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# Dynamics of the polycentric structure of the tertiary employment in the metropolitan area of the City of Toluca, 1994-2004

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## *Resumen*

En este trabajo se identifican los subcentros de empleo terciario que articulan la estructura espacial del área metropolitana de Toluca (AMT) y se analizan sus aspectos más relevantes: número, tamaño, densidad, jerarquía, localización, especialización económica y evolución en el tiempo, y se bosquejan algunas líneas de explicación. Adicionalmente, se propone una clasificación de los subcentros identificados en el AMT de acuerdo con su perfil económico y su lógica de funcionamiento en el contexto metropolitano, lo cual permite caracterizarlos y examinarlos más sistemáticamente. Para hacer esto se utiliza el método de doble umbral y se le incorporan algunas mejoras que lo hacen más objetivo y fácil de aplicar al estudio de ciudades mexicanas. Se utiliza información desagregada por subsector y rama de actividad (incluyendo el sector gubernamental) a escala de AGEB.

*Palabras clave:* estructura espacial urbana, terciarización, empleo terciario, área metropolitana de Toluca, Estado de México.

## *Abstract*

*Dynamics of the polycentric structure of the tertiary employment in the metropolitan area of the City of Toluca, 1994-2004*

In this paper the tertiary employment sub-centers articulated to the spatial structure of the Metropolitan Area of the City of Toluca (AMT) are identified and their most relevant aspects are analyzed as well: their number, size, density, hierarchy, localization, economic specialization and evolution through time; some explanation lines are outlined. In order to do so, a classification of the sub-centers, identified inside AMT, according to their economic profile and functioning logics in the metropolitan context is proposed; the previously stated allows characterizing and examining them in a more systematized manner. Hence, the double threshold method is used, and some improvements which make it easier and more objective to be applied in Mexican cities are incorporated. Disaggregated information according to sub-sector and activity sector (including the governmental one) at AGEB scale is used

*Key words:* urban spatial structure, tertiarization, tertiary employment, Metropolitan Area of the City of Toluca, State of Mexico.

## The monocentric city: the end of the debate

Large cities' tendency to structure their functioning through nodes of employment is something accepted in both theoretical and empiric terms (McDonald, 1987; Giuliano and Small, 1990).<sup>1</sup> These nodes, called in the specialized literature employment subcenters,<sup>2</sup> are a concentration of jobs at a scale large enough to have significant effects on a city functioning, especially on what is related to transport system, cost of the land and population distribution (McMillen, 2003).

In theoretical terms, the explanation of the existence of employment subcenters can be easily expressed: in the large cities there are two great economic forces which define in a general manner the distribution of employment in the city: the agglomeration economies and the costs of congestion. These economic forces act in opposite directions: whereas the agglomeration economies have a centripetal sense, which tends to concentrate the employment in the territory, the concentration costs act in a centrifugal manner, dispersing the employment in the city (McMillen, 2001). The spatial structure of employment in the city is the result of this interaction of opposite forces (Fujita and Mori, 2005).

The so-called agglomeration economies are referred to all those advantages the firms obtain from being spatially together: they share services, expertise, and specialized workforce, and even working in teams and afford as a set operation, publicity and infrastructure expenses. For instance, doctors' offices are usually concentrated in the same building in order to share specialized services (such as clinical laboratories, x-ray machines or tomographs), complement each other's knowledge, distribute help from nurses or qualified therapists, take care as a team of a patient, afford as a whole security, publicity or equipment maintenance expenses, and very importantly, offer the patient several medical services easy to acquire in the same territorial localization.<sup>3</sup>

On its own, costs of congestion (measured in monetary, temporary, distance, risk units or as a mixture of these and other units, both objective and subjective) are mainly referred to those related to movement of people and goods in the city.

<sup>1</sup> It is employment, not population, the key to understand the formation of subcenters in the interior of the cities (Giuliano and Small, 1990: 4).

<sup>2</sup> However, in occasions they are also called nucleus or employment poles.

<sup>3</sup> Hence, the greater agglomeration economies, the larger the employment tendency to be concentrated in space (the example of the doctor's consulting rooms and hospitals is illustrative in this sense); while the less agglomeration economies, the lesser the tendency of employment to have contiguous places (for instance, grocery stores).

Thus, the lesser costs of congestion, the greater the mobility of people and things; conversely, the greater the congestion costs, the lesser mobility of people and goods, hence, the city inhabitants will tend to work and acquire their goods and services in places near their residence, which will generate employment subcenters additional to the traditional city downtown, they will be oriented to satisfy this demand.

Consequently, if agglomeration economies are superior to the costs of congestion, the city will follow a mono-centric model, for it will not be excessively expensive (in relation to the amount of the agglomeration economies) to reach downtown. Yet when congestion costs increase and reach a certain level, the activities will tend to decentralize and the solution reached by the city is that of the polycentric structure (García and Muñiz, 2005). The reason that explains this solution is that polycentric urban structure diminishes the costs of congestion, since, theoretically, it reduces the costs of transport within a city, for the population instead of having to reach the only urban center (the traditional downtown), could only have to reach the closest subcenters, at the same time it manages to capitalize the economies derived from the spatial agglomeration of the activities that in these centers congregate activities and jobs.<sup>4</sup> This general polycentric solution acquires particular features in each city. The process is generic, the result singular (Garrocho and Campos, 2007)

The large cities' polycentric tendency is already taking place in different parts of the world (Annas *et al.*, 1997; Baumont *et al.*, 2004). Several reports indicate that the traditional city, which concentrates its employment in the central business area is, save exceptions, a thing of the past (Bourdeau and Huriot, 2002). Employment is not found in a single zone of the city nor is it homogeneously distributed in the intra-urban space in any large city in the world (Carlino, 1998; Muñiz *et al.*, 2005), but it is located in diverse zones of the urban area that offer better conditions to start, develop and multiply (Garrocho and Campos, 2007).

