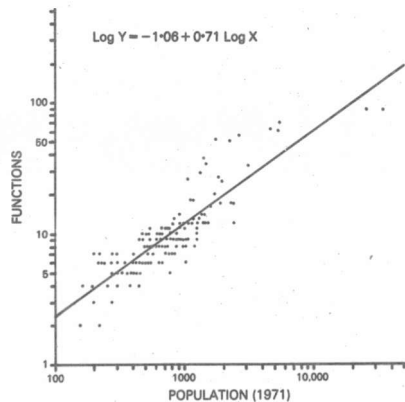
FIGURE 3. *Functions and Functional Units*



studies which included a larger range of settlement sizes than these ones found the curvilinear distribution more characteristic, indicating that the best expression of the relationship is a log-log one. This is shown for West Thessaly in Fig.4, and the regression equation is

$$\text{Log } C = -1.06 + 0.71 \text{ Log } P_c, \text{ and } r = 0.86$$

FIGURE 4. *Population and Functions*



6) conclusion

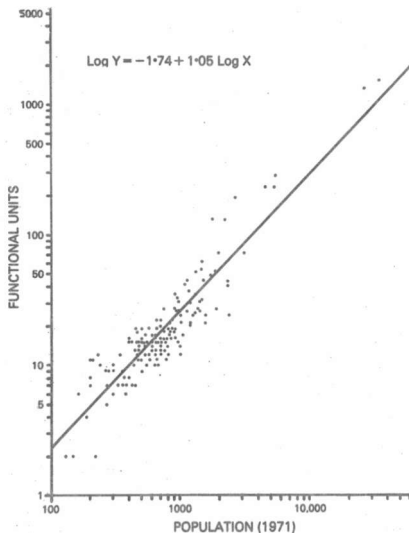
The settlements of *B* and *C* hierarchical levels all have large positive residuals. That is, they have more functions than their population might warrant, confirming their role as central places. On the other hand, Trikala and Kardhitsa have negative residuals. This can be explained partly by the study not including all possible functions, and partly by Thomas's (1960) suggestion that once a certain size level is reached, establishments are added more rapidly than functions since the greater numbers of people in larger places do not need different types of functions but rather easy access to the same ones.

(c) *Population and Functional Units*: Berry and Barnum (1962) regarded this relationship as being log-log. This relationship has been found in many studies and is also found in the present one (Fig. 5). The regression equation is

$$\text{Log } Y = -1.74 + 1.05 \text{ Log } X, \text{ and } r = 0.91$$

Berry and Barnum interpreted this as showing that multiplication of establishments of the same kind occurs in direct response to growing demand within the urban centre. This implies that as higher order functions are added, it is the lower order functions which duplicate.

FIGURE 5. *Population and Functional Units*



Three principal features of the structure of the central place system of West Thessaly have been discerned from the preceding analysis. Firstly, it has been demonstrated that the settlements of the system are grouped into distinct hierarchical levels, each level being distinguished from the one below it by a «basket of functions» found only in settlements at that level and those above. Secondly, it has been shown that the spatial distribution of higher order settlements has a tendency towards regularity. Thirdly, it was found that there are strong positive relationships between the numbers of functions, functional units and population, the constituent elements of the central place system. Together, these findings point to the existence of a well-defined and structured system with a high degree of internal organization. This accords closely with the kind of patterns and relationships predicted by the Christaller model of a central place system. Nevertheless, despite the regularities in hierarchical and spatial structure which have been identified, it may be that refinements of Christaller may provide better generalization. The environmental and behavioural assumption of the Christaller model are unlikely to be fulfilled in reality, for example, although in some respects West Thessaly may come closer to this than many other areas. Some of the more recent developments such as those by Mitchell et al. (1974) and Parr (1978) which relax some of the more rigid assumptions of the original model may provide even more satisfactory explanations of the observed patterns.

