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**Localisation and concentration in urban labour markets and submarkets
in the metropolitan areas in central Mexico**

Alejandra Trejo Nieto

Paola Domínguez Paniagua

Introduction

Mexico is a country that has undergone an intense urbanisation, an increasing urban expansion and the emergence of several metropolitan areas. At the end of the first decade of the twenty-first century Mexico belongs to the group of nations that are considered highly urbanized with a degree of urbanisation of 71.6% (UN-Habitat and SEDESOL, 2011). Moreover the Mexican urban system is characterised by a high concentration of its population in the 59 metropolitan zones (ZMs), which account for more than 80% of the national urban population and 56.8% of the total national population (UN-Habitat and SEDESOL, 2011 and CONAPO, INEGI and SEDESOL, 2012). Urbanisation and metropolisation have impacted the efficiency and competitiveness of Mexican cities in varied ways, for instance through their labour markets.

The urban dimension of labour markets has an essential significance on population's wellbeing due to the possibilities and constraints that impose on access to employment and income within cities. Particularly, labour income remains as the most relevant way for accessing welfare, social security and consumption of goods and services in today's urban societies. For this reason the functioning of the urban labour market and its efficiency remains as a focus of interest.

From the urban perspective, space and location play a determining role in the functioning of labour markets including the employment and welfare opportunities of individuals and families. The definition of urban labour markets has been closely linked to that of the urban structure because the former expresses the distance between residence and workplace, and between different types of workplaces and residences. The localisation of labour demand and supply and its spatial proximity has been the source of multiple research. During

the sixties the Spatial Mismatch Hypothesis (SMH) emerged referring to the presence of a spatial gap between labour demand and supply within cities. The spatial mismatch suggests that workers and firms can have different locations and, depending on the extent of separation, it has negative effects on the labour market outcomes and the efficiency of a particular city. This idea is based on the assumption that the mismatch increases transportation costs and reduces disposable income which, in turn, translates into an unequal access to employment between different social groups within cities (Martin and Morrison, 2003). The origin of the hypothesis goes back to the empirical work of Kain in 1964 (cited in Gobillon, *et al.*, 2007) and lies in the observation of racial segregation in the inner cities of the United States as a consequence of jobs suburbanisation. This suburbanisation of labour demand restricted the accessibility to jobs for black population due to the long distances to the suburbs, the lack of public transportation, the inadequate information about jobs requiring low qualification and the high costs of residential mobility

The SMH has been revived recently due to the interest on the rising tendency to polycentric big cities. Over the last decades polycentricity has been perceived as a path for the integration of large cities by improving accessibility to jobs. This chapter goes back to the importance of measuring location patterns of residence, firms, and their spatial proximity as a necessary step to analyse and understand the competitiveness of urban labour markets. This line of research has been recently known as the jobs–housing balance, which is considered as a question of access to jobs from residential locations. Recent literature on the jobs-housing balance has pointed out that higher spatial proximity to jobs from the place of residence translates into greater opportunity for intraurban commute reductions. Shorter commutes in the aggregate can help to improve traffic congestion patterns and air quality as well as other urban problems such as the mobility of low-income residents (Horner and Marion, 2009).

Different aspects of the SMH or the jobs-housing balance have been the basis of empirical researches on Mexican cities. These works have focused particularly in the case of Mexico City Metropolitan Zone (MCMZ), given its

population size and economic significance, as it concentrates 25% of national GDP and 23% of jobs (Suárez-Lastra, 2007; Suárez-Lastra and Delgado, 2007; Graizbord and Acuña, 2007; Ibarra, 2010; Nava, 2010; Salazar and Sobrino 2010; Koike, 2011). Yet there are also studies that analyse other cities such as Hermosillo, Zacatecas and Ciudad Juarez (Rodríguez, 2009; Fuentes, 2008; Gonzalez, 2007). Overall, these studies conclude that even though employment sub-centers are proliferating in numerous instances, Mexican cities exhibit some level of imbalance due to the accelerated urban expansions in the last years. Therefore the results suggest that the spatial mismatch is found not only in large metropolises such as Mexico City.

This paper goes in line with the literature on the SMH and the jobs-housing balance. First, it attempts to identify spatial patterns of workers and jobs and the locational differences between labour submarkets in the Metropolitan Zones of central Mexico. Labour submarkets are determined by the worker's level of education and the corresponding jobs according to knowledge and technology level. Secondly, the study suggests different methods to measure the spatial gap in the labour market. Lastly, it contrasts the results for metropolitan areas of different sizes and economic characteristics. The manuscript presents the results for the six biggest metropolitan areas in central Mexico: Pachuca, Queretaro, Mexico City, Puebla-Tlaxcala, Cuernavaca and Toluca. These metropolises represent almost 25% of Mexico's total population, include the largest metropolis in the national urban system and are part of the so-called Megalopolis of Mexico City.

The spatial economy of central Mexico has been characterised in recent years by a particular evolution: in the first place the growth of cities such as Queretaro, Toluca, Cuernavaca, Puebla-Tlaxcala and Pachuca along with a relative reduction of Mexico City; secondly, metro zones have developed particular specialisations generating an important reconfiguration at the region level. This restructuring is the result of the economic and population dynamics in recent years. Apart from the importance of the MZs of central Mexico in the national economy the purpose of including them in this analysis refers to the

need to test the jobs-residence balance in various MZs and identify differences according to their size. On the other hand, the attention given to the labour submarkets responds to the systematic differences within the labour supply and demand according to different social groups.

The working hypotheses refer to: 1) the presence of differences in the spatial concentration and localisation of labour supply (workers) and labour demand (jobs) – a higher spatial concentration of employment and a more disperse population in the MZs; 2) regarding suburbanisation, there is a limited formation of employment subcenters but a more extensive localisation of population towards the periphery; 3) there are differences in the spatial patterns between sub-markets, particularly there is a higher employment concentration in the high technology submarket and less proximity to high skilled population, on the other hand, there are important levels of spatial mismatch in the low technology submarket but perhaps greater tendency to locate close to jobs; 4) all submarkets and all MZs suffer from systematic jobs–housing imbalances; 5) the extent and character of the imbalance varies depending on the city size.

The methodology incorporates as the main tool “Exploratory Spatial Data Analysis” (ESDA). LISAs and Moran Indexes in their univariate version are used for identifying spatial patterns of jobs and workers within a city. For the measurement of the spatial imbalance we develop a mixture of methods: the bivariate version of LISAs and Moran indexes, the “spatial mismatch index” developed by Raphael and Stoll (2002) which is a particular form of the Dissimilarity Index (DI) that links employment opportunities with groups of workers, as well as a spatial version of the DI proposed by Wong (2003).

We use data from the population census of 2010 and the economic census of 2008 carried out by the National Institute of Geography, Informatics and Statistics (INEGI) at the level of the basic geo-statistic area (AGEB) in the country.

In the next section the methodology is explained, then we discuss the empirical results, and finally we conclude with some brief comments on the implications and lines of further research.

Methodological framework

The urban dimension of labour markets

Labour markets are territorially defined either by their specific location, or by institutional structures, practices, cultures, labour relations and forms of regulation. These elements impose local limits to spatially segmented national markets, resulting in various sub-markets (urban and regional). From the point of view of spatial location, a local labour market (a generic name for subnational markets) is defined as the meeting point between labour supply and demand. It is the area within which certain workers offer their services and businesses buy them, or the economically integrated area within which individuals can reside and find employment within a reasonable distance or can readily change employment without changing residence. Hence the determination of that meeting place is usually linked to two locations, and the dissociation between them: the location of labour supply (place of residence) and the location of labour demand (workplace). Particularly, the urban dimension of labour markets is representative of the idea of the spatial proximity of residence to the workplace (Bartik and Eberts, 2006).

