# 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 interconnect. A restructuring of the urban hierarchy can bridge the gap between developed and less developed areas and ensures 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 planed 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 mayor 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 concantrate 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 surroindings. 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 , dealtling with different types of spatial interaction processes has concantrated not only on the usual mass and distance effects , but also on the elements of accessibility and competitiveness in flows (**Esparza** and **Krmenec**, 1994; **Fotheringham**,1981,1982,1983; **Fotheringham** and **Weber** , 1980 **; Krmenec** 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-autocorreleted 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 benefical 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 areevaluated 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 hierarchicallycoordinated multi-level cities which affect eachother'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 = Pj / j  j=1,....ng  growth centers
L2 = Pj / j  j=1,....m  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 backround 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. Ýzmir was and had been important harbour and trade center for international import and export trade. Gaziantep , located on the Ýstanbul – Baghdad railway (an important transportation connection in the late 19 th and early 20 th century), has had traditional manufactoring 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 succesful 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 hierarchically coordinated multi-level system of centers.

Table 1. Population of Growth Centers

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

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 hinterlend 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 hinterlend 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 hinterlends 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 aggretion 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 rangeof 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 |
| Kýrýkkale | 137874 | 178401 | 208018 | 185431 | 205208 |
| Sakarya | 114130 | 130977 | 152291 | 171225 | 184013 |
| Balýkesir | 99443 | 124051 | 149989 | 170589 | 184612 |
| Gebze-Kocaeli | 33110 | 58318 | 92592 | 159116 | 237494 |
| Manisa | 78114 | 94167 | 127012 | 158928 | 194775 |
| Ýskenderun | 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 |
| Aydýn | 59579 | 74021 | 90449 | 107011 | 133939 |
| Karabük | 69182 | 84137 | 94818 | 105373 | 102728 |
| Uºak | 58578 | 71469 | 88267 | 105270 | 124042 |
| Edirne | 63001 | 71914 | 86909 | 102345 | 108547 |
| Ordu | 47481 | 52785 | 80828 | 102107 | 116083 |
| Adýyaman | 43782 | 53219 | 71644 | 100045 | 213596 |
| Afyon | 60150 | 74562 | 87033 | 95643 | 111580 |
| Aksaray | 45564 | 62927 | 81056 | 90698 | 100944 |
| Nazilli-Aydýn | 52176 | 60003 | 77627 | 80277 | 102593 |
| Karaman | 43759 | 51208 | 64735 | 76525 | 103899 |
| Çorlu-Tekirdað | 40134 | 47086 | 59107 | 74681 | 117447 |
| Siirt | 35654 | 42291 | 53884 | 68320 | 104475 |
| Kýzýltepe-Mardin | 21531 | 30445 | 40852 | 60134 | 112504 |
| Viranºehir-Urfa | 26244 | 40820 | 45329 | 57461 | 106685 |
| Alanya- Antalya | 18520 | 22190 | 28733 | 52460 | 110101 |
| Bismil- Diyarbakýr | 12775 | 19059 | 24862 | 39834 | 101526 |

Source : D.Ý.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 :

$$ri = a0 + a1\ VSi + a2\ Vgi \qquad (1)$$

where :

ri — growth rate of large centers ;

a0,a1,a2 — constants;

Vsi — locational potential of large centers with respect to small centers within 100 km

Vgi — 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**, 1060) :

$$Vi = \sum_{J=1}^{n} Pj / d^{b} \qquad (2)$$

where

| | |
|---|---|
| Vi | locational potential of n centers on center i |
| Pj | population of the center j |
| d? | 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 :

$$VSi = \sum_{J=1}^{ns} Pj / d^{b} \qquad (3)$$

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 VGi, VSi in each remaining combination are determined.

### 3.2. Population Growth Rate[3]

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 :

$$ri = (Pn-Po) / Po*N$$

where:

| | |
|---|---|
| ri | annual population growth rate for the city i |
| Pn | population of city i in most recent census |
| Po | 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 regrassion 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 separete large centers into four groups by their location as Western Turkey, Middle and Nothern 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 te period between 1985-1990. All other periods, there isn't a correlation.

In the Middle and Nothern 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 doesnot 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 purprose. 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.

A important result of the analysis as 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 industrilization 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 industrilization in North-West, and to situmulate 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 comprehensize 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 foundamental characteristics of urban growth processes with respect to international urban networks.

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