Mexico is not the exception. However, an ardent debate has been taking place, for some years now, on the fact that if Mexico City is polycentric or not (Suárez and Delgado, 2007) and this debate has been extended to other metropolitan areas in the country (Garrocho *et al.*, 2006, 2007; Garrocho and Campos, 2006, 2007). The debate from our perspective is finished now. There are enough argumentations and evidence to state that Mexico City and very possibly all of the large cities in the country are clearly polycentric;

<sup>4</sup> See other perspective in the interesting work on Mexico City by Suárez and Delgado (2007)

conversely, no argumentation or proof that Mexican cities are mono-centric. The large mono-centric city time ago ceased to exist in Mexico and perhaps it never existed.<sup>5</sup>

Hence, in relation to urban structure, the discussion in Mexico should be no longer focused on whether urban polycentrism exists or not, but be focused on the explanation and characterization of the polycentric structure of concrete cities instead. It is, in exploring and explaining the number, size, density, hierarchy, localization, economic specialization and evolution of the system of urban subcenters which articulates a city's functioning (Garrocho and Campos, 2007). For the competence of urban structure that must be one of the central themes in Mexico, and leave aside the now infertile discussion whether polycentrism exists in the large cities of the country or not.<sup>6</sup>

Having clear the polycentric structure of a city is a key factor to evaluate, for instance, if the subcenter system is efficient in terms of employment accessibility (Suárez and Delgado, 2007) or fundamental basic services (Garrocho and Campos, 2006); or if the dominant subcenters of population and employment have moved along time, where to, and which the explanations and implications are (Garrocho, 1996; Garrocho and Campos, 2006; 2007);<sup>7</sup> it is also fundamental in order to take advantage of the poly-nuclear structure in the transport planning and urban expansion tasks (Delgado *et al.*, 1999; Graizbord and Acuña, 2005) and to understand how employment concentrates on the territory and how it articulates the metropolitan economies (Aguilar and Alvarado 2005; Sobrino, 2006; Garza, 2006). As it can be seen, identifying and characterizing the cities' polycentric structure can be really useful to help to answer several and complex research questions, of a great relevance both theoretic and applied.

<sup>5</sup> Evidence from Garrocho, 1996; and recently: Aguilar and Alvarado, 2004; Graizbord and Acuña, 2004; Suárez and Delgado, 2007; Garrocho and Campos, 2007.

<sup>6</sup> If the polycentrism's abundant available evidence is accepted, then the old analytic schema of dividing the city in concentric circles around the traditional center (usually the most important of the urban subcenters but not the only one) must also be left aside. Firstly, because that presupposes the existence of a monocentric city (which does not exist), and secondly, because the circles' definition (of their limits and the spatial units which integrate it) usually lacks solid argumentations or responds to urban criteria overly simple. More useful and closer to reality, in any case, it would be to use an analytic schema based on the subcenters which articulate the city's functioning.

<sup>7</sup> For instance, according to Fujita and Mori (2005), polycentric cities are more efficient than their ancestors (monocentric cities), since they combine the advantages of having a traditional center in addition to those other of having a constellation of decentralized employment poles in the city, which generate agglomerating economies and allow reducing congestion costs (for instance, commuting time or the time people take to acquire goods and services). Nevertheless, this does not seem to be so clear for the Mexican cities (Suárez and Delgado, 2007).

Additionally, to acknowledge the structure of the city from the identification of the subcenters of tertiary employment does not only facilitates the understanding of the commercial and services organization of the city, but to foresee risks and opportunities in transport, cost of the land and employment and population's distribution, which can support the construction of more efficient and fairer cities (Chatterjee, 2003). More efficient, for there will be advancement in achieving a better correspondence between offer and demand of goods and services in the territory, as well as a better understanding between the collective interests and urban development orientation; and fairer, for among other things, there could be advancement in increasing the accessibility to employment and basic services for the population with lesser mobility resources (Garrocho and Campos, 2007).

## **Objectives, presentation strategy and information sources**

This work's objective is that of identifying the polycentric structure of the tertiary employment in the Metropolitan area of the city of Toluca (AMT), State of Mexico, Mexico, and analyzing its evolution between 1994 and 2004. We use a recently designed methodology and tested in the same area of study in order to identify subcenters of total employment, this is something easy to replicate in other Mexican cities (Garrocho and Campos, 2007). The number and hierarchy of the subcenters of tertiary employment are defined, they are characterized according to their main functional features and the factors that explain their location in the intra-metropolitan space are identified.

Besides this introduction, the text is divided into three main sections. In the first one, the methodology followed to identify the metropolitan subcenters is explained, although some details are omitted since the methodology is analyzed and explained in other work (Garrocho and Campos, 2007). In the second section, the subcenters of tertiary employment are empirically identified in AMT<sup>8</sup>

<sup>8</sup> The metropolitan area of the City of Toluca is integrated by twelve municipalities of the State of Mexico, and with 1.6 million inhabitants, it is one of the five largest cities in Mexico. AMT demographic growth starts in the second half of the 1980's decade and ever since, its demographic growth rate has been highly above national average (Garrocho, 1990). In 1990 AMT had 1.04 million people, who reached 1.25 in 1990, by 2000 there were 1.45 and in 2005 had 1.61. This meant a surprising percentage growth of 53 percent of the total population in only five years, which is the same as five hundred and sixty-four thousand new inhabitants, who demand urban goods and services and employment, among other things. This humongous and accelerated population's growth has evolved into an anarchic expansion of the urban area and into enormous pressures upon public services and employment.

and the polycentric structure of the city is analyzed, in the previously proposed terms, it is, considering the number, size, density, hierarchy, localization, economic specialization and evolution of the urban subcenters' system that articulates the city functioning, for three moments in time: 1994, 1999 and 2004.<sup>9</sup> Finally in the third section, the work's main conclusions are presented and a research agenda is outlined.

To elaborate this work, information from the 1994, 1998 and 2004 economic census was used, the census are carried out by the National Institute of Statistic, Geography and Computing (*Instituto Nacional de Estadística, Geografía e Informática, INEGI*). The information is disaggregated by sub-sector and activity line (including the government, education and health sub-sector) at a basic geo-statistic area scale (AGEB). Since there were not an INEGI product which offered the information on employment at this scale and disaggregation level, the tables of ATM information for the mentioned years as well as their complementary cartography were especially requested from INEGI.<sup>10</sup>

The information provided by INEGI underwent a normalization process because of two fundamental reasons: the first, the original format of the information made their integration to the SIG environment difficult; the second, the information had comparability problems between the years, since, for example, data from the 1994 economic census were elaborated according to the Mexican Classification of Activities and Products (*Clasificación Mexicana de Actividades y Productos, CMAP*), whereas the 1999 and 2004 were elaborated under the North American Industry Classification System (NAICS). The procedures the information underwent allowed comparing, displaying and analyzing the information satisfactorily for this work's objectives.

## Subcenters of tertiary employment in AMT

The methods to identify the subcenters of employment reported in the specialized literature can be generally classified in five categories:<sup>11</sup>

<sup>9</sup> In order to facilitate future comparisons, we decided to use the publication years of the official INEGI's statistics, instead of the year this institution carried out the survey.