The choice of place of residence and place of employment are not random events. Individual workers have as a main motivation to work in exchange of the highest salary in order to maximize the utility derived from the consumption reachable with their labour income. On the other hand, firms locate where they minimise their costs and maximise their profits. In the case of labour supply, there is a tradeoff between the cost of housing (usually higher in the central business center) and commuting costs. With increasing distance to the work place, transportation costs increase whereas the housing costs decrease, resulting in a compensatory scheme. In the case of labour demand, the objective of profit maximisation leads to location decisions subject to agglomeration economies or cost savings that companies get to concentrate geographically (Suárez-Lastra, 2007).

The different locational logics of labour demand and supply create

differences in the spatial choices of place of residence and place of firms. The friction of distance between both locations and the associated commuting costs, place limits on the movement of workers, forcing them to work only in certain areas of a city (Suárez-Lastra, 2007). Therefore, labour markets are segmented in space even within a city (Graizbord and Acuña, 2007).

The foregoing attempts to account for local and urban labour markets have given rise to various lines of analysis, including the idea of the gap or spatial separation between labour supply and demand. The spatial mismatch has been a prominent idea for several decades in the area of the urban economics, and recently has enjoyed renewed interest due to many recent transformations of urban structure in cities worldwide, for instances the tendency towards polycentrism, a phenomenon observed in a number of large cities. The issue of polycentricity arised from the studies on employment suburbanisation that took place during the sixties in the United States and the associated changes in accessibility and inequality within labour markets (Suarez, 2007).

The process of suburbanisation in American cities, especially Chicago and Detroit, originated the Spatial Mismatch Hypothesis (SMH) that was aimed at analyzing the relationship between residential segregation of African-americans in the inner cities, the lack of accessibility to jobs at the face of the emerging suburbanisation of businesses, and the poor labour market outcomes for this population group that faced higher unemployment and lower earnings. This idea follows the work "The Effect of the Ghetto on the Distribution and Level of Nonwhite Employment in Urban Areas" of Kain in 1964 where three observable facts for almost all American cities were highlighted: 1) the relocation of employment opportunities predominantly for the unskilled to the suburbs; 2) segregation of black population living in the central city; and 3) employment and wages rates lower for blacks compared with whites. From these observations Kain relates the poor results for blacks in the labour market to the distance between their place of residence in the central city and the jobs in the suburbs (Kain, 1992; Ihlandfelt, 2006. Gobillon, *et al.*, note that although the SMH was never formally established by Kain, it is derived from the three observations in his

work. (Gobillon, *et al.*, 2007)

In short, the SMH expresses the existence of spatial separation between labour demand and supply, revealing a necessity for daily mobility and an uneven accessibility to jobs, depending on the location and other socioeconomic features of different population groups. The SMH is also interpreted as the excess of workers living in a specific spatial area relative to the number of available jobs. Therefore it is regarded as a useful framework for addressing the spatial definition and organisation of urban labour markets and for analysing inequality in wages and employment opportunities within cities. Furthermore, the literature suggests that the extent of the spatial mismatch can have negative effects on the efficiency and competitiveness of the city if this does not develop adequate accessibility. This idea is based on the assumption that the mismatch increases transportation costs and reduces disposable income which, in turn, translates into an unequal access to employment between different social groups within cities (Martin y Morrison, 2003).

The hypothesis has been addressed and tested not only considering race or ethnic segregation but discrimination according to other labour supply characteristics, which has allowed empirical works in different contexts. Some studies have looked at labour market results and mechanisms, whereas others have been mainly concerned with measuring the spatial imbalance as well as the localisation patterns. The methodology in this chapter is more in fashion with the latter approach.

Data and methods of analysis

The methodology has as a main focus the measurement of the location patterns of and spatial gap between jobs and workers in urban labour markets and submarkets. We employ “Local Indicators of Spatial Association” (LISA) in its univariate and bivariate form, which allows identifying location and concentration of employment and population in the city, and co-location between jobs and place of residence. As a complementary measure, we use the Dissimilarity Index (DI) which measures the percentage of jobs that need to be relocated within a

city in order to obtain a perfect balanced distribution of employment and workers. The dissimilarity index is useful for making direct comparisons between metropolitan areas, and for linking the results with local characteristics. There is a spatial version of the DI that is more accurate because adds the geographic location reference for each variable.¹

The methodological design follows various stages, in the first place we classify employment according to the industry's technology level based on the EUROSTAT classification of high and low technology and knowledge economic sectors. This classification also incorporates the OECD's division of high and low technology manufactures. We categorise employment at the level of economic subsectors, North American Industrial Classification System (NAICS), which are included in the Mexican Economic Censuses. Labour supply is classified based on population's education levels following Caragliu et al (2012) criterion. They identify a high correlation between workers with some university education and high technology and knowledge employments. Therefore we assume that labour force with some university education is employed mainly in high technology and knowledge economic sectors.

After performing this classification exercise, which defines labour submarkets, we examine the spatial patterns of employment (occupied personnel) and labour supply (occupied population) for each category using LISAs. LISAs are statistics that allows identifying the behaviour of a variable through space by identifying local patterns of location and spatial association (Anselin, 1995; Gutiérrez, 2010). In other words, a LISA gives an indication of the extent of spatial clustering of similar values around a spatial unit of observation. The sum of LISAs for all observations is proportional to a global indicator of spatial association. This measure identifies non-stationary processes in space

¹ $D = \frac{1}{2} \sum \left| \frac{w_i}{W_i} - \frac{b_i}{B} \right|$; b_i and w_i represents black and white population respectively in the location i , B and W represents all the population at the analyzed region, using the traditional index for groups Duncan and Duncan in 1955. The Index goes from 0 to 1 where 0 represents no segregation and 1 perfect segregation, this Index is considered one of the most useful's measures for understanding equity distribution in elements within a region or city (2, 2002: 55).

which that are understood as spatial autocorrelation (Gutiérrez, 2010: 58).

Anselin (1995:95) expresses LISA for a variable y observed at location i , as a statistic L_i :

$$L_i = f(y_i y_{j_i})$$

Where f is a function (that might include additional parameters) and y_{j_i} are the values observed in neighbour J^2 of i . The local spatial clusters, usually referred to as hot spots, are identified as the locations or set of contiguous locations for which the respective LISA is significant. LISAs can be calculated as a local Moran's Index (Moran I). Anselin (1995: 98) defines a local statistic of Moran for an i observation:

$$I_i = z_i \sum_j W_{ij} z_j$$

Where, observations z_i, z_j are expressed as deviations from the mean and the summation over j is such that only neighbouring values j that belong to J_i are included. w_{ij} are weights (these are spatial weights that ponderate geographical impact of z_j values) that can be standardized and for convention $w_{ii} = 0$. The sum of the local Moran I results in the corresponding global statistic.

In this analysis LISA and local Moran I allow identifying areas where labour force and jobs locate in order to find clusters. The global Moran I reflects the overall tendency of a variable to form clusters or groups of matching values by identifying patterns such as low-high, high-high, low-low, and high-low. This is one of the most commonly used measures of spatial autocorrelation and it is analogous to the usual correlation coefficient between two variables (Anselin, 1995; Celemin, 2009) but considering a weight matrix. Therefore, it takes values in the range between -1 and 1.