The main purpose of this study has not been, however, the verification or modification of central place theory. Rather, the theory has been used as the most appropriate background for the investigation of the structural characteristics of the settlement system of West Thessaly, and it is the practical implications of this research which should be given the greater emphasis. The creation of an efficient spatial structure is a major element in maximising social and economic welfare. The application of the principles of central place theory can therefore be seen as a valuable aid to the creation of a policy framework which will avoid wasteful locational strategies and achieve a more efficient allocation of resources. Although used widely in many places, the potential of this approach is only gradually being appreciated in Greece (Andreadhis 1966, Thessaloniki University 1975) and still remains to be applied in practice. Compared to many countries in the world, the relatively unsophisticated state of Greek planning in general is not unusual, but in a European context it does contrast unfavourably with the systems operating in most countries (Hoffman 1971, 1972, Clout 1976). Given

the eventual accession of Greece to the E.E.C., the problem of regional inequalities within the country (in which the nature of the settlement system is an important element) will become part of the problem of regional inequalities within the community. The optimum allocation of resources, both internally and externally provided, therefore becomes a concern for more than the Greeks alone. While there has been some recognition in Greece of the fact that regional development requires sectoral economic development policies to be related to the settlement system (Ministry of Co-ordination 1968) much work still needs to be done in refining and actually applying these principles. Not least among the problems of doing so is the paucity of information and research work on many of the relevant aspects of this question. The work reported here may be viewed as a contribution towards a greater understanding of but one of these aspects, the structure of the Greek settlement system, and some implication for future planning strategies may be drawn from it.

(a) *Implications for planning research:* The basis for any effective formulation and implementation of regional planning policies is a sound knowledge of the physical, economic and social characteristics of the region. Because of this obvious need, and the shortage of centrally collected and published data, the activities of the Regional Development Services after they had been established in the 1960s were initially concentrated on providing such information. However, the analyses of the data were mainly rather subjective. In the specific instance of settlement classification in Thessaly, the scheme published by the Regional Development Service of Thessaly (1968) differs considerably from that which has emerged in the present study. The Service, for example, group Palamas and Kalambaka with Trikala and Kardhitsa as large centres of attention, and Pili with Leondari and Kedhros as small centres. That the analysis made here suggests that there is no basis for such a grouping is illustrative of the need to apply objective techniques of the type used in the study, especially if the classification is to be used subsequently as the basis for any kind of allocative decision making. While it may not be practical to undertake detailed *ad hoc* data collection exercises like that made in West Thessaly, the analytical approach could nevertheless be used with more aggregated data such as that in the 1969 Census of Commercial Establishments (NSSG 1971).

(b) *Implications for regional and sub-regional planning:* The spatial perspective can never be removed from sectoral planning considerations and it is here that central place principles can be most readily applied. As Dawson (1973) noted, the «description and explanation of the relative marketing impor-

ance of the settlement system in a region, together with the retail/wholesale structure of these centres, is vital to any attempt to produce a regional development plan». In many developed and developing countries this is already recognised, and the aim is often to establish a network of service centres in newly settled areas or in regions where a subsistence economy prevails (Johnson 1970). In the Greek context greater value may be obtained from central place theory in the insight which it provides into the structure and behaviour of the existing settlement system while it may also form a basis for making decisions about the future provision of retail and non-retail service activities.

The significance of the service sector in the economy of Greek provincial towns and the orientation of industry to localized raw material sources (especially agricultural) means that the future prosperity and growth or decline of most towns is closely tied to changes in the economy of their hinterlands. Changes in the national economy influencing the output of large scale industry, or in the international economy influencing tourism, will be confined in their impact to a relatively small number of provincial settlements. As such, a closer understanding of the relationship between town and country is a prerequisite to effective regional and sub-regional planning, and planned interventions in either rural or urban economies cannot be divorced from each other, nor from physical planning activity.