<sup>10</sup> The construction of the information database took almost a year of work, later it was integrated into a System of Geographic Information (SIG) using the ArcView 3.2 computing program and in Excel spreadsheets to make their analysis easy.

<sup>11</sup> An excellent revision of the subcenter identification methods can be consulted at García and Muñiz, 2005.

1. Those of double threshold, which use two reference thresholds, one linked to employment's magnitude and the other linked to employment's density. Hence, the employment concentrations that surpass the two established thresholds are considered employment subcenters.<sup>12</sup>

2. That of mobility, founded on the analysis of the data of the flows of workers to certain areas of the city or the density of travel generation. The areas of the city distinguished as nodes attractors of workers' flows will be considered employment subcenters.<sup>13</sup>

3. That of peaks, which identifies special units that have greater employment densities or resident population employment ratio, superior to those of their neighboring areas and then they will be considered employment subcenters.<sup>14</sup>

4. The positive residues methods, they consist in identifying the areas of the city that have positive residues calculated from an employment density function (usually of the exponential kind), or even, by means of a combination of parametric and non-parametric methods.<sup>15</sup>

5. The methods that use spatial econometrics' techniques—for instance, the Moran autocorrelation index or the index of local spatial correlation—to identify areas of the city whose employment concentration is atypically elevated, given the case these will be considered employment subcenters.<sup>16</sup>

The method used in this work is that of the double threshold and it is specifically derived from the one proposed by Giuliano and Small (1990), for it offers an interesting mixture of simplicity and clarity, which has proved to be useful for the identification and tracing of polycentric metropolitan structures in North American (McMillen, 2003) and Mexican (Garrocho and Campos, 2007) cities.<sup>17</sup> Besides, in accordance with the literature, this method is the most adequate to compare the polycentric structure of a city along time (García and Muñoz, 2005; McMillen and Lester, 2003).<sup>18</sup> Here, the great advantages of the

<sup>12</sup> Examples of works oriented to subcenter identification based on the double threshold methodology are: Giuliano and Small (1990), Song (1994), Cervero and Wu (1997), McMillen and McDonald (1997; 1998), Bogart and Ferry, (1999), Anderson and Bogart (2001), McMillen (2003); and Garrocho and Campos (2007) for a Mexican city's case.

<sup>13</sup> Good examples of works which use this methodology are: Bourne (1989) and Gordon and Richardson (1996).

<sup>14</sup> For instance, Gordon *et al.* (1986), Craig and Ng (2001), McDonald (1987), McDonald and McMillen (1990).

<sup>15</sup> Examples of works which use this sort of methods are: McDonald and Prather (1994) and McMillen, (2001).

<sup>16</sup> See, for instance: Baumont *et al.* (2004) and Guillain *et al.* (2004).

<sup>17</sup> Giuliano and Small (1990) work was almost simultaneously published with McDonald and McMillen (1990) work. Both propose similar methodologies; however Giuliano and Small's achieved a better impact on international literature.

<sup>18</sup> See an in-depth discussion on the topic in McMillen and Lester (2003).



Giuliano and Small (*op. cit.*) are taken and the improvements by Garrocho and Campos (2007) are included with the aim that the original method becomes more objective, simple and applicable to Mexican cities.<sup>19</sup>

In this way we define as subcenters of tertiary employment those areas<sup>20</sup> that register:

1. A tertiary employment magnitude superior to the mean of the city in study plus a standard deviation.

2. A density of tertiary employment superior to the mean of the city in study.<sup>21</sup>

Hence it is guaranteed that the subcenters identified have a density and employment magnitude atypically high respect to the employment's behavior in the city under study. Magnitude and employment density are key variables for the functioning of the city, and cannot be understood in an isolated manner when the spatial structure of the employment subcenters of a city are tried to be identified.

The threshold for the identification of the employment subcenters are instrumented as follows:

$$D_{i, s} > D_{c, s, t}$$

$$M_{i, s} > (E_{c, s, t}) + (STD E_{c, s, t})$$

Where:

D = Density of employment (jobs/ hectare)

I = Basic geo-statistical area (AGEB)

s = Sector aggregation

c = City in study

t = Year for which the analysis is performed

M = Magnitude of the employment (number of jobs)

E = Average employment magnitude by AGEB

STD = Standard deviation

Tertiary employment threshold values for AMT were 6.3, 8.6 and 7.6 jobs/ha for the years 1994, 1999 and 2004; and those of employment magnitude were 1524, 1587, and 1339 jobs for the same years, respectively.

<sup>19</sup> The justification and argumentation of the improvements, as well as the application details, can be seen in Garrocho and Campos, 2007.

<sup>20</sup> Basic Geo-statistical Areas (commonly called AGEB).

<sup>21</sup> A wide justification of these thresholds is presented in Garrocho and Campos (2007).

## Tertiary employment subcenters in AMT 1994-2004

The methodology presented in the previous section allowed identifying the subcenters of tertiary employment in AMT and examine their spatial structure, specifically their size, hierarchy and economic specialization and spatial location, absolute and relative; we present this below.

### *Subcenters in 1994*

In 1994 there were five clear metropolitan subcenters, which we have called Toluca-Centro, Tablajeros-Tollotzin, Terminal-Mercado Juárez, La Maquinita and Sedagro. The hierarchy of all these subcenters in terms of their employment magnitude is as we have mentioned them (table 1, figures 1, 2 and 3).

Undoubtedly, the AMT traditional downtown, we have called Toluca-Centro, was the dominant as for tertiary employment in 1999. In relative terms, its 33637 employments represented 30 percent of the tertiary employment in AMT and 61 percent of the employment of the five subcenters identified. Thus, in that year virtually one in three tertiary jobs in the city was located in this subcenter, despite that its surface, 178 hectares, barely represented 0.59 percent of the total AMT surface. From this high employment concentration in such a small area (which only covered four AGEBA) is derived that the Toluca-Centro subcenter registers an employment density of 189 jobs/ha, the highest of all the identified subcenters by far. Its primacy index,<sup>22</sup> 1.6, indicates that its employment was the same as 1.6 times the employment of the other four subcenters, which confirms its importance in relation to them. The economic profile of this subcenter was clearly lean to the governmental sector, since this sector held 73 percent of its total tertiary employment (24441 jobs), which caused that its specialization index

<sup>22</sup> There are several manners to calculate the primacy index, nonetheless the principle is the same, having a measure the relative size of the biggest subcenter (or the highest hierarchy) in relation to the other subcenters. In this case we compared the size of the biggest subcenter (in terms of employment) in relation to the accumulated size of the four subcenters of the hierarchy. It is, the highest ranked subcenter (Toluca-Centro in this case) is divided by the addition of the rest of the subcenters (Tablajeros-Tollotzin, Terminal-Mercado Juárez, La Maquinita and Sedagro). The explanation we know about how to calculate the primacy index is in Unikel *et al.* (1976).

reached 1.73 in this sort of activity at metropolitan level.<sup>23</sup> However, this subcenter was not only the main seat of governmental employment in the city, but also was the main employment-offering subcenter (table1).

