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POLYCENTRIC EMPLOYMENT GROWTH AND IMPACTS ON URBAN COMMUTING PATTERNS: CASE STUDY OF ISTANBUL

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Abstract: There is strong trend for suburban clustered employment growth in many large cities. However, such a polycentric employment growth is quite complicated and subject to many factors. Empirical research mostly focuses American cities. Therefore it is necessary to analyze different cities with different specific characteristics to provide a better explanation of polycentrism. This paper analyzes the metropolis of Turkey, Istanbul, by using available data between 1985 and 1997. Employment centers are defined and a methodology explained to classify clusters of employment centers using rank-size distributions. The dynamics of each center are examined. The impacts of multi-centers on commuting patterns and the spatial extent of labor sheds are also discussed for each type of sub-center. The location policies of the Istanbul Metropolitan Area Sub-Region Master Plan are described and the stated outcomes of the plan for 2010 are assessed based on evidence from historical changes in employment location.

Key Words: Urban dynamics, Polycentric cities, Employment sub-centers, Policy

1. INTRODUCTION

Location theory examined the mono-centric city, and how to define, and delimit, the central business district (CBD). Large, sprawling, metropolitan regions of the type experienced in North America or Australia have suburbanized, or decentralized, many of their employment functions. This strong trend for suburban-clustered employment growth in metropolitan areas is complicated, and subject to many factors given market forces operating in the land market. There has been considerable interest in the analysis of polycentric employment nodes (Greene, 1980;

Gary, 1990). However, the existing empirical research on employment sub-centers is mostly for American cities, as elaborated on in Section 2.

In developing countries, public transport is predominantly road based, and the employment location dynamics are poorly understood (Hayashi, *et. al*., 2004). Therefore, more findings from different cities with their own specific characteristics will provide a better explanation of clustered employment growth to assist planners, and this is the research gap addressed in this paper. The case study is of a rapidly growing city where there is no commuting rail systems but a very uniform bus services (stage bus and dolmus – minibus jitney service) across the city. Istanbul, with more than 10 million people is one of the largest metropolises in Europe, and the largest settlement in Turkey, which is a developing country located at the southeastern edge of Europe. Recently, master plans have been formulated to guide the future development of the region, including the spatial location of urban functions. Understanding polycentric employment growth is important for policymakers because as the city has expanded rapidly its functions in recent years to create different clusters of employment sub-centers, especially with the construction of two highway bridges over the Bosporus Strait, travel patterns have been shaped in such a way that more than half of the daily trips are work-related trips.

Three contributions are made in this paper. First, with the application of the rank-size rule (Section 3), and other descriptive statistics, clusters of sub centers are identified, and their urban dynamics between 1985 and 1997 are compared in order to understand the possible distinctions between old and new agglomerations of Istanbul (Section 6). Secondly, in Section 7, the impacts of polycentrism on commuting patterns are analyzed by comparing the trip characteristics attracted by each type employment center in terms of trip length frequency, and the spatial extent of the labor market, as determined by its intervening opportunity surface to commuters (Stouffer, 1940). Typical levels of public transport mode share in the different clusters are given. Finally, the context for this analytical research into employment clusters is explained with particular reference to a recent master planning exercise for Istanbul (Section 5).

2. STUDIES ON POLYCENTRISM

Analytical studies are dependent on sound definitions and adequate data availability. Polycentric or multi-centric employment is defined as the decentralized, but clustered, formation of work agglomerations in sub-centers rather than employment concentrating in one central business district. Early location theorists considered the properties of the mono-centric city, and criteria for the geographical delimitation of the central business district (CBD), but new urban spatial structures have emerged. A substantial amount of job growth or relocation occurred in employment centers other than downtown. Between 1980 and 1987, office space increased by 48,5 % in Chicago (McDonald and McMillen, 1990). William and William (1998) also showed that in 1972 half of the total employment was within the city limits. However, by 1992 only 28 % of the total metropolitan employment was within the city limits. All the above empirical studies for American cities have reinforced observations that there has been a strong trend towards new employment center developments, predominantly along expressways and freeways, or close to airports. Office agglomerations have also formed around major rail stations.

Greene (1980) defined zones as sub-centers that had an employment density twice the average for the city. This was a very simple definition to distinguish between the CBD and already existing or newly emerging centers. Giuliano and Small (1991) defined agglomerations (in Los Angeles) as sub-centers that are a set of contiguous zones with at least 10 employees per gross acre and a total employment of at least 10 000. Similarly, Cervero and Wu (1997) used small census tracts (in San Francisco) and defined the employment centers as a contiguous set of census tracts with employment densities that exceed 7 workers per gross acre, with the total of the tracts being more than 10 000. Both approaches are not useful definitions because the values of density and absolute employment may differ with the different size of the city. Donald and Prather (1994) followed a two-step statistical approach, determining a regression equation for employment densities that change with the distance to the CBD in Chicago. Significant positive residuals indicate the sub centers.

Increasing numbers of studies analyzing the impacts of polycentrism on residential location choices and commuting patterns have also appeared in the recent years. Poisson regressions for a sample of 62 large American urban areas provide strong support that the number of employment major sub-centers increases with population and commuting costs. Urban areas with low congestion develop their first sub-center when population reaches 2.68 million; and a second at a population of 6.74 million (McMillen and Smith, 2003). Cervero and Wu (1998) analyzed the trends in commuting distances and modal split for four class of employment centers defined in the San Francisco Bay Area. They have postulated that the multi-center employment structure failed to reduce the average commuting distance. The commuting distance increased by 12 % between 1980 and 1990. To the contrary, Gordon et al (1986) found for the Los Angeles County that shorter trips were compatible with the decentralization of both residential and business location in the area.

3. METHOD FOR CLASSIFYING EMPLOYMENT CENTERS

We propose a simple methodology using descriptive statistics then forming a typology of sub-centers (Alternative methods are discussed in Alpkokin, *et. al.* 2005). Zipf's Law of rank frequency distribution was applied to identify the clusters of sub-centers in Istanbul.

$$R_i^{\alpha} \times S_i = K.$$

When drawing the diagram for natural logarithms of size (S) and rank (R), a log-linear pattern is observed. When the slope equals -1 it is known as Zipf's Law.