The kind of analysis which has been made in this research can provide a general framework and insight for the formulation of policies within which more specific work may have to be done. Thus, for example, it could be said that in the West Thessaly plain improvements in agricultural productivity brought about by the further extension of irrigation or by land consolidation would most likely benefit the main towns of Trikala and Kardhitsa rather than those smaller centres located on the edge of the plain. In contrast, these latter settlements may see the erosion of their economic base as the depopulation of the mountain areas which they serve continues. The future of these areas is not encouraging: the expansion of forestry remains the main long-term hope and the further development of wood-based industries in small towns like Pili and Mouzakion may offer the best prospects for them. Similarly, it can be hypothesized that if real incomes do rise in this region then there should be a tendency for increased concentration of service activity on the larger centres since transport costs form a lower proportion of expenditure and personal mobility increases. This would be emphasized if some organizational changes were to occur in retail trade and larger shops were established in the main towns.

By providing this kind of interpretation of settlement systems central place analysis can provide pointers to future planning strategies. The detailed quantification of relationships for predictive purposes, however, ideally needs the application of techniques like regional accounting and input-output analysis such as Papageorgiou (1973) has attempted. In applying these at the regional level, and even more at the sub-regional, however, major methodological and data difficulties occur. It may therefore be that the less precise indications provided by this kind of central place analysis will have to suffice.

The identification of future trends in town-country relationships is complemented by the more common use of central place concepts as a basis for locating new retail and service establishments. As far as retail units are concerned, application of this kind of research can be made either by entrepreneurs to assess locations for new shops or by physical planners to determine the amount of new shopping development that should be permitted or provided for in any particular place. At the moment in Greece shop location decisions by the independent entrepreneur are probably largely intuitive, while physical planning intervention is minimal. In the case of non-retail services, central place principles can also be usefully applied, especially for educational, health, administrative and other similar functions.

There are a number of elements involved in the decision about where to locate a new shop. One of the most crucial is accessibility to consumers and this, of course, is the focus of central place analysis. This research has provided information on the types of centres found in provincial Greece and their characteristic functions, and the threshold populations of functions. Together with work on patterns of consumer movement (Bennison 1977) it should provide potentially useful background information for any person or organization actively interested in this field even if some additional research more specific to their circumstances may be necessary to take into account other influences on store location and performance (see R. L. Davies, 1976). From the viewpoint of planning for future retail provision, the kind of information provided here would form a useful basis for estimating future retail requirements in new suburbs or in existing centres even if again more specific additional information may be needed.

The development of local centres through the planned provision of additional service activities (especially non-retail commercial and non-commercial ones) may produce a net increase to the real income of the centres and of the regions served by them, particularly if they are government financed when they can be regarded as agents of the transfer of wealth from the richer regions to the poorer.

Moreover, certain activities may act as stimuli to further social and economic change and/or assist the reduction of regional emigration. The information provided by this research might be used in a similar way for these functions as its application in retail trade although in the case of centrally financed social services economic criteria are by no means the only ones to be taken into account.

In all potential applications of central place theory to planning problems it needs to be emphasized, however, that it does provide a simplified view of reality, in particular through the assumptions that are made on entrepreneurial and consumer behaviour, and the exclusion from consideration of the social, political and economic environment of the system. These shortcomings point the direction in which future research effort in this field in Greece could be most profitably concentrated. Thus, for example, within the specific field of retail trade it is clear that there is very substantial scope for work on both the nature and costs of distributive channels. Similarly, in examining the role and behaviour of the settlement system, for instance, more sophisticated regional and sub-regional studies might be made, looking particularly at migration and the performance of local economies, although data problems remain a major hindrance to any research in the country. The practical application of either this or any additional research, however, can only be realised within the context of an effective planning machinery and a political readiness to intervene: neither of these conditions really exists at the moment. That there is a need for this, however, should not be open to doubt in the light of the impending full membership by Greece of the European Economic Community.

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