The Tablajeros-Tollotzin subcenter (located on Paseo Tollocan road, this is the highway to Mexico City, 2.1 km from the traditional city center) had, with 13066 tertiary jobs, the second position in the hierarchy due to its important employment offering in the public sector (9762 jobs equivalent to 75 percent of the total offer of tertiary jobs in the subcenter). This subcenter appears from a first attempt of decentralization of governmental jobs in the traditional center of the city and the fact that in the Tablajeros neighborhood there was a bus call on the way towards Mexico City and the north of the State of Mexico. This function of transport node generated abundant pedestrian flows (potential buyers) which provoked the appearance of numerous consumer-oriented establishments in this subcenter.<sup>24</sup> Additionally, its accessibility advantages also provoked the appearance of several services for production. This subcenter surface is about 118 hectares, as many of the enterprises there located used the land extensively (hotels, construction warehouses, second-hand motor parts retail shops, for instance). Nonetheless, there is also an important population density (110 jobs/ha) due to the presence of numerous independent commercial consumer-oriented establishments.

The third place in the hierarchy, although far behind the aforementioned subcenters, is held by the Terminal-Mercado Juarez subcenter (on Paseo Tollocan, less than 1.3 km from the Tablajeros-Tollotzin subcenter and two from

<sup>23</sup> Local specialization index (IE) for each subcenter was obtained relating the employments percentage in each sector in relation to the total employment in the subcenter, with the employment percentage in each sector in relation to the total of the subcenters. Its mathematic expression is:

$$IEs = (Es, i / Es, t) / (EST, i / EST, t)$$

Where:

IEs = Local specialization index of «s» subcenter;

Es, i = Subcenter employment in «i» sector;

Es, t = «s» subcenter total employment «s»;

EST, i = AMT subcenters' employment in «i» sector;

EST, t = AMT Subcenters' total employment.

The IE values superior to 1 correspond to the sectors where *there is* specialization in respect to the rest of subcenters. Own its own, the IE decimals express the intensity of the local specialization, for they represent the difference between the proportion of employment in «i» sector in «s» subcenter (i.e., at local scale) in respect to the employment proportion in the same «i» sector, at metropolitan subcenter scale.

<sup>24</sup> In this subcenter, very promising at the early 1990's decade, the first McDonald's in town was located, what can give us an idea of how important it was; finally, it decreased because of the congestion costs of the zone itself.

the traditional downtown). This subcenter only had 4047 jobs, yet highly agglomerated (116.7 jobs/ha) in a surface of just 34.7 hectares (this was the least extensive subcenter identified in 1999).<sup>25</sup> What is interesting in this subcenter is that barely 2 percent of its employment is in the public sector, and it registers specialization indexes in both the producer-oriented jobs (2.77), where most of the employment is concentrated (2457 jobs), and consumer-oriented ones (1.02). The Terminal-Mercado Juarez subcenter had accessibility advantages<sup>26</sup> and two powerful generators of potential buyers flow: Mercado Juarez (A public market called Juarez, and the largest market in AMT, both of formal and informal commerce) and the Bus station (Terminal de autobuses). These are the key factors that explain the existence and localization of this subcenter.

The Maquinita (a neighborhood called so after a Locomotive monument) and Sedagro are the other two subcenters identified in 1994 with the fourth and fifth places in the rank, respectively. Both centers can be classified as emergent, for their shares are not very important: The Maquinita had 2040 jobs (however, it was an important connection hub between diverse routes of urban transport), and Sedagro, starting to develop as governmental administrative center, with 1808 jobs. Both centers had large extensions (table 1), so their employment density per hectare was very low (less than 14 jobs per hectare). The Sedagro subcenter is interesting because it is a planned subcenter (or artificially created), located in the AMT limits, and by then it had not started to receive the offices which later would be decentralized from the traditional center. In 1994, it had more than 987 governmental jobs, 821 consumer oriented jobs (mostly generated by the demand of the governmental employment and the flow of people who went to the government's offices there) and no producer-oriented employment. The planned Sedagro subcenter had a tremendous development in the following years. On its own, La Maquinita is very interesting because of its high economic specialization in services to producer (with a specialization index of 4.21), this is so because of its localization, close to the most traditional AMT industrial zone.

To sum up, out of the five subcenters of tertiary employment identified in 1994 in AMT, three (Toluca-Centro, Tablajeros-Tollocan, and Sedagro) are government's administrative centers, nonetheless the first had the most important

<sup>25</sup> Take in consideration that because of the limitations of the official information sources, in this work we only consider formal jobs.

<sup>26</sup> Located surrounding the only bus station in the city, it connects AMT with all the Toluca Valley, with Mexico City and the rest of the State and important highways.

TABLE 1  
SURFACE, TERTIARY EMPLOYMENT, GROSS DENSITY,  
AVERAGE EMPLOYMENT AND ECONOMIC SPECIALIZATION  
BY SUBCENTERS' AGEB, 1994-2004

