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## Multi-Level Interaction And Growth Potential of Large Centers: A Case Study In Turkey

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**MULTI-LEVEL INTERACTION AND GROWTH POTENTIAL OF LARGE CENTERS :  
A CASE STUDY IN TURKEY**

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**ABSTRACT**

The impact of growth on urban centers within a multi-growth centers environment has become an important subject for investigation in both developed and developing countries. This study presents a variation of a multi growth technique developed by Fotheringham. A model is developed to test growth impacts under the assumption that an urban center may be influenced not only from the center's upper levels , but also from the center's lower levels in a multi-level coordinated system of centers. The model is based on a multiple-regression analysis. The growth rate of urban centers is defined as the dependent variable , while their locational potential with respect to other centers on each level of the hierarchy and their population size are defined as independent variables. Because large centers have the most important function in Turkey in diffusing growth from both upper to lower levels of the hierarchy and lower to upper , their growth impacts in different time periods are investigated. According to the application of the model for Turkey , the large centers on the periphery showed more potential for growth than those in close vicinity to growth centers during periods when their growth was supported through extraordinary national subsidies. Another result of this application was that there was an important interaction between the growth of large centers and changes in rural areas.

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## INTRODUCTION

In many developing countries, unbalanced urbanization is a serious problem that retards overall development. When urban growth is limited to only a few large centers, diffusion to peripheral rural areas tends not to occur. In particular, the lack of intermediate urban centers hinders upper and lower levels of the urban hierarchy from being adequately interconnected. A restructuring of the urban hierarchy can bridge the gap between developed and less developed areas and ensure a more efficient allocation of resources to generate growth effectively. Urban growth diffusion can be best controlled by the use of development programs that expand chosen centers in key locations – known as planned or induced growth poles – in the urban hierarchy (Friedmann, 1966; Konstantinov, 1977; Richardson and Richardson, 1973; Moseley, 1974; Walsh, 1980). Since the economic efficiency of the urban system is critical to the efficient use of national resources, more research needs to be done on such programs at both regional and national levels.

Several studies have been done on growth pole strategies, on central places and hierarchical interactions between them, as well as their spatial competitive structures (Boisier, 1980; Bylund, 1972; Derwent, 1969; Gilbert, 1974; Higgins, 1972; Morrill, 1973; Parr, 1973, 1978, 1981, 1987; Mulligan, 1984). A great deal of them have investigated ways to divert urban growth from overcrowded metropolitan areas toward smaller cities.

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Their major concern was to determine the most efficient allocation of resources in order to generate growth effectively. Some of them claimed that the most efficient way to generate development in lagging regions is to concentrate investments in a relatively few places with genuine growth potential, i.e., in growth centers (Hansen, 1972, 1978).

Another approach to the growth process is described by **Berry** (1973) as a general model of hierarchical diffusion. According to Berry , a city system consists of hierarchically interrelated centers and their urban influence areas within their surroundings. Growth effects radiating from a given urban center are proportional to the center's size and are transmitted from higher to lower centers in the hierarchy.

A more general model of testing multi-center diffusion of urban growth is given by **Fotheringham** (1979). In addition to using a more comprehensive measure of distance , this study developed a method to test for polarized growth within a multi-growth center environment in the United States. It showed that there are centers around which growth is polarized , and the type of polarization can vary with time and with the size of centers to which growth is diffused. Further research , dealing with different types of spatial interaction processes has concentrated not only on the usual mass and distance effects , but also on the elements of accessibility and competitiveness in flows (**Esparza and Krmeneč**, 1994; **Fotheringham**,1981,1982,1983; **Fotheringham and Weber** , 1980 ; **Krmeneč and Esparza**, 1993). Other research has focused additionally on the feedback amongst the different interactional effects (**Fotheringham** ,1983, 1984 ; **Haynes and Fotheringham** ,1984) , as well as on reducing the statistical problems both of spatial-autocorrelated error and of internal dependence amongst regressors(**Fik**,1988; **Fik and Mulligan** 1990).