Many empirical studies in classifying sub-centers have used gross employment density - the ratio of the total amount of employment to the total area including all the other land use activities – and this study is no different. However, we have not followed Cervero and Wu (1997, 1998) by accepting three types of employment centers (Old town or mature employment sub-center as CBD as Cluster 1;developing as an employment sub-center as Cluster 2) and not necessarily, but likely, to develop as an employment sub-center as Cluster 3) but we have examined the data to see what patterns emerge.

As the first step, the rank size distribution for natural logarithm of employment densities was drawn for traffic zones where data on employment is available. In the next step, the diagram was visually inspected and divided into parts indicated by obvious break of slopes. Cities with no

inflection points on the distribution would not have the same rationale to distinguish separate clusters. For Istanbul, a part at the end of the distribution was discarded where the densities in zones were too low to be taken as possible future employment centers. (We can also say something about the degree of concentration of employment in a few zones, or otherwise, by calculating the Lorenz curve for the cumulative proportion of jobs plotted against the cumulative proportion of zones.)

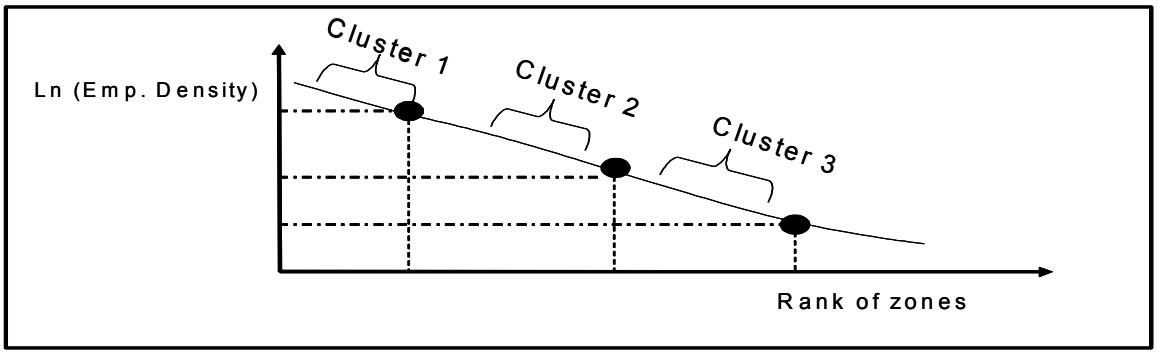


Figure 1. Rank Size Distribution of Logarithmic Employment Density

Comparison of the rank size distribution over two time periods can tell us a lot about the dynamics of change (Figure 2). If the increment of employment growth is exactly the same in every zone then the two distributions are parallel (Figure 2a). Other theoretical patterns are possible: smaller increments in the big centers and larger increments in the smaller zones – decentralization (Figure 2b); larger increments in the big centers and smaller increments in the smaller zones – centralization (Figure 2c); and the possibilities of absolute declines in employment in the larger zones (or in the smaller zones).

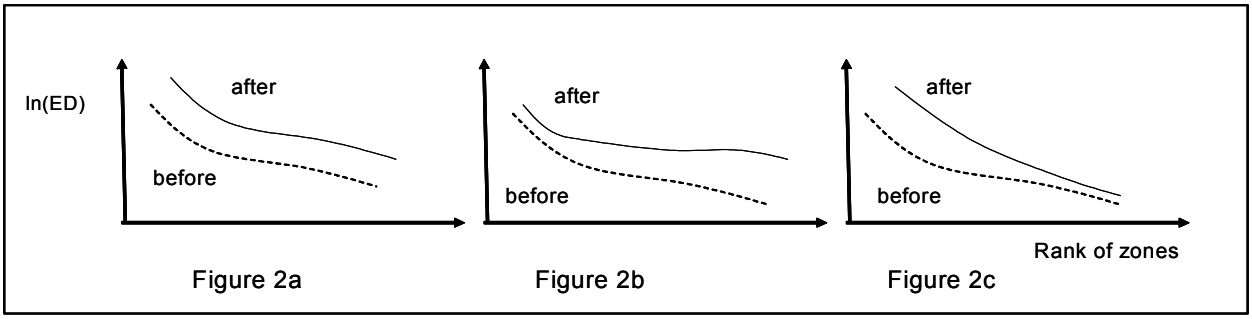


Figure 2. Dynamics of Employment Density Changes

4. THE CITY OF ISTANBUL

Istanbul is one of the most attractive cities with its strategic location on two continents, Europe and Asia, connecting them through the Bosporus Strait (Figure 3). The city has shown rapid growth after the First World War and became the core of the Turkish economy. Such a development, together with the driving forces of spatial dynamics, brought about a polycentric and mixed urban pattern over an area of more than 150,000 ha. Istanbul kept developing its

traditional CBD centre without loosing its primacy. Istanbul has a very important place among all the other historical cities in the world, mostly for its key role and position between the east and the west. Until the 15th century the Byzantium identity shaped the city with its settlements in the peninsula, as called historical peninsula today.