Subcenter	AGEB number	Employment	Surface ha	Gross density	Average employment by AGEB
1994					
Toluca Centro	4	33 637	177.98	189.00	8 409.3
Terminal Mercado Juárez	1	4 047	34.68	116.71	4 047.0
Tablajeros Tollotzin	2	13 066	117.79	110.93	6 533.0
La Maquinita	1	2 040	148.32	13.75	2 040.0
Sedagro	1	1 808	153.58	11.77	1 808.0
Subtotal	9	54 598	632.34	86.34	6 066.4
Rest of the metropolitan area	351	57 577	683.26	1.94	164.0
Total metropolitan area	360	112 175	315.60	3.70	311.6
1999					
Greater Toluca Centro	17	67 005	853.35	78.52	3 941.5
Tollocan	1	2 117	141.84	14.93	2 117.0
Las Torres	2	6 349	129.78	48.92	3 174.5
Metepec Galerías	2	4 771	371.10	12.86	2 385.5
Sedagro	1	1 649	154.84	10.65	1 649.0
Lerma Centro	1	1 788	122.60	14.58	1 788.0
San Mateo Centro	1	1 635	75.34	21.70	1 635.0
Subtotal	25	85 314	848.85	46.14	3 412.6
Rest metropolitan area	365	91 645	027.96	2.86	251.1
Total metropolitan area	390	176 959	876.81	5.22	453.7
2004					
Greater Toluca Centro	22	70 241	414.46	49.66	3 192.8
Toluca Norte	2	2 863	123.82	23.12	1 431.5
Juzgados Hospital	1	1 909	102.76	18.58	1 909.0
Central de Abastos	1	2 943	274.95	10.70	2 943.0
Metepec Galerías	2	8 145	378.85	21.50	4 072.5
Sedagro	1	2 259	154.83	14.59	2 259.0
San Mateo Centro	2	3 325	136.58	24.34	1 662.5
Lerma Centro	1	1 594	122.60	13.00	1 594.0
Subtotal	32	93 279	708.85	34.43	2 915.0
Rest of metropolitan area	412	94 342	426.75	2.91	229.0
Total metropolitan area	444	187 621	135.60	5.34	422.6

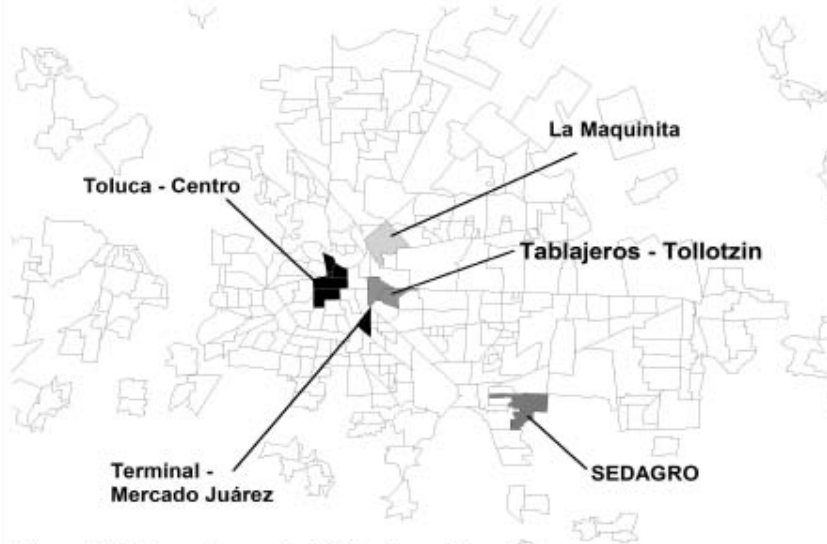
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TABLE 1  
SURFACE, TERTIARY EMPLOYMENT, GROSS DENSITY,  
AVERAGE EMPLOYMENT AND ECONOMIC SPECIALIZATION  
BY SUBCENTERS' AGE, 1994-2004 (CONTINUATION)

Subcenter	Employment respect to AMT (%)	Surface respect to AMT (%)	IEE producer	IEE consumer	IEE government, education and health
1994					
Toluca Centro	29.99	0.59	0.60	0.91	1.12
Terminal Mercado					
Juárez	3.61	0.11	3.89	1.88	0.04
Tablajeros Tollotzin	11.65	0.39	0.51	0.87	1.16
La Maquinita	1.82	0.49	5.91	0.35	0.01
Sedagro	1.61	0.51	0.00	2.30	0.84
Subtotal	48.67	2.09	0.71	0.55	1.54
Rest of the metropolitan area	51.33	97.91	1.27	1.43	0.49
Total metropolitan area	100.00	100.00			
1999					
Greater Toluca					
Centro	37.86	2.52	1.04	0.96	1.02
Tollocan	1.20	0.42	0.49	0.79	1.27
Las Torres	3.59	0.38	0.30	0.97	1.20
Metepec Galerías	2.70	1.10	1.97	1.56	0.38
Sedagro	0.93	0.46	1.54	0.03	1.50
Lerma Centro	1.01	0.36	0.37	1.33	0.95
San Mateo Centro	0.92	0.22	0.13	2.13	0.48
Subtotal	48.21	5.46	0.91	0.78	1.27
Rest of the metropolitan area	51.79	94.54	1.08	1.20	0.75
Total metropolitan area	100.00	100.00			
2004					
Greater Toluca					
Centro	37.44	4.03	1.06	0.94	1.04
Toluca Norte	1.53	0.35	1.67	0.57	1.19
Juzgados Hospital	1.02	0.29	0.37	0.35	2.11
Centraol de abastos	1.57	0.78	1.09	1.78	0.01
Metepec Galerías	4.34	1.08	0.89	1.49	0.46
Sedagro	1.20	0.44	0.65	0.04	2.35
San Mateo Centro	1.77	0.39	0.18	1.86	0.36
Lerma Centro	0.85	0.35	0.36	0.86	1.50
Subtotal	49.72	7.71	0.99	0.80	1.46
Rest of the metropolitan area	50.28	92.29	1.01	1.20	0.55
Total metropolitan area	100.00	100.00			

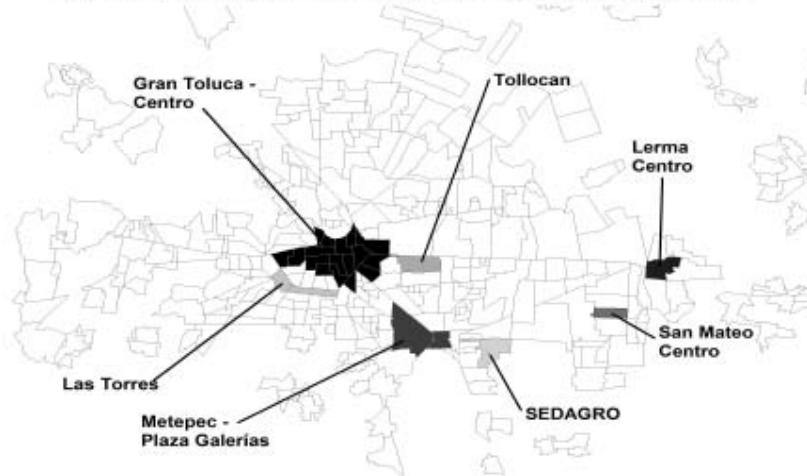
Source: INEI, Economic census by AGE, 1994, 1999 and 2004, and own elaboration.