Furthermore, we calculate the local Moran I corresponding to the bivariate LISAs. The bivariate LISAs show how the units around a given spatial unit behave, according to the value of a different variable. In our case, it identifies how units around a unit where employment is located behave in terms of labour

² The J_i neighbour for each observation can be defined by using spatial weights or a contiguity matrix, W .

supply. The bivariate version allows knowing the areas where there is a spatial coincidence between jobs and workers, or in the opposite case, areas where employment is high and labour is low and vice versa.

The decision to use LISAs responds to the need of having, at a local level, the capability of identifying subcentres of employment, subcentres of population and areas of balance or imbalance between these categories. However bivariate LISAs only allow one to observe graphically the spatial gap or connection between jobs and workers but they fail to identify the extent or percentage of jobs or workers facing this spatial separation between work and place of residence. Horner and Marion (2009) consider that a comprehensive view of spatiality in the jobs–housing balance may be achieved by considering measures of spatial separation, such as those used to study segregation patterns. With the purpose of measuring the spatial separation between labour force and jobs we use the spatial dissimilarity index for each submarket. The Dissimilarity Index has been employed in the past to measure the extent of residential segregation between members of different racial and ethnic groups within a given metropolitan area. The advantage of this index is that it produces meaningful summary measures of the jobs–housing balance. As in Raphael and Stoll (2002), we substitute the ethnic categories for jobs and workers categories in order to measure the degree of the spatial gap between the physical locations of jobs (according to technology level) and the locations of workers (according to their qualification) at the metropolitan level.

We define the dissimilarity Index for the high technology and knowledge submarket (DIH) as:

$$DIH = \frac{1}{2} \sum_i \frac{P_{ia}}{P_{ta}} - \frac{E_{ia}}{E_{ta}} \times 100$$

Where P_{ia} are high qualified workers that live in AGEB $i, i = (1, \dots, n)$ and n are all the AGEBs in the MZ; E_{ia} are high technology jobs in AGEB i . P_{ta} is the total sum of high qualified labour supply that lives in the MZ whereas E_{ta} is the sum of high technology jobs in the MZ.

The spatial dissimilarity Index for the low technology and knowledge submarket (DIL) is:

$$DIL = \frac{1}{2} \sum_i \frac{P_{ib}}{P_{tb}} - \frac{E_{ib}}{E_{tb}} \times 100$$

Where P_{ib} represents low qualified workers living in AGEB $i, i = (1, \dots, n)$ and E_{ib} represent low technology jobs in AGEB i . P_{tb} is the total sum of low qualified workers across AGEBs in the MZ and E_{tb} is the sum of all low technology jobs.

Both indexes are also calculated with the spatial correction proposed by Wong (2003). This dissimilarity index modification is based on the assumption that spatial interaction its not only a function of adjacency, but also of the neighbourhood length. Wong incorporates a component of length that moderates interactions through spatial units. The SDI is estimated by applying the following formula (Wong, 2003: 57):

$$SDI(w) = D - \frac{1}{2} \sum_i \sum_j w_{ij} |z_i - z_j| \times 100$$

Where D is the Dissimilarity Index; z_i y z_j are the proportions of jobs and workers in i and j ; while c_{ij} will be 0 if i and j are not neighbours and 1 if they are; and:

$$w_{ij} = \frac{d_{ij}}{\sum_j d_{ij}}$$

w_{ij} are the weights including neighbour's length, d_{ij} is the lenght of the shared boundary between spatial units i and j , and $\sum_j d_{ij}$ is the total length of the boundary for spatial unit i .

The next section presents and discusses the results of applying the proposed methodology to the analysis of labour markets in the MZs of central Mexico in the year 2010.

Locatisation and spatial concentration in urban labour markets in central

Mexico

Labour demand in high and low technology and knowledge economic sectors

In the first place, we analyse jobs spatial configuration using univariate LISAs. The technique produces a map representation of all the LISAs for each spatial unit (AGEBs in this case) and a global Moran I that shows the general tendency of jobs to form clusters. LISAs are one of the methods that have been used in recent years to identify employment centers.

Table 1 shows the Moran I in the high technology economic sectors. For all the MZs the Moran I takes statistically significant values, namely there is a non-random spatial behaviour of jobs. The results show that Pachuca has the highest tendency of cluster formation for high technology jobs; on the other hand, MCMZ exhibits the lowest clustering tendency. This can be understood as MCMZ having a more homogeneous distribution of employment.

Table 1

The Moran Index for high technology and knowledge labour demand

Metropolitan Areas	High Technology Moran's I	p-value
MCMZ	0.067	0.001
Toluca MZ	0.074	0.029
Puebla Tlaxcala MZ	0.277	0.001
Querétaro MZ	0.102	0.001
Pachuca MZ	0.473	0.001
Cuernavaca MZ	0.169	0.001

Source. Elaborated by the authors based on the results in GEODA.

The univariate LISAs shown in the maps (Figure 1)**NOT IN THE PAPER** allow identifying the location and concentration of jobs in each MZ. A general

pattern shows that the biggest and more important employment centre is located in the central area of each metropolis (red clusters). These main employment nuclei are accompanied, in the case of Mexico City, by numerous small subcentres which are located in the north, south and west (but relatively close to the central business district –CBD-); in Toluca there are also a number of subcentres along the east relatively proximate to the highway to MCMZ; in the case of Queretaro, Puebla-Tlaxcala and Cuernavaca there are a few small subcentres located close to the CBD. Pachuca is a MZ that shows one well-defined employment centre with barely economic sub-centres, which explains the higher clustering tendency showed by Pachuca's Moran I. This is not to say that there is no economic activity outside the main economic hub but that the concentration of businesses in other areas is not significant. As a matter of fact, spatial units in pale red are AGEBS with high concentration of jobs but surrounded by AGEBS with low employment. On the other hand, in all MZs there are cold-spots or clusters of low concentration of jobs located in the suburban areas (blue clusters). In some cases maps show pale blue clusters that correspond to AGEBS with low concentration of jobs surrounded by high concentration of jobs.

All the Moran Indexes are significant in the low technology and knowledge economic sectors (Table 2). As with high technology sectors Pachuca appear with the highest Moran I meaning that this is yet a monocentric city. On the other hand, Toluca has the lowest Moran I revealing the most dispersed pattern for this submarket. It is pertinent to point out that low technology activities in MCMZ, Puebla-Tlaxcala, Cuernavaca and Queretaro have similar tendencies to cluster and these trends are not very different of low technology economic sectors in Pachuca. Overall the Moran Indexes for low technology jobs are higher than the values for high technology jobs. This is revealing, as low technology jobs show a higher propensity to cluster in space than high technology jobs. Therefore agglomeration advantages are presumably stronger in the low technology activities.

Table 2

The Moran Index for low technology and knowledge labour demand

Metropolitan areas	Low technology labour demand	p-value
MCMZ	0.340	0.001
Toluca MZ	0.138	0.007
Puebla Tlaxcala MZ	0.321	0.001
Querétaro MZ	0.379	0.001
Pachuca MZ	0.451	0.001
Cuernavaca MZ	0.351	0.001

Source. Elaborated by the authors based on the results in GEODA.

The univariate LISAs are shown in Figure 2.**NOT IN THE PAPER** Low technology and knowledge jobs are located mainly in the central areas of MZs. In this case the principal cores are more expanded than in the high technology employment centres, i.e. low technology submarkets exhibit more extended centres. In addition, small sub-centres are found and follow a location pattern similar to the high technology sub-centres.