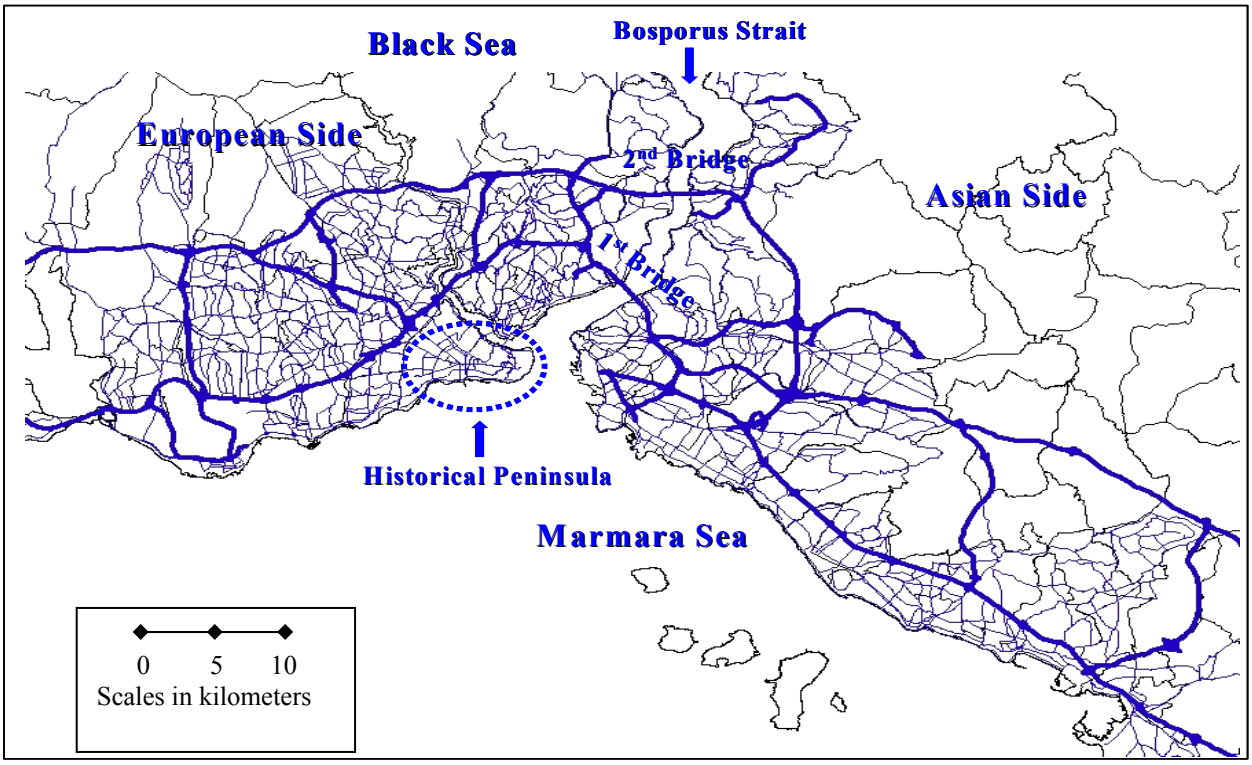


Figure 3. Highway Network in the Greater Metropolitan Area of Istanbul

After the 16th century when the Ottomans captured Istanbul and made it the capital city of the Empire, the city has gained an Islamic form but still with the structure of Byzantium times. In the 19th century, with the industrialization in the west, a multi centric development started along the Bosporus Strait and also on the Asian side of the city. After the First World War, the Ottoman Empire collapsed and Istanbul was no more the capital of the new Turkish Republic. However, large growth in industrial and commercial functions saved its role as the economic centre of the country. Approximately one-fifth of the total national GDP is produced in Istanbul.

As with many other metropolises, Istanbul has also been encountering problems of sustainability due to severe population increase, urban sprawl and highway dependency. The city is highly urbanized with its average population density of 89 persons/ha. Istanbul still keeps on growing with an annual rate of 4.3 %, and today's population of 10 million is expected to reach 16 million by the end of 2030. Employment density of 26 workers/ha is still somewhat low among the cities of the developed world because the country is still developing. Today, 65 % of the total population and 73 % of the total jobs are located in the West part of the city.

Two highway bridges connect the European and Asian sides over the Bosporus Strait. The first Bosporus crossing was constructed in 1973, together with the necessary beltway as an outer

motorway. The second bridge commenced operations in 1988 on the north side of the first bridge, connecting to the Trans European Motorway (TEM). Although the TEM serves as intercity transportation, it is being used for daily intra-city trips crossing the Bosporus, especially in the rush hours, where 11 % of the total daily trips (1, 070,000 trips/day) are made through the two bridges by cars and buses.

Buses and minibuses together form the main body of the public transport network with 591 bus routes and 123 minibus routes that provide service for approximately 6 million passengers on a network of 6100 kilometers. Therefore, almost the whole highway network, especially the main trunks including the two bridges with their beltways, is overloaded in the morning and evening peak hours. The rail system is quite poor with a total length of 97.5 km of which most provides a low level of service.

4.1 Data Preparation

There have been two transportation master plan studies conducted in 1985 and 1997. Table 1 very briefly summarizes the context and the findings of the two studies. Conventional four-step transport models were calibrated using the results of the surveys conducted in 1985 and 1997 and these constitute the database of this paper. The 108 zones and the relevant data in 1985 were divided in order match the 209 zoning system in 1997 to allow a proper comparison. The data were originally coded in the TRANPLAN transportation planning package but later converted to EMME/2 format. As Nagoya University has only a license to operate the former data were re-coded into TRANPLAN.

Table 1. Characteristics of Data Sets, 1985 and 1997

Characteristic	Master Plan in 1985	Master Plan in 1997
Total population of study area	5 347 147	9 057 747
Total employment of study area	1 875 500	2 532 211
Survey sampling ratio (%)	0.16	0.42
Study area (ha)	86 962	154 733
Number of zones	108	209
Private car ownership (per1000 population)	52	98
Average trip time (min)	53	41
Modal split (% public transport)	70	60

(Source: Istanbul Transportation Master Plan Study, Final Report, 1997)

Table 1 shows a high increase in car ownership and decrease in the average trip duration. Car ownership doubled between 1985 and 1997 and reached 113 cars/1000 persons in 2003. It is estimated to double to 225 by the end of 2015. The highway dependency is the most striking fact, not only for car share but also for the prominence of buses and minibuses. The modal shares in 1997 were as follows: automobiles 28.6 %; company and school buses 11.5 %; buses and minibuses 53.7 %; railways 3.6 %; and inland water 2.6 %.