Figure 1. Toluca's metropolitan area. Tertiary employment subcenters 1994

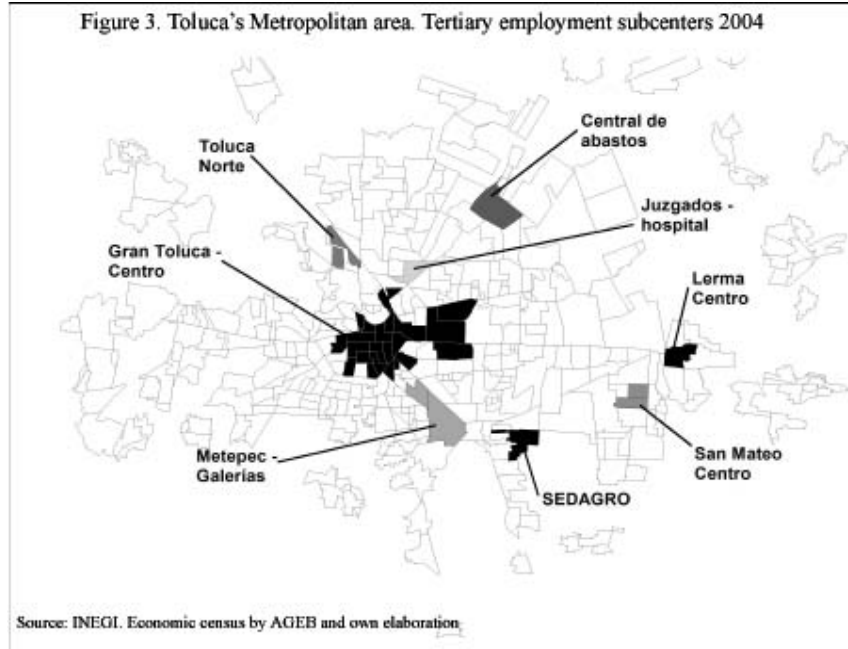


Source: INEGI Economic census by AGEB and own elaboration.

Figure 2. Toluca's Metropolitan area. Tertiary employment Subcenters 1999



Source: INEGI Economic census by AGEB and own elaboration.



offer of employment of both services to producer and consumer, due to accessibility reasons, to the existence of important people flow in the zone, to the prestige offered by the traditional center of the city as localization point. The other two subcenters (Terminal-Mercado Juarez and the Maquinita) were clearly specialized in services to producer; the former was besides specialized in consumer services, because of accessibility reasons, and the latter was the most specialized in services to producer in AMT, for its proximity to the industrial zone of the city.

### *Subcenters in 1999*

By now, in full demographic and employment growing in AMT (Garrocho and Campos, 2007), there are seven metropolitan subcenters. The most important is the Greater Toluca-Centro, which takes up two subcenters identified five years before: the Terminal- Mercado Juarez and the Tablajeros-Tollotzin. It is followed by the Torres subcenter (located on the six-lane road of the same name that



surrounds the traditional AMT and connects it on one end with the Municipality of Zinacantepec and on the other with the highway to Mexico City); the Metepec-Galerías, located in the dynamic municipality of Metepec; the Tollocan, on the road to Mexico City; the Lerma-Centro in the historical downtown of the municipality of Lerma (also on the road to Mexico City in the far end of the Greater Toluca), the Sedagro administrative center (a survivor of the previous quinquennium); and the San Mateo-Centro, which appears in the traditional center of the San Mateo Atenco municipality, and similarly to Lerma, stands out as subcenter when it functionally and physically joins AMT.<sup>27</sup>

The Greater Toluca-Centro has between 1994 and 1999 a very important physical expansion, changing from 177 hectares in 1995 to 85 hectares in 1999. This is the consequence of the overflowing of tertiary employment in the AMT's central AGEB. Those years the employment growth in downtown was surprising, changing from 33637 jobs in 1994 to 67005 jobs in 1999. This is a growth of slightly more than a hundred percent of its tertiary employment, which was besides generalized in all of the sectors: the producer-oriented employment was almost tripled (from 3140 in 1994 to 9324 five years later), the consumer-oriented ones increased 3.6 times (a net increment of sixteen thousand jobs in five years) and those of the public sector grew almost 50 percent. The Greater Toluca-Centro subcenter's importance clearly increased respect to 1994, if it is considered that in 1999 there were almost four jobs in ten existing in AMT. This is, it concentrated 35 percent of the metropolitan employment in producer services, 28 percent of the employment in consumer services and 49 percent of the public sector employment; all this in a surface of only 2.5 percent of AMT. The great hegemony of the historical center in the metropolitan subcenters hierarchy becomes evident when one estimates its primacy index, which changes from 1.6 in 1994 to 4.5 in 1999. It is worth mentioning that the systematic physical expansion of this subcenter dramatically reduced the employment density per hectare from 189 in 1994 to 78.52 in 1999.

As it has been anticipated by the high value of its primacy index, the other metropolitan subcenters are far from the magnitude of employment in Greater Toluca-Centro. The next subcenter in hierarchy is the Torres one, ten times smaller, yet important since it manifests two relevant issues: a) the close relation between the important roads and the location of the intra-metropolitan economic

<sup>27</sup> In order to illustrate the distances which separate the subcenters it is enough to say that the distance from the traditional historical center (Greater Toluca-Centro) to Tollocan Subcenter is 4.3 km; to Torres 2.3 km; to Metepec-Galerías 6 km; to Lerma-Centro 14.9 km; and to San Mateo-Centro 13.1 km.

activities (the Solidaridad-Las Torres Avenue, which articulates this center, was constructed in the early 1990's decade as one of the most important roads of AMT and soon became an advantaged location for tertiary employment); and b) the city's accelerated expansion process, which overlapped Paseo Tollocan, considered as a sort of peripheral road of the city and symbolic urban limit in the collective imaginary by then. Hence, the appearance of the Torres<sup>28</sup> subcenter lies mostly upon the accessibility acquired by the zone through the construction of the by-then new avenue and in the resulting localization of educational and health services (especially hospitals) of the government there (the specialization index in governmental, educational and health services is 1.5), these places caused abundant flows of users towards that part of the city, thus, the appearance of thousands of consumer-oriented job offers (table 1). These government's placement decisions (consciously or not) boosted the city expansion (of its employment and population) at rhythms never before seen in AMT.

The other subcenter worth of mention is Galerías-Metepec, which saw a notorious employment increment in the southern part of the city, with the important characteristic that the job offer was of a better quality than any other located in AMT. It is, employment in well-known firms, national commercial chains and in franchises. Even if Metepec-Galerías is 14 times smaller than the Great Toluca-Center, it has become a serious contender in metropolitan commerce competence, because of the quality of the services offered to the consumer and the prestige the place has reached as localization of producer-oriented firms. Galerías-Metepec became in 1999 in the most famous shopping and entertainment zone in the city and the most used by the middle and upper strata in AMT.