In general , previous studies investigated the spatial impact of growth centers by taking into consideration the degree to which growth impulses are transmitted from city to city through an urban hierarchy. In the present paper , however , the impact of two-level growth diffusion is investigated, such as from the growth centers to smaller centers and in reverse from the smaller centers to the large centers. Proximity to growth centers influences the growth rates of urban centers within local subsystems of interrelated centers, each comprising an urban center and surrounding satellites. Also , the growth potential of a center is a function of its accessibility to its satellites. In other words , improvement of mutual accessibility between growth centers and peripheries could be expected to be advantageous for the peripheral areas because of the improved access to large markets. In addition , such functional integration is beneficial for large centers through their superior capacity to utilize agglomeration and scale economies. The above-mentioned assumption is also supported by other studies that show that urban growth occurs principally through the interaction between cities

rather within an individual city (see, e.g. Robson,1973 ; Böventer,1973 ; Logan 1973).

Thus , the propose of this study is first to investigate relationships between the growth rate of an urban center and its accessibility to centers in upper and lower levels in the hierarchy and its population size in various time periods, then to identify strategically advantageous nodes which have growth potential because of their size and high degree of conductivity in the urban system. The concentration of effort and investment in a few strategic locations would create a new pattern of spatial change and influence , i.e. , hopefully become new growth centers. Although urban growth is a multidimensional phenomenon , this study is limited mostly to growth tendencies related to the relative location of the urban center in the urban hierarchy by omitting the growth case based on natural resources or large industrial investments.

The paper is organized in the following way. The definition of the urban system and explanation about the hierarchical levels of centers is given in the next section. A multiple-regression analysis is carried out for four five-year periods between 1975-1997 for Turkey in Section 3. The growth rate of cities is determined as a function of the change in their locational potential with respect to (i) growth centers , (ii) small centers, and (iii) rural centers and (iv) their population. The analysis is primarily concentrated on large centers since the growth of small centers can be easily stimulated through even small investments, which would make it difficult to measure their locational potential . The results are evaluated in Section 4. The final section is devoted to a conclusion , and the implications of the results for public policy are discussed.

## **2. DEFINITION OF THE SYSTEM**

According to spatial theory , a regional system consists of hierarchically coordinated multi-level cities. The development of this hierarchical network is dynamic and is continually influenced by multi-level interactions. Well-developed hierarchical linkages provide the system with effective flows and functional relationships between the various levels of the system and thus influence the growth of these centers. However , most of the models do not take into consideration hierarchical relationships. In this study , a city system is defined as hierarchically coordinated multi-level cities which affect each other's growth. Two hierarchical levels of centers are defined : (i) growth

centers (ii) Large centers (cities 100 000 – 300 000 ). Let us denote this system by L with  $p= 1,2$  as follows :

$$L1 = P_j / j \quad j=1, \dots, n_g \quad \text{growth centers}$$

$$L2 = P_j / j \quad j=1, \dots, m \quad \text{cities 100 000 – 300 000}$$

The existing hierarchy of cities is determined solely on the basis of population data. It is assumed that population is an important index determining city rank. Taking into consideration the particular circumstances of Turkey the population threshold for growthcenters is assumed to be 300 000. This assumption is also supported by previous studies. For instance, according to Berry (1970), above 250,000 the necessary conditions for self-sustaining growth, to the point that growth is diffused outward, seem satisfied. There were seven centers in this category in Turkey in 1997 (see in Table 1 and figure 1). Some of these growth centers have played important roles in the historical background of the country. For instance : Bursa , and afterwards Istanbul , had been for year's capital cities of the Ottoman Empire and therefore both cities have considerable economic, social and cultural potential. İzmir was and had been important harbour and trade center for international import and export trade. Gaziantep , located on the İstanbul – Baghdad railway (an important transportation connection in the late 19 th and early 20 th century), has had traditional manufacturing potential. Ankara which became the capital of the country after the foundation of the Turkish Republic in 1923 has changed gradually from a small Anatolian city to a main service center. The growth process of this city has been so successful that four large centers in its proximity have flourished. With urbanization and industrialization of the country , several central activities have located in each of these centers, partially as a result of the investments by the government and partially due to their strategic locations at the hub of several transportation connections. Adana has become an industry center based on agricultural production in its hinterland. According to the socio-economic changes in these centers , their population has increased permanently as well . It could be said that these growth centers , with settlements in their hinterlands, create to some extent a hierarchical ly coordinated mul ti-level system of centers.