Localisation and concentration of high and low qualified labour supply

Once labour supply was classified, we employed the LISAs and Moran Indexes to identify the spatial trends of high and low qualified labour supply. The Moran Indexes for high-qualified labour are statistically significant for all MZs. The results indicate interesting trends of location and clustering formation. First of all, high-qualified labour shows the largest Moran I values of all variables, meaning that this type of labour has the highest tendency to concentrate in space. Cuernavaca and Mexico City have the highest propensity to form clusters, that is, highly educated population tend to locate close to population of similar

educational level. In Queretaro this population group is less likely to cluster together across the city.

Table 3
Moran Indexes for high qualified labour supply

Metro zone	High-qualified labour	valor p
MCMZ	0.522	0.001
Toluca MZ	0.402	0.001
Puebla Tlaxcala MZ	0.477	0.001
Querétaro MZ	0.268	0.001
Pachuca MZ	0.436	0.001
Cuernavaca MZ	0.552	0.001

Source. Elaborated by the authors based on the results of GEODA.

The maps in Figure 3 **NOT IN THE PAPER** show the extent and form of concentrations in high-qualified labour. In Toluca, Puebla and Queretaro there is a well-defined node typically in or near central areas of the city, whereas in Cuernavaca and Pachuca concentration takes place towards the north. A few nearby subcentres complement the main cluster. Mexico City, on the other hand, exhibits several subcentres, located mainly at the northwest, west and southwest. Other smaller concentrations appear at the east and northeast but farthest from the main concentration. By comparing the MCMZ's maps of high-technology and knowledge jobs, and high-educated labour force we observe that workers in this social group has a high necessity to move from the place of residence to place of suitable jobs.

Table 4 shows the trends of spatial clustering for low qualified labour, according to Moran Is. We observe that in MCMZ this segment of labour supply is more propense to concentrate in space compared to other MZs. This is

evidence of a higher intrametropolitan concentration of low qualified population in particular areas of the largest metropolitan zone. Cuernavaca and Pachuca have the second and third largest Moran I values; meanwhile Toluca has a more dispersed pattern of low qualified labour. If we compare these overall results with the Moran I for high qualified labour supply, we observe that low qualified labour does not concentrate in space as much as the high educated workers.

Table 4
Moran Indexes low qualified labour supply

Metropolitan Areas	Moran I	p-value
MCMZ	0.437	0.001
Toluca MZ	0.082	0.001
Puebla		
Tlaxcala MZ	0.164	0.001
Querétaro MZ	0.220	0.001
Pachuca MZ	0.303	0.001
Cuernavaca		
MZ	0.322	0.001

Source. Elaborated by the authors based on the results obtained with GEODA.

Maps in Figure 4 uncover a very different spatial pattern of low qualified labour compared to high-qualified labour, and to low and high technology jobs. In all MZs low qualified workers present a clear suburbanisation pattern through several small or medium-sized subcentres in the periphery. Pachuca maintains some concentrations of low qualified workers near the city's central area where jobs and high-qualified workers also tend to locate. This city and Cuernavaca present the most consolidated spatial patterns of low qualified workers. MCMZ shows the biggest clusters in the east but has several clusters of different sizes all along the suburbs. Spatial patterns shown by low qualified labour imply also an important imbalance between jobs and workers location.

The spatial gap between jobs and workers

Bivariate LISA's for labour sub markets

The bivariate LISA's allow us identifying visually the jobs-housing balance areas within a MZ. High-high clusters or hot spots (in red) and low-low clusters or cold spots (in blue) must be understood as areas of spatial balance: areas of high concentration of jobs surrounded by areas of high concentration of labour in the case of hot spots, and areas of low concentration of jobs surrounded by areas of low concentration of labour. On the other hand, areas with high concentration of jobs and low concentration of workers (high-low in pale red) or low concentrations of jobs with high concentrations of workers (low-high in pale blue) are understood as areas of spatial imbalance or mismatch. These LISAs relate the location of low technology jobs to the location of low qualified labour, and the locations of high technology jobs and high-qualified workers.

The Moran Index is interpreted in this case as the general trend within cities for a spatial balance or imbalance. All Moran I values are statistically significant and are relatively low but positive in the high technology-high qualified submarket. Such results indicate a low and not very significant tendency to have a jobs-housing balance in this submarket in the six MZs. The smallest values are for Queretaro and Puebla-Tlaxcala showing a greater tendency for spatial imbalances in these two MZs. On the other hand, Pachuca shows the higher tendency towards a more balanced market as was suggested by the univariate results of labour supply and demand.

Table 5

Moran's I. High technology labour demand and high qualification labour supply

Metropolitan Zones	Moran's I	valor p
ZMCM	0.100	0.001
Toluca ZM	0.084	0.005
Puebla Tlaxcala	0.086	0.004

ZM		
Querétaro ZM	0.074	0.003
Pachuca ZM	0.274	0.001
Cuernavaca ZM	0.211	0.001

Source. Elaborated by the authors based on the results obtained with GEODA.

Figure 5 displays the spatial patterns of the high technology and high-qualified submarket. The bivariate LISAs indicate that hot spots (high demand-high supply red clusters) are very centralised and limited in space in MCMZ, Queretaro, Puebla-Tlaxcala and Toluca as indicated by the global Moran Indexes. In Mexico City there is one medium-sized cluster in the east and there are also several small hot spots in the northeast and southeast.

Areas of spatial imbalance, where there are a few jobs surrounded by high concentration of workers (low-high in pale blue), are more frequent than imbalances of the type high-low (pale-red). Low-high imbalance areas are generally around the biggest and more consolidated balance areas and are relatively extense, particularly in MCMZ and Puebla-Tlaxcala.

Table 6 shows the Moran Indexes for the low technology jobs and low qualified workers submarket. The values are not significant for Toluca and Queretaro. The significant Moran Indexes are very low; therefore the tendency of spatial balance between jobs and workers is extremely weak and in some cases not significant whatsoever. MCMZ has a negative Moran I pointing out a trend of imbalance between labour demand and supply. On the contrary, Pachuca is the city with the highest trend of jobs-residence balance in the low submarket.

Table 6

Moran's I low technology and knowledge jobs and low qualified workers

Metropolitan Zones	Moran's I	p-value
MCMZ	-0.013	0.019

Toluca MZ	0.001	0.468
Puebla Tlaxcala MZ	0.049	0.007
Querétaro MZ	0.008	0.360
Pachuca MZ	0.124	0.002
Cuernavaca MZ	0.117	0.002

Source. Elaborated by the authors based on the results obtained with GEODA.

The maps in Figure 6 **NOT IN THE PAPER** show a few hot spots or high-high clusters that are located in the periphery and seem smaller than the hot spots observed in the high technology sub-market. Visually, more areas with a spatial imbalance appear in this submarket than in the high submarket. Among MZs there are however differences; in MCMZ the most consolidated and extense areas of the city are linked to a low-high pattern (low employment and high population). In the opposite situation Pachuca has numerous clusters of high-high values close to the central city where important clusters of jobs match with concentrations of workers. Thus Pachuca appears as a city that keeps a well-defined economic centre where jobs and workers tend to locate and concentrate, i.e. there is greater jobs-housing balance. In order to have elements to evaluate the extent of the spatial mismatches the Dissimilarity Index is evaluated in the subsequent section.

The spatial dissimilarity index

The spatial dissimilarity index allows obtaining a summary measurement of the jobs-residence gap and also making comparisons between MZs and between submarkets. The results for the high submarket reveal a pattern of important imbalance in all MZs ranging from 37.8% in Cuernavaca to 53% in Toluca (Table 7). Therefore according to this methodology Cuernavaca exhibits the higher jobs-residence balance whereas Toluca as well as Mexico City has the largest spatial mismatch between jobs and workers. This dissimilarity index can be treated as a complementary tool to account for the spatial balance in the labour markets.