5. LOCATION POLICY IN THE 1995 MASTER PLAN

One of the three main strategies of the Istanbul Metropolitan Area Sub-Region Master Plan (Turkish Republic, Greater Istanbul Municipality, 1995) is to achieve growth of the urban macro-form in a linear and multi-centered fashion, but with a degree of hierarchical ranking. The Master Plan sets out general principles for planning that are of relevance to employment sub-centers and the achievement of the strategy. The development of sub-centers must be encouraged to achieve population decentralization away from the highly populated areas. Specifically, new "wing-attraction centers" should be proposed, and their development as primary centers of "first degree rank" should be promoted. This is closely related to the principle of a balanced distribution of development and growth over the metropolitan region.

The targets and policies in the Master Plan are very specific about employment sub-centers and home-work linkages. Target 9 is strongly worded as: "Abandoning the concept of concentric development as the single biggest danger that can destroy the historical identity of Istanbul." Policies to achieve this are developing ranked sub-centers, generating wing-attraction centers, and the preparation and application of development plans, and removing the Law Courts, buildings of the Central Government, and similar public bodies and institutions, from the city center and redistributing them to the sub-centers. Supportive policies from other target areas are a "balanced distribution of the centers in the whole of Metropolitan Area Sub-Region" (Target 3), creating organized employment areas and generating feasible, low-priced land (Target 8) and planning the integration of employment areas into the residential settlement areas while considering acceptable travel time lengths for access (Targets 12 and 13).

6. POLYCENTRIC GROWTH IN ISTANBUL

The form of Istanbul differs from that of the American city. Although the construction of the bridges also played important role in the increase of sub centers, the city was not necessarily growing along with the large construction of motorways as it was in the USA. Also, the lack of an efficient rail network, and the existence of rather large bus network, did not bring about the job agglomerations near major stations that have occurred in many European cities. The geographical structure of Istanbul divided by the Bosporus Strait makes it even more interesting to examine the polycentric growth in the city. Figure 4 shows the location of the major employment clusters in 1985 and in 1997, and identifies the six case study areas selected for more detailed analysis of commuting travel patterns in Section 6. The methodology described in section 3, above, was applied to determine the three clusters.

The rationale for proposing the employment clusters in Figure 4 is now given. Figure 5 is a plot of the rank size distribution of the size of zonal employment (natural logarithm of the number of jobs) in each zone (excluding those in Istanbul with very low amounts) in 1997. Although the results do not follow Zipf's rank size rule of a linear relationship, the points of inflection on the curve allow us to suggest there are three types of employment cluster in Istanbul. Cluster 1 contains the very highest employment concentrations with values above 5 on the vertical axis of the graph. Cluster 3 is zones where the number of jobs in each zone is getting progressively smaller. Cluster 2 is zones with from 3 to 5 units on the vertical employment axis of the graph.

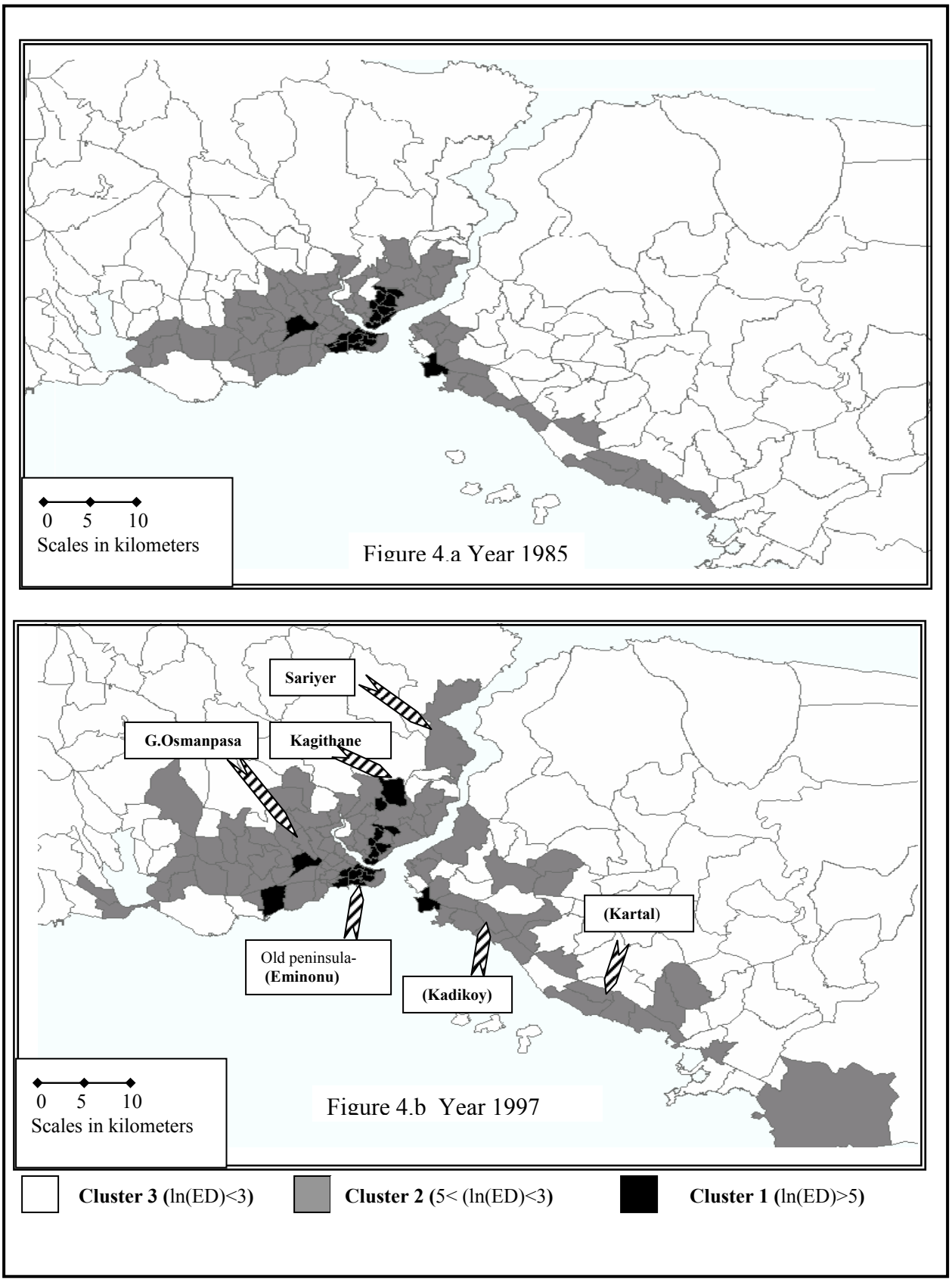


Figure 4. Major Employment Nodes in the Greater Istanbul Region and Case Study Areas