This is evident if the firms settled there are checked: Liverpool, Zara, C&A, Sears, Suburbia (clothing), SAM's (supermarket), Cinépolis (cinema), Starbuck's, Italiannis (restaurants), Nike, Martí (sports), Mercedes Benz, Honda, besides the most recognized hospitals and medical services centers in the city (such as the Medical Center of Metepec), banking and insurance companies' branches, and three shopping malls<sup>29</sup> and 25 movie theaters, which add up more than 150000m<sup>2</sup> of sales area,<sup>30</sup> an area of less than 28 hectares.

<sup>28</sup> Despite this subcenter would be better described as corridor, since it is located along more than nine kilometers on Solidaridad-Las Torres Avenue.

<sup>29</sup> A luxurious one with an ice rink, wireless internet connection in all of the areas and more than 130 stores. This shopping mall is controlled by Liverpool and preserves its shopping malls' model, it is called Galerías.

<sup>30</sup> At several levels.

The rest of the subcenters in 1999 (Tollocan, Sedagro, Lerma-Centro and San Mateo-Centro) have less than 2200 jobs each. Out of them, at least two (the Tollocan and Sedagro subcenters, which have the fourth and sixth places, respectively) are generated by means of the government's direct intervention, which in those years decentralizes numerous public offices to those parts of the city. i.e., their appearance as specialized centers of public sector employments (and their later consolidation, in the case of the Sedagro administrative center) does not respond to the city's economic dynamics but to other administrative criteria that had important collateral effects (and probably unforeseen) in AMT (table 1).

Finally, the Lerma-Centro and San Mateo-Centro subcenters correspond to the historical centers of the municipalities of Lerma and San Mateo Atenco, physically and functionally integrated to AMT. These historical centers are specialized in services to consumer and since they are the seat of the municipal government, are also specialized in government employment. This is crystal clear in the case of the Lerma subcenter, and less clear in San Mateo-Centro, as the employment offer in services to consumer in the latter is much more dynamic due to its specialization in leather and footwear products.

In this way in 1999 it is evident that the tertiary employment subcenters in AMT can be classified in four groups: a) the economic, base their strength in their producer-and-consumer-oriented employment's dynamics, i.e., on purely commercial criteria (Galerías-Metepec); b) the mixed, which combine employment mainly oriented to producer and consumer, supported on a large number of government jobs (Greater Toluca-Centro); c) the administrative, which derive only from government's administrative decisions, although as a result of the generated people flow cause the appearance of consumer oriented employment (Torres, Tollocan, Sedagro) and; d) the integrated, which normally are historical centers of places that have functionally and physically integrated to AMT, they are normally specialized in consumer-oriented employment and when they are the seat of municipal power, in government jobs.

### *Subcenters in 2004*

By 2004, the structure of employment subcenters in AMT, is much more complex than ten years before. Whereas in 1994 there were five, in 2004 it is possible to observe eight (figure 3). It is still remarkable because of its scale the Greater Toluca-Centro subcenter, which increases its magnitude in 3005 jobs in

relation to 1999 (reaching 70241 jobs in 2004), what is undoubtedly low in comparison to the 33368 jobs it increased in the previous quinquennium (between 1994 and 1999, the time of the most demographic and employment growth in AMT).

The relative size of the Greater Toluca-Centro is stable, in relation to 1999, since it still represents approximately 37 percent of the total tertiary employment of the city. Nevertheless, the surface of this subcenter is expanding, mainly along Paseo Tollocan in the direction to Mexico City, and in 2004 it already represented 4 percent of the total AMT surface, in comparison to 2.5 percent it represented five years before. Consequently, employment density in this subcenter decreases even more until it reaches 49.6 jobs/ha, i.e., 3.8 times less than ten years before (in 1994 its tertiary employment density was 189 jobs/ha and in 1999, it was 78.5 jobs/ha; table 1). This is partially explained by the moving of the government's offices out of this subcenter, whose employment density is higher than that of the employment oriented towards consumer or producer.<sup>31</sup>

Two very important items of information which define this subcenter's profile and evolution are the facts that it stops concentrating most of its tertiary employment in the government sector (due to net reduction of 8748 jobs between 1999 and 2004), which represents 72.6 percent of its tertiary employment in 1994 and 53 percent in 1999, to reach a 38 percent of the total tertiary employment. This percentage is very important indeed, nonetheless, it has been already overcome by employment in consumer-oriented services, which in 2004 represented 42 percent of the total. This change in the economic profile is very interesting, for the tendency in government employment will be towards decreasing or growing at decreasing rates, whereas employment in consumer and producer services has a growing tendency: between 1994 and 2004, consumer-oriented employment grew 23479 positions (4.8 times) and those consumer-oriented grew 10714 (4.4 times). What is more, the primacy index, is reduced to four, when five years before was 4.5, this shows that Greater Toluca-Centro subcenter preserves its hegemony and consolidates, in economic terms rather than administrative, in a most competitive context between the metropolitan subcenters.

The second steady place in the hierarchy is Metepec-Galerias, which increases its tertiary employment 70 percent between 1999 and 2004, years of

<sup>31</sup> The highest density registered in AMT since 1994 of employment in governmental sector is 579.2 jobs/ha; that of employment oriented to services to consumer is 54.8 jobs/ha; and that of producer-oriented employment is 70.9 jobs/ha; this is consistent with the theory's postulation.

slow growth for AMT, generally speaking. The motor of the tertiary employment here were the consumer-oriented services, which slightly surpassed twice its employment magnitude changing from 2570 jobs in 1999 to 5416 in 2004, with a surprising 110 percent growth in just a quinquennium. This growth is more spectacular if it is considered that most of these jobs are quality tertiary ones in exclusive firms, franchises, shopping malls, financial and insurance services, for instance. Undoubtedly, Metepec-Galerias is the emblematic tertiary subcenter of the AMT development in this early XXI century. The other three survivors of the previous quinquennium are San Mateo-Centro, Sedagro and Lerma-Centro. However, the one that developed the most in the 1999-2004 quinquennium was San Mateo-Centro, it increased its tertiary employment 105 percent, changing from 1635 jobs in 1999 to 3325 in 2004: a net increment of 1690 jobs.