However we need to be careful when interpreting the results with respect to LISAs and Moran indexes because the ranking or ordering of MZs according to the extent of the imbalance might not be exactly the same. In the latest case, results show that jobs and labour were more propense to concentrate together in space in Pachuca and Cuernavaca and the SDIs indicate that certainly these MZ have the higher jobs-residence balance, nonetheless the rest of the ordering differs between indicators. Overall results display an important amount of spatial mismatch. Toluca has to relocate 53% of jobs to have a perfect jobs-workers balance, MCMZ almost 50%, Puebla and Toluca more than 45%, Pachuca 40% and Cuernavaca more than 37% of jobs.

Table 7

Spatial Dissimilarity Index for the high technology job-high qualified labour sub-market

Metropolitan Zone	SDIH
MCMZ	49.58
Toluca MZ	53.55
Puebla Tlaxcala MZ	47.17
Querétaro MZ	46.85
Pachuca MZ	40.38
Cuernavaca MZ	37.81

Source. Elaborated by the authors using Arc-View with the seg.apr extension

The results of the SDI for the low technology-low qualified market are lower than the values for the high submarket (Table 8). That is, the percentage of jobs that need to be relocated in order to have a homogeneous distribution between jobs and workers is lower than in the other submarket. MZs have to relocate between 27% of jobs in the case of Pachuca and Cuernavaca and 33.8% of jobs in Queretaro. The highest spatial imbalance is observed in

Queretaro and MCMZ meanwhile Pachuca has the smaller spatial gap between workers and jobs.

Table 8
Dissimilarity Index for low technology jobs and low qualified workers in central Mexico
Metropolitan Zones

Metropolitan Zones	SDIL
MCMZ	33.81
Toluca MZ	32.31
Puebla Tlaxcala MZ	30.51
Querétaro MZ	36.16
Pachuca MZ	27.31
Cuernavaca MZ	27.86

Source. Elaborated by the authors using Arc-View with **seg.apr spell out** extension

Final discussion

This chapter focuses on the patterns of labour market location and concentration within MZs, and the sectoral segmentation of the market by looking at the spatial patterns and the jobs-residence balance across six cities of different sizes, in differentiated labour submarkets, showing the possibility of a variety of hypotheses and undeveloped lines of research.

The results show a diversity of patterns of location and concentration between labour demand and supply in such submarkets and across MZs. Evidence of significant spatial separation between areas of clustering of labour and jobs is also found, as jobs and workers are distributed in different fashions within a city. This demonstrates that although labour supply and demand share incentives to locate in the central areas of cities, their choices and capabilities are defined by a variety of factors that are not addressed here.

Localisation and concentration of jobs within the MZs of central Mexico indicate that in most cases, a concentrated core employment is maintained in the central area of the city even though the formation of small clusters of high

concentration of jobs is identified in other parts of the metro zone. On the other hand, the suburbanisation of workers is more common than the suburbanisation of jobs. Workers tend to locate in more remote areas where land prices tend to decrease. Accelerated urban growth has meant that workers increasingly have to live on the periphery, in areas where population density is variable but with deficient job availability, and often also poor transportation supply, which increases the relative costs of moving to areas of greater labour availability. Varying localisation patterns between labour supply and demand can become a major factor in generating and increasing inequality in access to employment and, consequently, to labour income. The medium or smaller cities have a more consolidated centre of jobs. Firms seem to find greater incentives to locate in the central area, probably because of the externalities that are still strong in this area of the city. As for the location and concentration patterns of labour supply, as already mentioned, increased suburbanisation is observed since there are important centers of high concentration of workers in the periphery, showing a dissimilar distribution governing the location of jobs. In the segment of high-qualified workers the tendency to locate in the periphery is lower compared to the low qualified workers and their location can be more selective.

Regarding the spatial patterns of labour demand in the segment of high technology jobs, there is a trend of lesser concentration with respect to the low technology demand. Most clusters are located in central cities, that is, high-tech companies tend to find advantages in locating near to each other in the central city but these advantages seem to be weaker than agglomeration gains in the low-tech segment. Labour demand in low-tech sectors has, in general, greater concentration and higher suburbanisation.

High qualified labour supply tend to locate in central areas but clusters are more extended around the central city, while in the case of MCMZ there are also important clusters in far away areas in the periphery. Such workers could be classified into two groups, those who have the resources and conditions to live in areas of greater availability of jobs likely in the central city, and another group that is located in more remote areas, in some cases in the periphery, which can

afford daily mobility. Low-skilled labour concentrates in different areas of the periphery often causing workers being further away from jobs. These results demonstrate that the spatial patterns for both jobs and workers differ and that there are also differences between submarkets.

The presence of a substantial imbalance between jobs and residence is confirmed. To the extent that the jobs-residence balance is considered a measure of some aspects of urban efficiency this means that central Mexico has important issues to be concerned about related to their labour markets. The spatial separation is significant and is greater for the low submarket under the perspective of bivariate Moran Indexes. However, from the perspective of SDI a higher percentage of jobs should relocate in the case of high technology sectors in all MZs. Therefore, in this case the different measurement techniques of spatial jobs-residence balance remains to be discussed.

Having this collection of results makes possible to assert that the hypothesis of spatial imbalance between supply and demand for labour is generalizable to all selected metropolises, however there are differences in the extent of the mismatch among cities. The mismatch is observed even when distinguishing between segments of labour supply and demand. As for the differences between the two submarkets the results obtained from alternative techniques do not allow us to define any conclusive assessment.

As subsequent lines of research we suggest an analysis of the determinants of location of jobs and the determinants of the location of workers, in order to try to understand more deeply the spatial configuration of the labour market of the metropolises in central Mexico. It is also necessary exploring carefully methodological issues of measurement but also those related to the impact of a higher spatial imbalance between jobs and workers, that is, knowing the main effects of this gap on the costs of daily mobility, travel times, and the main needs of each segment of the labour market.