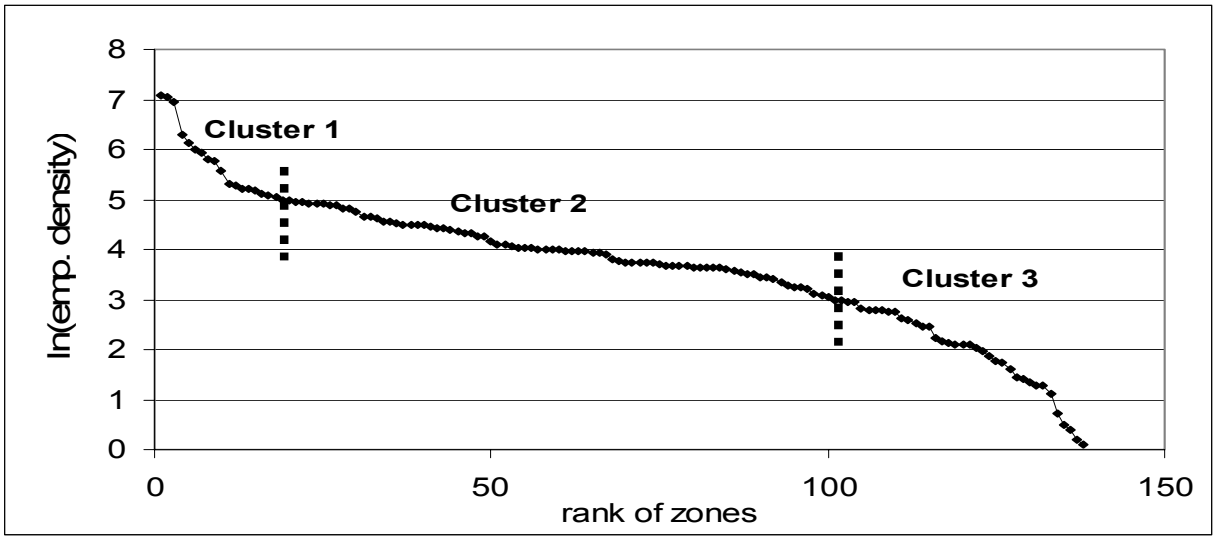


Figure 5. Classification of Istanbul Employment Centers by Rank Size Distribution for 1997

Table 2 summarizes the job location dynamics in the metropolitan region of Istanbul over a 12-year period. The employment share of Cluster 1 has fallen from one-third to 27 per cent. The employment share of Cluster 3 has also fallen, from 16 per cent to 11 per cent. Cluster 2 has gained about three-quarters of a million jobs – about 78 per cent of the job growth from 1985 to 1997 – and increased its metropolitan share from 50 per cent in 1985 to 62 per cent in 1997.

The importance of applying simple descriptive statistics in the identification of employment centers and their dynamics over time can be illustrated with particular reference to Istanbul in the period 1985 to 1997. Figure 6 contrasts how the zonal employment rank-size distribution has changed in the period from 1985 to 1997. There are over 900 000 additional jobs in 1997 so we would expect to see the curve from 1985 shift upwards. The total number of jobs increased from 1,887,652 jobs in 1985 to 2,794,223 jobs in 1997. The middle and lower clusters have gained employment, and Cluster 1 has remained relatively stable.

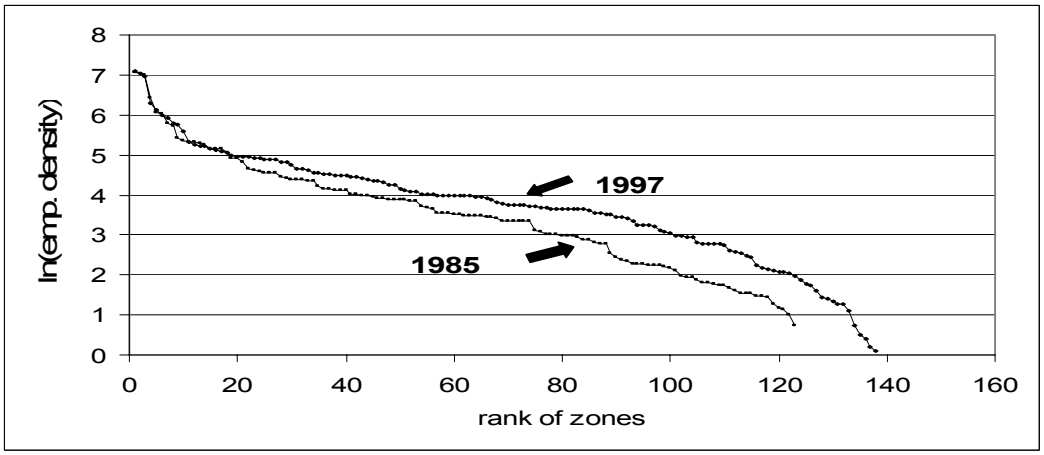


Figure 6. Comparison of Rank Size Distribution of Istanbul Employment Zones, 1985 and 1997

Table 2. Comparison of Business Location Dynamics in Istanbul, 1985 and 1997

Characteristic	1985 (%)	1997 (%)
Share of cluster 1 zones	33.2	27.7
Share of cluster 2 zones	49.8	61.6
Share of cluster 3 zones	16.4	10.7
Frequency of cluster 1 zones	18	18
Frequency of cluster 2 zones	59	82
Frequency of cluster 3 zones	45	37
	1985-1997	1985-1997 (%)
Employment changes in cluster 1 zones	147 134	23.5
Employment changes in cluster 2 zones	781 138	83.0
Employment changes in cluster 3 zones	-9 858	-3.2
Total increase	906 571	48.0