Table 1. Population of Growth Centers

Growth Centers	1975	1980	1985	1990	1997
Istanbul 8260438	2547364	2772708	5475982	6620241	
Ankara 2984099	1701004	1877755	2235035	2559471	
Izmir	636834	757854	1489772	1757414	2081556
Adana	475384	574515	777554	916150	1041509
Bursa 1066559	346103	445113	612510	834576	
Gaziantep 712800	300882	374290	478635	603434	
Konya 623333	246727	329139	439181	513346	

Source: D.Ý.E., 1997 Census.

Level two consisted of large centers with population between 300,000 and 100,000. Their relative size indicates that the cities have begun to outdistance most competitors within their national or regional city-system. Much of their growth is attributable to the impact from growth centers. They also contain several urban activities, however, at a lower level than these in growth centers. If a large center is in the vicinity of a growth center, its urban activities have an intensive functional relationship with those in that relevant growth center. These large centers have also been supported by urban and rural hinterland linkages. There were 36 such centers in 1997 in Turkey (see Table 2). Of them, 36 were included in the analysis. The boundary of urban hinterland is assumed to be 100 km for large centers. Based on the condition of Turkey's transportation system this seems to be a reasonable distance, which should correspond approximately to 3 hours go-and-back travel time between large centers and their hinterlands for socio-economic, commercial and managerial daily activities. As such, this is accepted as the maximum distance between two centers to go from one to the other, meet some needs and return on the same day to the dwelling site. Due to the insufficient transportation network in Turkey, interactions of a large center with rural and small centers outside of its hinterland do not seem realistic and therefore have not been taken into consideration in the analysis.

In functional terms, cities are an aggregation of specialized activities which are spatially concentrated and functionally interrelated. Each activity has its own set of relationships with the centers below and above

its level in the hierarchy. Because of the multidimensional aspects of these relationships, the boundary of urban hinterlands is the result of the spatial range of several central place activities. By taking into consideration the interdependence between the levels of the system, the growth potential of a center can be defined as a function of the change in the locational potential with respect to growth centers as well as the locational potential with respect to urban and rural centers within its hinterland.

Table 2- Population of Large Centers

Large centers	1975	1980	1985	1990	1997
Kocaeli	165483		190423	233338	256882
202003					
Erzurum	162973	190241	246053	242391	298756
Sivas	149201	172864	198553	221512	224103
Denizli	106902	135373	169130	204118	230708
Tarsus	102186	121074	146502	187508	192413
Kırkkale	137874	178401	208018	185431	205208
Sakarya	114130	130977	152291	171225	184013
Balıkesir	99443	124051	149989	170589	184612
Gebze-Kocaeli	33110	58318	92592	159116	237494
Manisa	78114	94167	127012	158928	194775
Yskenderun	107437	124824	152096	154807	166228
Van	63663	92801	110653	153111	225628
Batman	64384	86172	110036	147347	212563
Trabzon	97210	108403	142008	143941	177904
Kütahya	82442	99436	118773	130944	158776
Hatay	77518	94942	107821	123871	140601
Osmaniye	61581	84212	103824	122307	159318
Çorum	64852	75726	96725	116810	147391
Zonguldak	90221	109044	117879	116725	106742
Isparta	62870	86475	101215	112117	126196
Aydın	59579	74021	90449	107011	133939
Karabük	69182	84137	94818	105373	102728
Uşak	58578	71469	88267	105270	124042
Edirne	63001	71914	86909	102345	108547
Ordu	47481	52785	80828	102107	116083
Adıyaman	43782	53219	71644	100045	213596
Afyon	60150	74562	87033	95643	111580
Aksaray	45564	62927	81056	90698	100944
Nazilli-Aydın	52176	60003	77627	80277	102593
Karaman	43759	51208	64735	76525	103899
Çorlu-Tekirdağ	40134	47086	59107	74681	117447
Siirt	35654	42291	53884	68320	104475
Kızıltepe-Mardin	21531	30445	40852	60134	112504
Viranşehir-Urfa	26244	40820	45329	57461	106685
Alanya-Antalya	18520	22190	28733	52460	110101
Bismil-Diyarbakır	12775	19059	24862	39834	101526