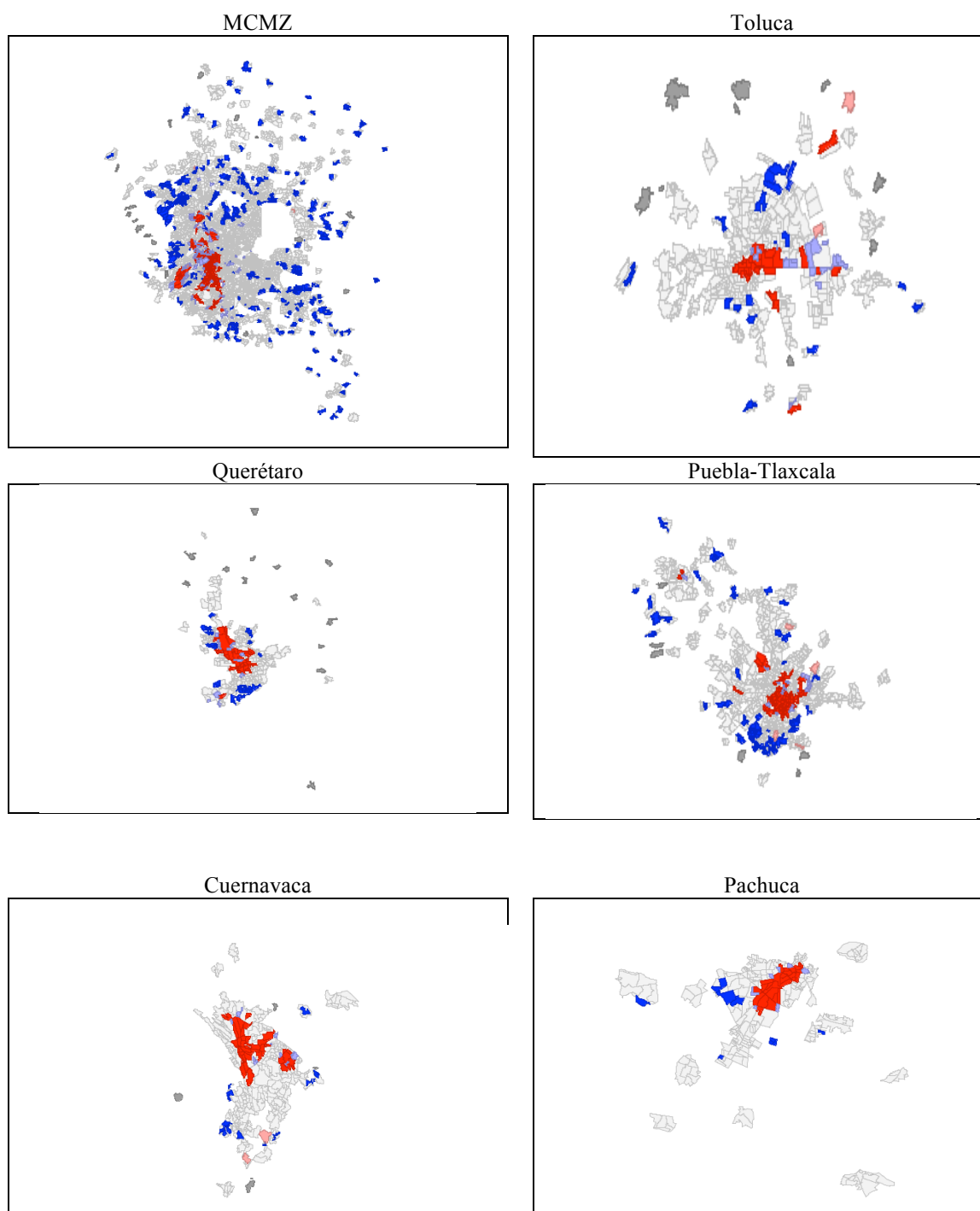
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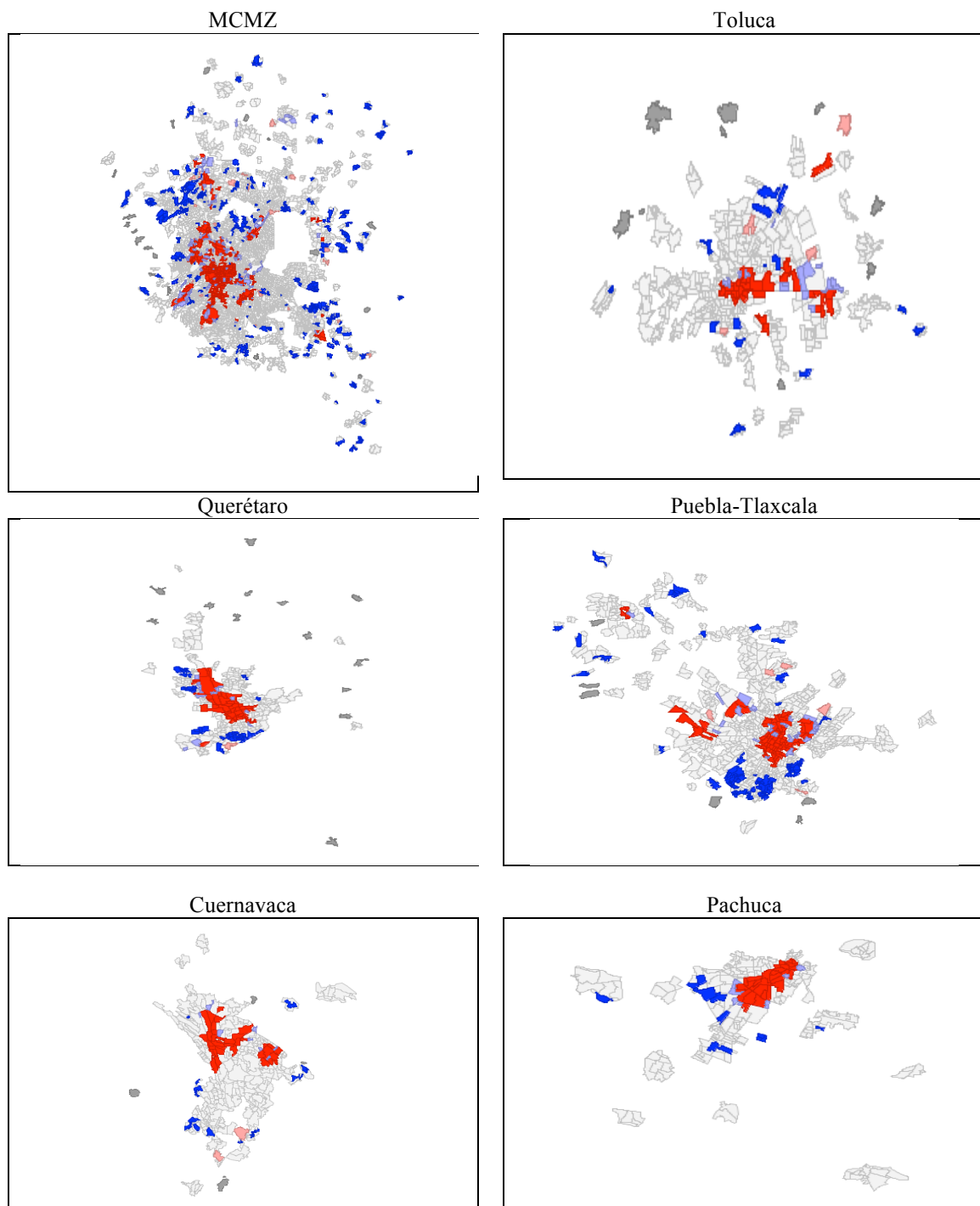
Figure 1. Univariate LISA's for high technology and knowledge labour demand



* significant clusters for $p < 0.05$.

Source: elaborated by the authors based on Economic Census 2008.