The Istanbul Metropolitan Area Sub-Region Master Plan refers to as one of its principles as a balanced distribution of development and growth across the metropolitan region. Whilst "balanced" is open to interpretation when making an assessment of policy and its outcomes, one meaning is a fairer pattern of location for employment – that is, one distributed spatial into the residential suburbs. Figure 7 suggests that a fairer spatial pattern of employment distribution has occurred from 1985 to 1997 – a trend most likely to continue with time. The figure shows two Lorenz curves - one for 1985, and the other for 1997. These distributions are the cumulative proportion of employment plotted against the cumulative zonal land area. An equal employment density surface would lead to a Lorenz curve with a linear characteristic at an angle of 45 degrees from the origin of the graph, as illustrated in Figure 7.

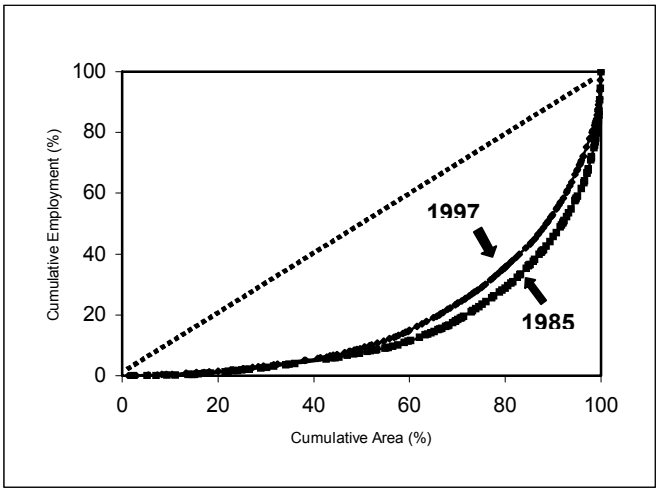


Figure 7. Lorenz Curves - Absolute Values of Employment and Zone Areas, Istanbul, 1985 and 1997

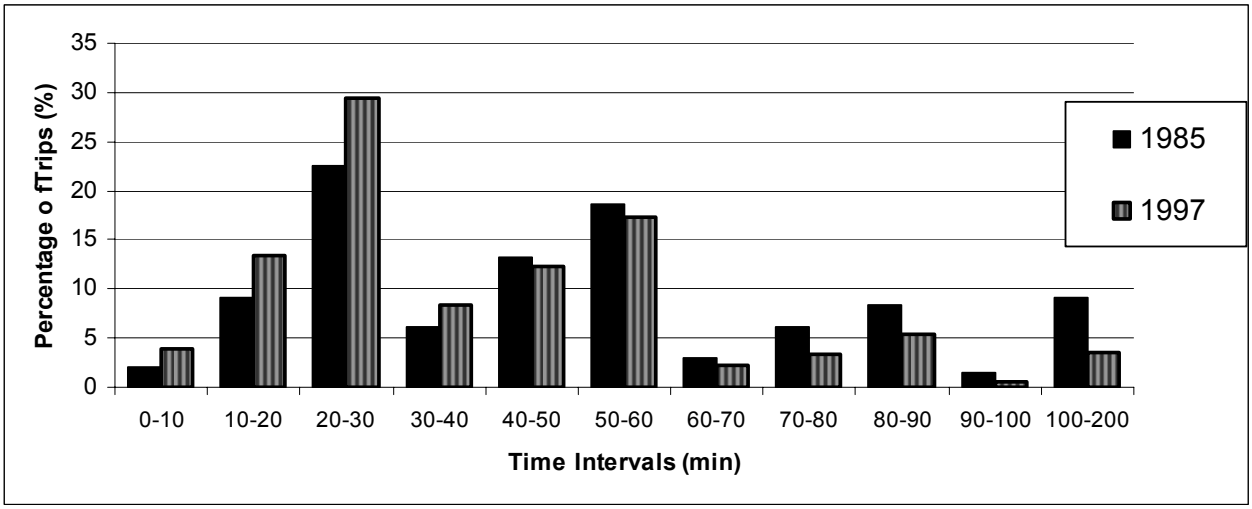
Clearly, the actual distributions are skewed, but there is evidence that the spatial distribution if moving toward greater equity. The distribution observed for 1997 is closer to the 45 degree line. In policy assessment, it is worthy of note that the process of poly-centric development envisaged in the recent Master Plan was well underway in the period 1985 to 1997, and any assessment of policy outcomes in 2010 would expect to find a much greater shift upwards from the 1997 curve in Figure 7 if the policies have indeed achieved their objectives.

7. IMPACTS OF POLYCENTRISIM ON COMMUTING PATTERNS

The previous section has established the categorization of employment centers into one of three types (Clusters 1, 2 and 3). The middle groupings of zones have experienced the greatest increases from 1985 to 1997, and a polycentric pattern of employment nodes is clearly emerging in metropolitan Istanbul. The key questions from a transport perspective are: has the emerging spatial structure lead to shorter distances traveled for the journey to work, and associated commuting travel times?; are their differences in the journey to work mode splits of different types of employment center?; and how do the preference functions from each center to surrounding housing opportunities vary by type of center? We address these with particular reference to six case study employment nodes – each drawn from the two clusters of cluster 1 and cluster 2 identified in section 6. The places are: Eminonu; Kagithane; G. Osmanpasa; Kartal; Kadikoy and Sariyer. (see, Figure 4 for the locations).