Source : D.Ÿ.E ., 1997 Census

### 3. MODEL

A model is developed to investigate the key nodes which have growth potential in an urban hierarchy. This model were based on a technique developed by Fotheringham (Fotheringham,1979). The main emphasis is given to the supposed interdependences of a city-system in a developing country, and especially to the importance of growth transmission linkages between



growth centers and large centers supported through urban and rural center linkages. The interdependences of the system are especially investigated for large centers because of the difficulties of measuring locational growth potential for small centers since they are easily affected by even small local investments.

A multiple-regression model is used for the analysis. The growth rate of large centers is assumed to be the dependent variable of the analysis. Locational potential of large centers with respect to growth centers, to small centers, to rural centers and distances to the growth center which effects large centers are taken as independent variables. It is assumed that growth is transmitted from growth centers to large centers if the supporting potential on large centers from small and rural centers in their hinterlands exists. In other words, there should be backward and forward growth transmission linkages from large centers to the surrounding hinterland to secure a genuine growth diffusion from growth centers to large centers. The multiple-regression model used in the analysis is given below :

$$r_i = a_0 + a_1 V_{si} + a_2 V_{gi} \quad (1)$$

where :

$r_i$  growth rate of large centers ;

$a_0, a_1, a_2$  constants;

$V_{si}$  Locational potential of large centers with respect to small centers within 100 km

$V_{gi}$  Locational potential of large centers with respect to growth centers

The variables of the model - the locational potential , urban growth rate - are explained below.

### 3.1. Locational Potential

The proximity of individual centers to each other represents an important element in the definition of the urban system. Geographical

patterns of accessibility to population can often be expressed in terms of potential value for city  $i$  as (see, e.g. Isard, 1960) :

$$V_i = \sum_{j=1}^n P_j / d_{ij}^b \quad (2)$$

where

$V_i$	Locational potential of $n$ centers on center $i$
$P_j$	population of the center $j$
$d_{ij}$	distance between the points $i$ and $j$
$b$	exponent
$n$	number of urban centers.

If the hierarchy concept is included in the simulation of locational potential, the locational potential of a large center can be decomposed into two elements :

(i) locational potential with respect to growth centers, (ii) locational potential with respect to small centers. These can be expressed as follows :

$$V_{Si} = \sum_{j=1}^{n_s} P_j / d_{ij}^b \quad (3)$$

This expression of locational potential provides a comprehensive measure for the analysis by taking into consideration the weighted distances by population of the centers whose impacts are in question. The distances are expressed in terms of real distance measures.

The correlations between the growth rate (dependent variable) and  $V_{Gi}$ ,  $V_{Si}$  in each remaining combination are determined.