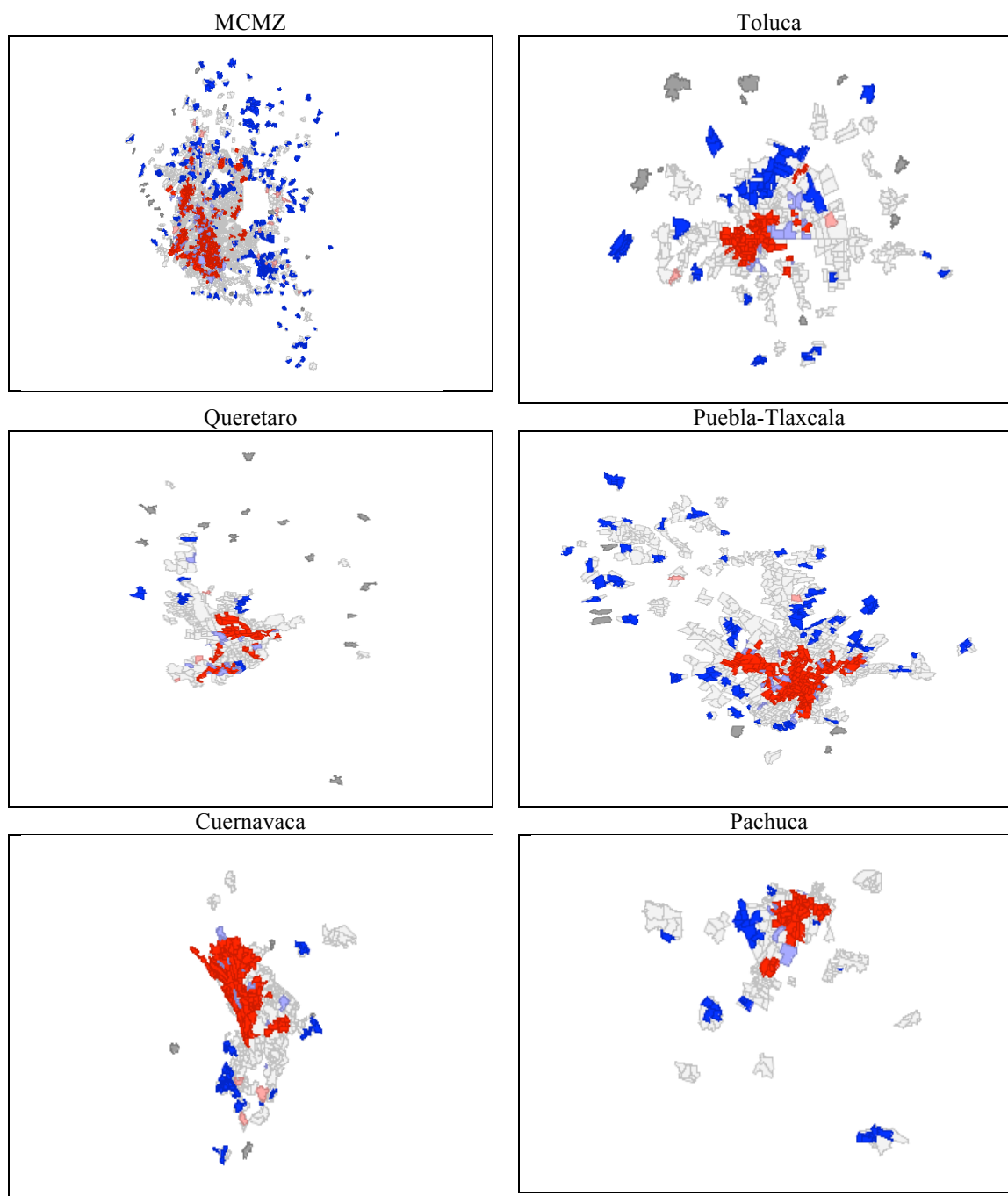
Figure 2. Univariate LISA's for low technology and knowledge labour demand



*Significant clusters p value < 0.05.

Source: elaborated by the authors based on Economic Census 2008.

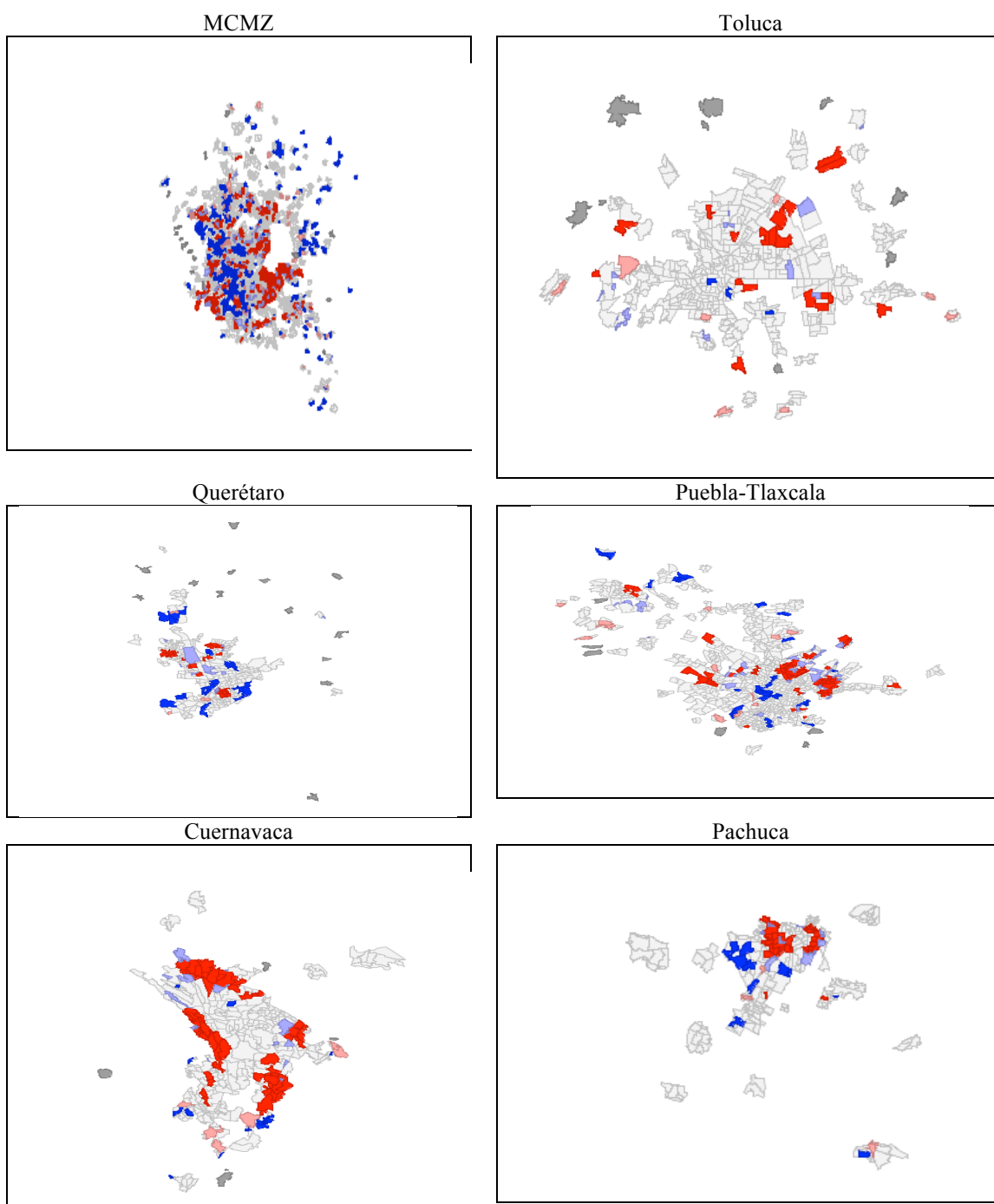
Figure 3. Univariate LISAs for highly qualified labour supply



* significant clusters for p values < 0.05.

Source: elaborated by the authors base don Population Census from 2010.