The car usage for the journey to work to these six employment centers representing the three clusters is not so very different varying only by 7 per cent. This is probably a result of the uniformly ubiquitous public transport coverage of buses, minibuses and dolmus. A policy concern in sprawling Western cities is that as jobs suburbanize from central locations served by public transport (often rail) there is a substantial shift from public transport to private transport. In Istanbul, on the other hand, this concern appears unwarranted. Eminonu (Cluster 1), located on the old peninsula of Istanbul, has the lowest car usage of 38 per cent in 1997, followed by Kagithane (Cluster 1 on the European side to the north) with 39 per cent. In Cluster 2 are G. Osmanpasa, on the European side as a middle suburb, and Kartal on the Asian side to the far east with 42 per cent and 41 per cent car usage, respectively. Finally, again in Cluster 2, but with rather low densities, is Sariyer on the European side to the distant north with 45 per cent car usage, and Kadikoy, on the Asian side at a middle distance, with 44 per cent car usage.

In contrast to many Western cities experiencing growth, commuting times have declined for the journey to work. Over the whole of the region, average morning peak hour trip time for motorized trips decreased from 53 minutes in 1985 to 41 minutes in 1997 – a remarkable outcome given the growth in traffic over that period. Such a 12-minute decrease during 12 years is explained by two important reasons. First, the construction of the second Bosporus Bridge with its expressways improved travel times or drivers and users of public transport. Secondly, the multicentric growth of the city has put more jobs within reach of suburban residences. Figure 8 is a comparison of 1985 and 1997 motorized home based work trip trip-length distribution for time as the impendence. There was an increase in shorter duration trips in 1997, especially between 10-30 minutes compared to 1985. Since the traffic congestion between 1985 and 1997 did not increase, the case of Istanbul supports the idea that polycentrism might decrease the distances traveled.



(Source: Istanbul Transportation Master Plan Study, Final Report, 1997)

Figure 8. Travel Time Frequency Distribution for Work Trips between Years 1985 and 1997

To emphasis the same point, a further analysis of three employment center zones were chosen to draw the trip length distribution of home based work trips attracted to given zones for the year 1997. One zone belonging to the cluster 1 was chosen from the old town (Eminonu), namely the historical peninsula, the next zone as cluster 2 was picked from the north part as a newly developing area after the construction of the second bridge (Sariyer 1). The third was also belonging to the cluster 2 and it was chosen because it was located far from the city center in the eastern part of the city and being designated as industrial sub center by the Istanbul Metropolitan Area Sub-Region Master Plan (Kartal). The northern zone had a lower rank as the second cluster when compared to the eastern one.

When examining the trip length frequency distribution of the three zones in Figure 9, it can be seen that the shortest trips among the three were for the first and the third zone on the eastern suburb of the city. The average trip time for each was very similar with 43 minutes for the CBD zone and 47 minutes for the eastern zone. The distribution assured that the eastern zone attracted higher percentage of trips than the CBD zone at the city average. This might be just opposite to the expectation of one assuming that suburb employment center would attract longer trips. (Figure 9)

When specifically comparing the two cluster 2 centers (one lying on the north and the other on the west), the zone in the northern part had somewhat longer trips than that of the western zone. As the city has a homogeneous public transport network, an explanation might be the job-housing ratio for each zone. A region was described around the each selected zone with an approximate diameter of 10 km. The total population area was divided by the total employment in the zone to find (one measure of) the job-housing balance ratio. The job housing balance ratio for the eastern zone was 50 whereas it was 15 for the northern zone. Since the eastern zone was standing among more densely residential zones compared to the northern zone, it has a higher ratio. This might be

the reason of the above finding that the western zone produced shorter trips despite the fact that it was located at a greater distance from the city center compared to the northern zone.

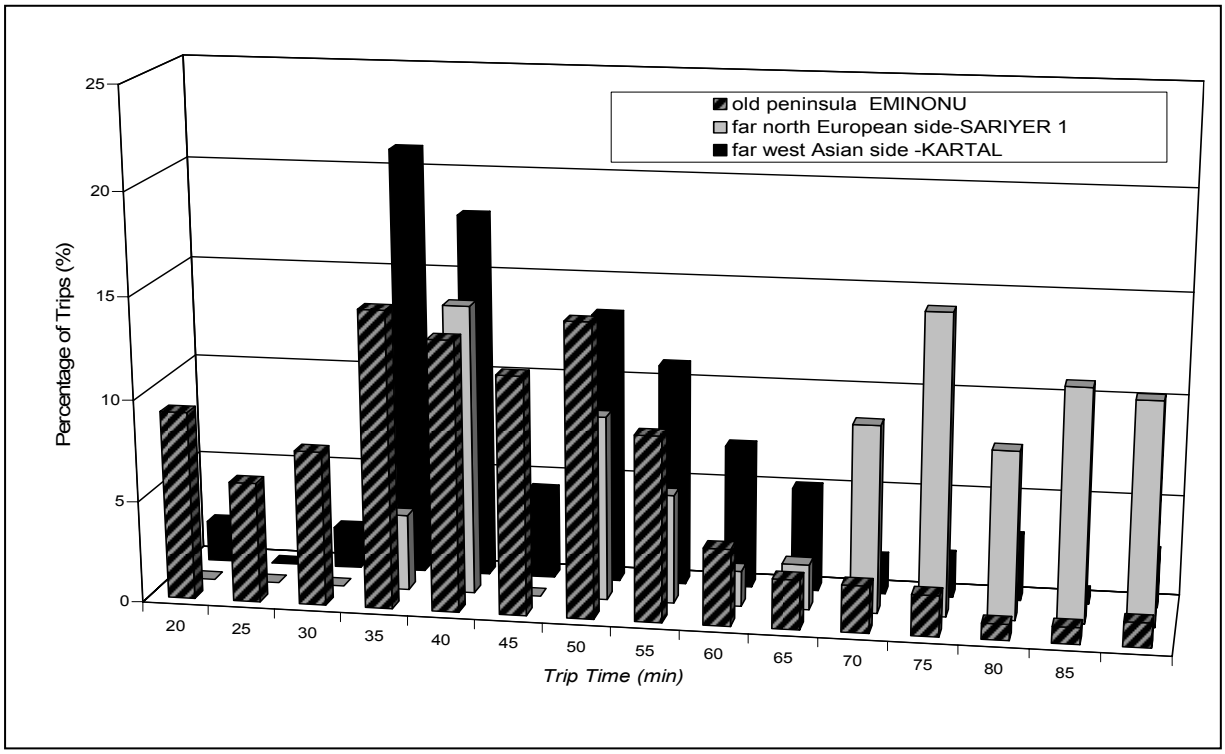


Figure 9: Trip Length Frequency Distribution of Work Trips Attracted to Three Employment Centers, Istanbul, 1997