The interesting fact about San Mateo-Centro is that 92 percent of its tertiary employment growth was concentrated in consumer-oriented services (1570 jobs to reach 2771), whereas the growth of its producer-oriented and government employment were fractional (81 jobs in producer-oriented services and only 39 new jobs in the public sector). This impressive commercial development in San Mateo Atenco contrasts with the decline of Lerma-Centro, which reduced its total tertiary employment 194 jobs. The gravest of this situation is that these jobs were lost in consumer-oriented services (206 jobs less than five years before), while employment in services oriented to producer and in government had fractional variations. On its own, Sedagro subcenter continued receiving decentralized offices from the Greater Toluca-Centro subcenter so that it increased its government employment in 655 new positions (50 percent more than the previous year). This growth was accompanied by reduction in services to producer and consumer, derived from new regulations on the use of the land in that zone.

Apart from the five surviving metropolitan subcenters from the last quinquennium (Greater Toluca-Centro, Galerias-Metepec, San Mateo-Centro, Sedagro and Lerma-Centro), three additional subcenters appear: Central de Abastos, Toluca Norte and Juzgados-Hospitales; while, on the other hand, two subcenters, identified in the last five years, disappear: Tollocan and Torres. The former was absorbed by the systematic expansion of the Greater Toluca-Centro subcenter, and the former disappeared because of the reduction in government employment, which reduced its dynamism in relative terms before the rest of the metropolitan subcenters.

Out of these new subcenters, the most important are Central de Abastos (ranked fourth in the hierarchy with 2943 jobs) closely followed by Toluca Norte (with 2863 jobs). Both of them are located north of AMT, the latter northeast, on the highway to Naucalpan; and the former northwest, on the highway to Ixtlahuaca and Atlacomulco (2.8 km from each other). Central de Abastos subcenter is purely economic, specialized in employment in services oriented towards both the producer and consumer (specialization indexes 1.1 and 1.4, respectively), and with a minimal offer of government employment (only ten positions, equivalent to 0.01 percent of the total tertiary employment in the subcenter). Due to its magnitude, in this subcenter the consumer-oriented employment is distinguishable: 2340 positions, 80 percent of its total tertiary employment. On its own, Toluca Norte subcenter is of the mixed kind specialized in employment in services oriented towards producer and in the government (specialization indexes of 1.7 in both cases). Finally, the new third subcenter that appears in 2004 is the Juzgados-Hospitales, which is of the administrative kind, thus result of government's locating decisions.<sup>32</sup> In this subcenter nearly 80 percent of the employment is in the public sector, so its specialization index in this sort of activities is very high (3.07).

It is worth mentioning as a closure for this section that the proportion of tertiary employment in the metropolitan subcenters in relation to the AMT total has been rather the same along the period of study: 48 percent in 1994, 48 percent in 1999 and 50 percent in 2004. This empirical consistency can also be useful in the generation of planning AMT scenarios.

## Conclusions

At international level, it is undeniable the large cities' tendency to adopt polycentric structures. Nonetheless, in Mexico, the debate on whether the country's larger cities are polycentric or not, is still open. Despite the debate, theoretical reasoning and available empiric reports point out that the great monocentric city does not exist in Mexico and probably never existed. At least, there is no solid evidence of its present or past existence. Conversely, there is available abundant evidence on the clear polycentric structure of several

<sup>32</sup> In this subcenter the tribunals of the Judicial Power and two large hospitals (one general and the other specialized), among other services.

contemporary Mexican cities, at least of Mexico City and the metropolitan area of the city of Toluca.

If we accept this, then it would be worth to reevaluate the pertinence of using urban analytical schemas based on rings which succeed around the historical center of large cities, due to its inconsistency with the polycentric reality of the metropolis and offering a false sense of order. Our suggestion is to substitute them with polynuclear analytical schemas which, with all of their possible limitations, reflect in a better manner the urban structure of the large cities. In other words, let us pass from the 'center-periphery' simple paradigm, to the more complex and realist one of 'centers-peripheries'. The outer shape is the background, and the preconceived researcher's paradigm can definitely determine the urban structure model of the city under research: monocentric or polycentric. The former has neither conceptual nor empiric fundamentals, the latter does.

Separately, it would also be convenient put aside infertile debates in order to focus our research efforts better in relation to the urban structure to be characterized and explain the polycentric structure of specific cities, with the aim to gather theoretical and empiric knowledge which supports the planning of more efficient and fair cities; at the time it promotes the elaboration of reasoning of general applicability.

In the specialized literature several methods to identify the intra-urban employment subcenters that articulate the large cities' structure are reported. It is important to acknowledge that all of them have advantages and limitations. In this work we selected the double threshold method because of its clarity and simplicity, but mainly because it considers two fundamental elements which allow identifying and analyzing the employment concentration in the city; the magnitude reflects the importance of the employment concentrations in the city; the density filters the magnitude indicator and confirms it or not as an employment nucleus in the territory. Both magnitude and density, when used simultaneously offer basic information to identify employment subcenters in urban areas.

In this work some improvements were done to the double threshold methods, this makes it more objective and easy to use in the study of Mexican cities. Basically, what was done was to link the values of the two thresholds (density and magnitude) with the spatial behavior of the employment in the city under study.

Databases have a crucial role in this; this work had disaggregated information by sector and activity line (including government sector) at AGEB scale, which was specifically prepared by INEGI for this research project.

In the end, the information and method used allowed not only identifying the tertiary employment subcenters that articulate the spatial structure of AMT, but also analyzing their most relevant aspects: number, size, density, hierarchy, localization economic specialization and evolution in time. Some explanatory lines were even sketched.

Additionally, it was possible to outline a classification of the subcenters identified in AMT according to their economic profile and its functioning logic in the metropolitan context, which enables us to characterize and examine them more systematically. Said classification includes four types of subcenters: a) economic (those which are born and develop by means of purely economic forces, such as Metepec-Galerias); b) Mixed (those which are born and develop by means of economic impulse, yet supported on a large supply of jobs in the government, such as the greater Toluca-Centro); c) Administrative (those which are born and develop due to government's administrative decisions, such as Sedagro); d) Integrated (normally historical centers of neighboring locations which are functional and physically integrated to AMT, such as San Mateo-Centro)

A final warning: as long as similar studies to this one are not performed in different cities of the country, the methodological, analytic, taxonomic and explanatory proposals hereby presented are in the best of cases only applicable to AMT. It is necessary then, broaden the research angle on the urban structure to other Mexican cities in order to complete, reinforce or correct the proposals therein contained and so achieving a better generality level. This is just the beginning; there are many thrilling tasks yet to be performed.



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