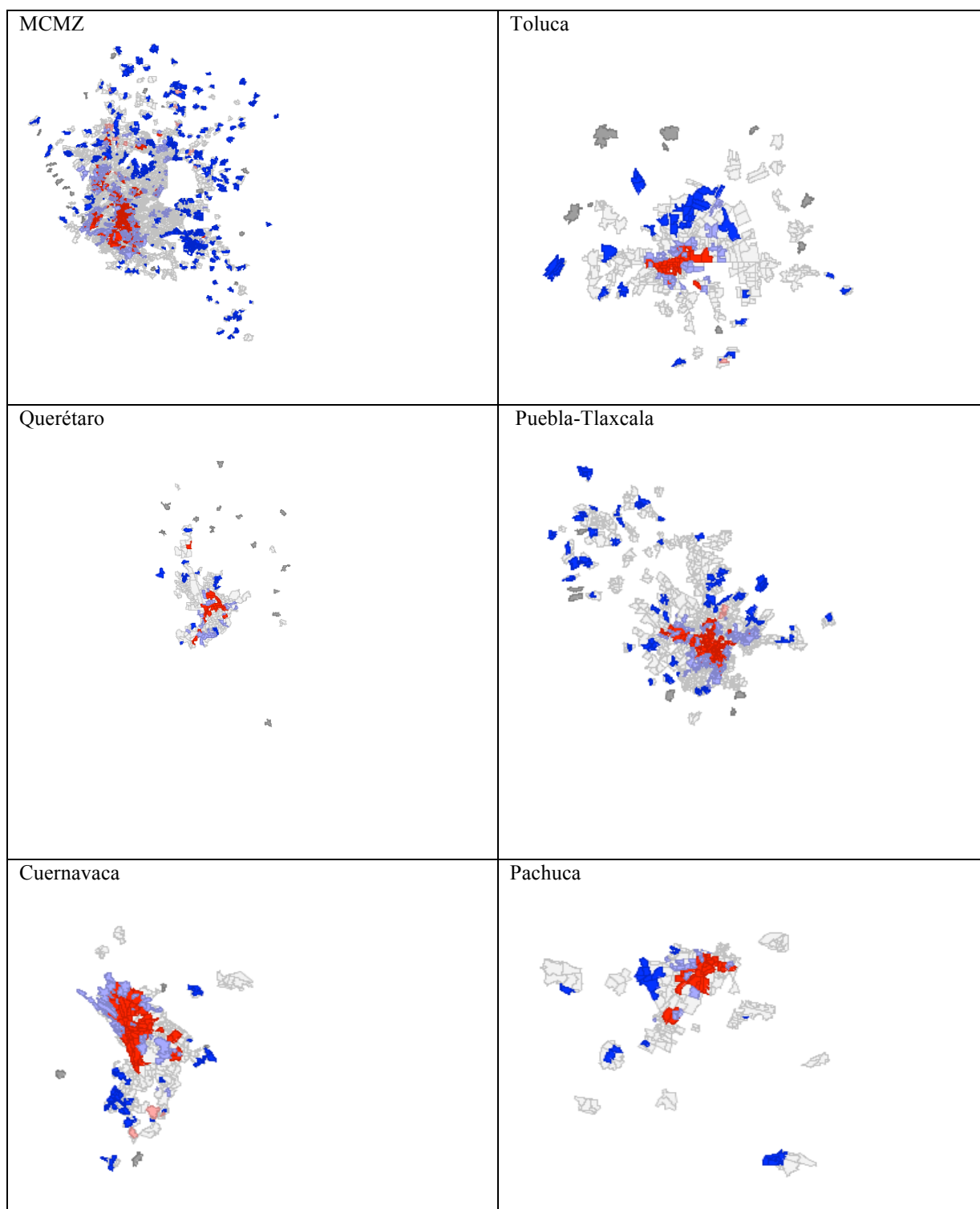
Figure 4. Univariate LISA's for low qualified labour supply



*significant clusters for p values < 0.05.

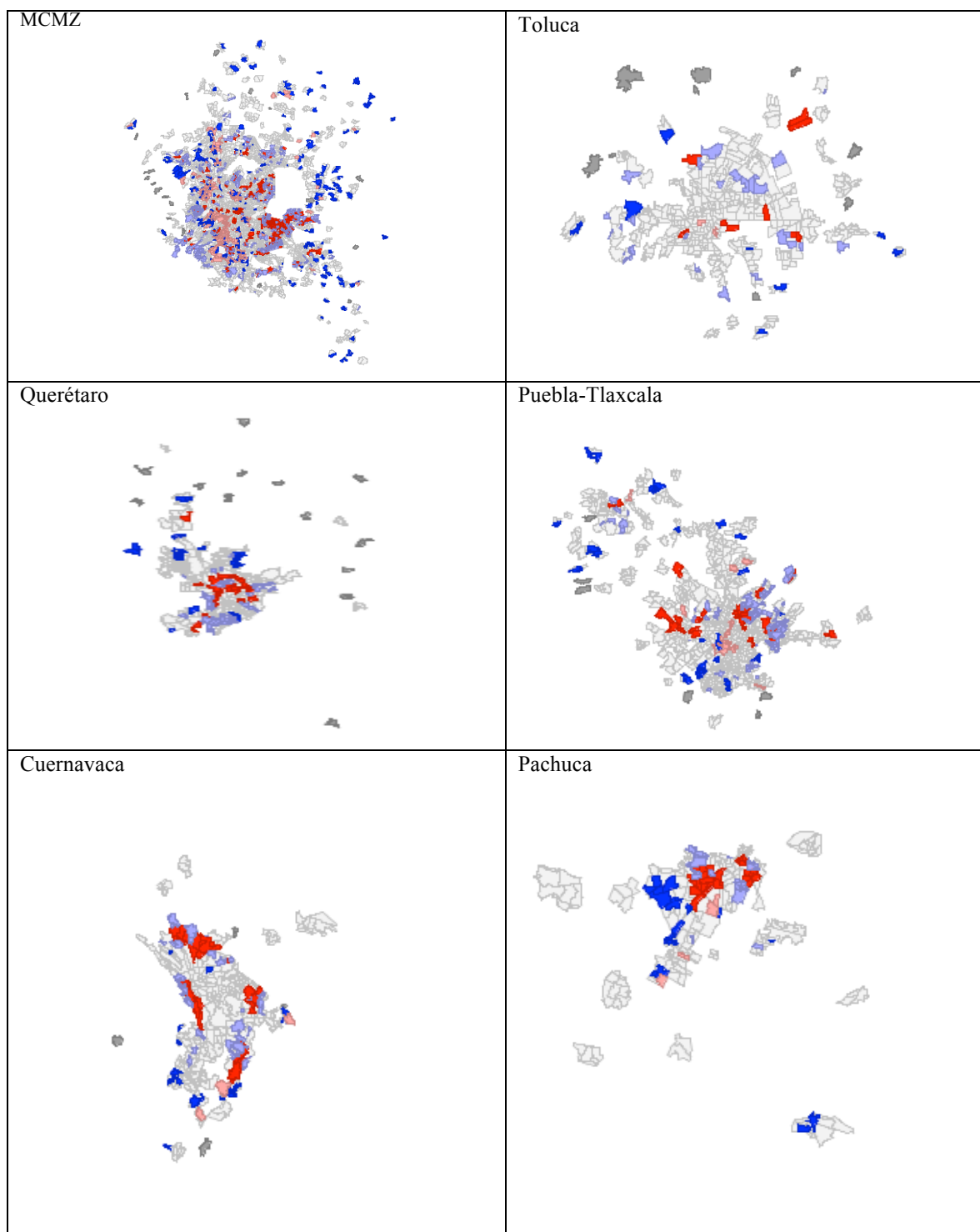
Source: elaborated by the authors based on Population Census from 2010.

Figure 5. Bivariate LISA's High technology labour demand and high qualification labour supply



Source: elaborated by the authors based on Population Census from 2010 and Economic Census 2008.

Figure 6. Bivariate LISA's low technology labour demand and low qualified labour supply



Source: Elaborated by the authors base don Population and Economic Census 2008 and 2010.