### 3.2. Population Growth Rate<sup>3</sup>

The urban growth rate is another variable of the analysis. The calculation procedure for the urban growth rate assumes that past population growth has followed a linear pattern in which population is explicitly a function of time. In order to take into consideration the differing time periods, each intercensal period was reduced to an average annual change figure. This is expressed as :

$$r_i = (P_n - P_0) / P_0 * N$$

where:

$r_i$	annual population growth rate for the city $i$
$P_n$	population of city $i$ in most recent census
$P_o$	population of city $i$ in the preceding census
$N$	number of years in an intercensal period

#### 4. REGRESSION RESULTS

According to the regression results, it is found that in Turkey there is not a correlation between growth rate and the population potential and distance to the growth centers. The regression results do not support the core-periphery model of growth for all the periods (1975-1997).

Again according to the regression results, there is a correlation between growth rate and the population potential and distance to the growth center which influences large centers with population between 200.000 – 300.000 in 1970-1975 period.

When we separate large centers into four groups by their location as Western Turkey, Middle and Northern Turkey, Middle and Southern Turkey and Eastern Turkey; regression results as below:

During the period between 1975-1997 there is not a correlation between growth rate and the population potential and distance to the growth centers in the Western Turkey.

In the Eastern Turkey there is a correlation between growth rate and the population potential and distance to the growth centers during the period between 1985-1990. All other periods, there isn't a correlation.

In the Middle and Northern Turkey there is a correlation between growth rate and the population potential and distance to the growth centers during the period between 1975-1980. All other periods, there isn't a correlation.

In the Middle and Southern Turkey there is not a correlation between growth rate and the population potential and distance to the growth centers during all the periods (1975-1997).

These results could be attributed chiefly to the government's socio-economic policies against unbalanced urbanization and the lower socio-economic status of some regions of the country during the latter mentioned time periods.

The regression results do not support the core-periphery model of growth for all the period (1975-1997) for Turkey. These results could be attributed chiefly to the government's socio-economic policies against unbalanced urbanization and the lower socio-economic status of some regions of the country during the mentioned time periods.

## 5. CONCLUSION

The main objective of the study is to investigate whether the new forces of urban growth can be used to channel development into peripheral areas that are lagging behind the nation in income and employment opportunities. For this purpose, the relationship between the growth rate of a city and its locational potential with respect to other centers at different levels of the hierarchy were investigated. Urban growth with respect to the urban system is a difficult process to model. In this study, a model was developed to determine the key nodes which had growth potential relative to the system of cities. Because of their potential for growth, special emphasis was given to large centers. It was accepted that in a multi-level coordinated hierarchical system of cities, a city is not only under the potential influence of centers in levels above but also under the potential influence of centers in lower levels as well. Previous studies, however, have taken into consideration only the impact to a center from centers in levels about it. A step-wise regression analysis was used for this purpose. The growth rate of large centers was taken as the dependent variable. The independent variables were the locational potential of large centers with respect to growth centers, small centers in their hinterlands.

An important result of the analysis is to highlight the reality that the growth rates of large centers was influenced mostly by changes in rural centers. In other words, investments in large centers attracted population from rural centers. Urbanization and industrialization were the main factors in Turkey causing permanent migration since the 1960's from rural areas to urban centers, especially to growth centers and large centers. It is, therefore, urgently necessary to set a rational development planning into action to control disorderly urbanization and industrialization in North-West, and to stimulate existing resources and to create new resources in Eastern Turkey. So it could be possible to stabilize population flows in an optimum level.

It is possible that the explanation of growth could be improved by the use of other variables for which population is used as a surrogate, or

by modifying the formulation of the locational potential. For instance, to get more comprehensive results, industrial investments made to different levels of the urban hierarchy and locational potential of a large center with respect to other large centers could be included as further independent variables to the analysis, or instead of population growth, the employment growth rate could be taken as the dependent variable. Spatial autocorrelated error and internal dependence of variables could be tested as well with the help of more comprehensive analysis. These could be the subject of further research. In addition, more comprehensive results can be obtained when the analysis is repeated to include time periods after 1980.

In recent years, important progress has been made in the analysis and development of urban systems. However, their diverse results indicate that further extensive research is needed to predict the fundamental characteristics of urban growth processes with respect to international urban networks.

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