Another perspective on the spatial characteristics of different employment clusters may be gained by applying Stouffer's theory of population migration in the USA (Stouffer, 1940) to the propensity of workers in an employment zone to take up near by or further away residential locations relative to that center. We are unaware of any such similar urban analysis, although it is obviously the reverse of the intervening opportunities model of trip distribution. For each employment zone, residential zones are ranked according to increasing transport travel time away from that zone, and the number of residential workers living in each zone is a proxy for housing opportunities. By plotting the cumulative distribution of residential workers reached a "housing" opportunity surface around that employment zone is constructed. From journey from work to home O-D data to each of these ranked destination zones the proportion of commuting trips stopping in each successive zone can be calculated and shown graphically.

Figure 10 selects three employment zones: Eminonu Cluster 1; Kagithane Cluster 1 and G.Osmanpasa Cluster 2 and shows the results of the employment location specific preference functions where the quadratic function is best supported by the survey O-D data. Because these are plots of quadratic functions the curves cross the vertical ordinate of unity. Subsequent work truncates the curve at unity (see, Alpkokin et al, 2005). All three zones have the residential opportunity normalized to the percentage of metropolitan "housing" opportunities reached, but zone G.Osmanpasa has a steeper preference function and has a more "localized" labor market. On the other hand, zone Eminonu, CBD zone in the old town of historical peninsula is much

flatter, and nearby opportunities are by- passed suggesting a labor shed that is more metropolitan-wide.

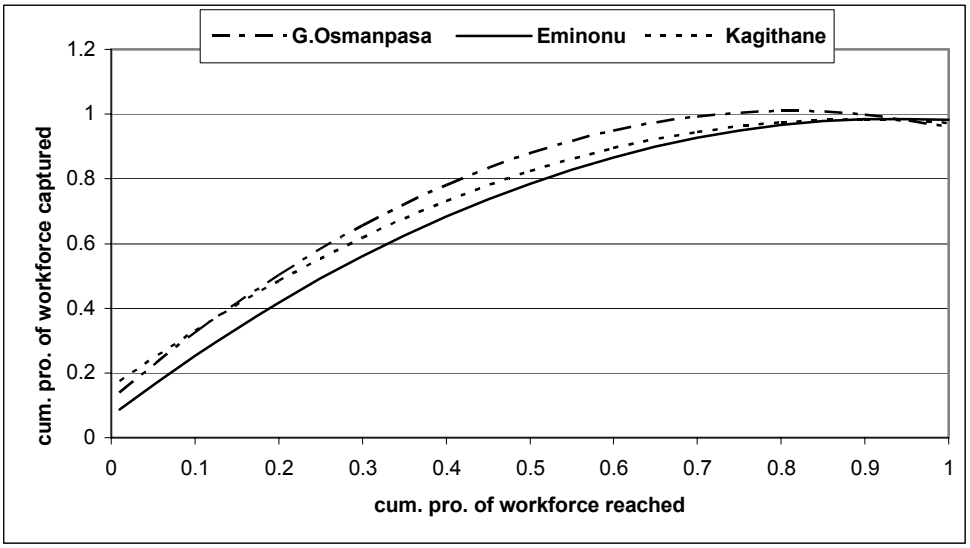


Figure 10. Employment Zone-Specific Preference Functions for Home Destination Choice

8. CONCLUSIONS

The methodology presented in this paper is being developed to ensure its general applicability. The data requirements are not onerous, and all of the information required for the analysis of polycentric employment clusters would be readily available from land-use and transportation studies and from census data of population and housing – if it exists. Different definitions of employment sub-centers have been presented by reviewing the empirical research since the beginning of the 1990s in American cities. In the case of Istanbul, three clusters are tentatively proposed but further research is examining the robustness of this proposition. We have analyzed the employment growth changes in these zones in terms of emergence, moderate growth and either stability or decline from 1985 to 1997. The greatest growth has occurred in the middle cluster of zones.

We have also examined the commuting trips made to each type of sub-center by computing the commuting trip length frequency distribution (which has reduced with time) and by computing modal shares of the trips attracted to that sub-center. Public transport usage is uniformly high at around 60 per cent. In an old, and large, city such as Istanbul both employment growth and mobility patterns were rather stable within the old agglomerations, but not necessarily so in the new suburbs. We have also presented examples of employment zone specific preference functions based on Stouffer's theory of intervening opportunities to illustrate the spatial extent of sub-cluster labor markets.

The location policies of the Istanbul Metropolitan Area Sub-Region Master Plan were described and the stated outcomes of the plan for 2010 are assessed based on evidence from our analysis of

changes in employment location. Our provisional conclusions as to the effectiveness of the policies and principles and the stated outcomes of the plan for 2010 are that a suburbanization of employment is, and will continue to occur, that the middle-sized centers are evolving at the fastest rate, and that polycentric centers are assisting in the reduction of commuting travel times and maintaining the share of public transport journeys.

Further research, now in progress, aims to analyze all employment clusters in the Istanbul Greater metropolitan region rather than the selected analysis reported here to gain a comprehensive picture of employment centre formation and dynamics and commuting travel to these centers. Other descriptive statistics will be tested (Cobb-Douglas functions, spatial statistics) in addition to those presented here. Both time periods will be analyzed thoroughly to tease out the dynamics. Changes in the origin – destination pattern of trips will be mapped. This will include a comprehensive evaluation of the zone specific preference functions and how they have evolved over time in Istanbul, as a springboard for a major comparative study of different cities. When linking analysis and policy assessment in any city, the application of spatial statistics to spatial associations of the preference functions (Paez and Scott, 2004) will prove useful tools.

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