NEW PERSPECTIVES ON THE SPATIAL ANALYSIS OF URBAN EMPLOYMENT
DISTRIBUTION AND COMMUTING PATTERNS: THE CASES OF HERMOSILLO
AND CIUDAD OBREGON, MEXICO

by

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recommend that it be accepted as fulfilling the dissertation requirement.

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SIGNED: Liz Ileana Rodríguez Gámez

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DEDICATION

To the light of my life

To my family

To my mom, for encouraging me to study, but she never thought how much

To my dad, for his example of honesty, responsibility and hard work every day

To my brothers for their love and support: walking together has being a wonderful trip

To Ivanna… whose single smile is an inspiration

For two incredible women in my life:

To Kuquis, who showed me to undertake every single mission with intelligence

To Carmen… for her patience and company in this journey

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ABSTRACT

Whereas no prior contribution has focused on the case of a medium-sized city in a

developing country, such as Mexico, to explore how urban structure and its expansion

has affected the spatial distribution of employment, three distinct, but related papers were

developed, which combine urban economics literature and spatial sciences techniques to

fill this gap and provide new evidence.

The first paper, entitled "Spatial Distribution of Employment in Hermosillo, 1999

and 2004" identifies where employment subcenters are. Testing the presence of spatial

effects, it concludes that an incipient process of employment suburbanization has taken

place; however, the city still exhibits a monocentric structure. As a complement, a second

paper, "Employment Density in Hermosillo, 1999-2004: A Spatial Econometric

Approach of Local Parameters" tests if the Central Business District (CBD), despite

suburbanization, maintains the traditional attributes of attracting activities and

influencing the organization of employment around it. The CBD is still attractive, but its

influence varies across space and economic sector, conclusions that were masked by

global estimations.

Thirdly, a study was essential to uncover how important is the urban structure and

the suburbanization of jobs in explaining the dispersion resulting of households and

workplaces (commuting). The paper entitled "Commuting in a Developing City: The

Case of Ciudad Obregon, Mexico" examines this issue. To take advantage of the

commuting information available, the study area was switched. In general, the results are

consistent with those suggested by urban economics; moreover, the inclusion of workplace characteristics was a novelty to model commuting behavior and proves that space matters.

Additionally, new evidence was provided to the field of spatial science through the applications of techniques able to expose the spatial effects associated with the distribution of employment, more specifically, the Exploratory Spatial Data Analysis (ESDA), Geographically Weighted Regression (GWR) with spatial effects, as well as the generalized multilevel hierarchical linear model (GMHL) were used. The new findings produced for this dissertation provide a more comprehensive understanding of urban dynamics and could help to improve the planning process. It is hoped that this dissertation will contribute to that development as well as stimulate further research.

CHAPTER 1. INTRODUCTION

1.1 Explanation of the problem and its context

Currently over one-half of the world population lives in urban areas, 70% of urban population (around 2,000,000,000 of inhabitants) live in less developed regions; and population is expected to double by 2030 (Cohen, 2006).[1] The Mexican Urban Development Program (2000-2006) indicates the 66% of total population lived in 364 cities of over 15,000 inhabitants. According to the Mexican Bureau of Population (*Consejo Nacional de Población* [CONAPO for its acronym in Spanish]), in the future, Mexico will continue to strengthen its urban profile. Projections for 2030 show that most of the urban population (56.8%) may concentrate in 15 large cities, while the population of medium-sized cities (between 100,000 and 1,000,000 inhabitants) and small cities (more than 15,000 and less 100,000), may be 30.8% and 12.4% of total urban population, respectively (CONAPO, 2005).

Mexican cities also face, and will still face in forthcoming years, problems with their physical expansion; since 51% of Mexican land is owned by *Ejido* and other forms of communal property, while two-thirds of the land, surrounding the urban areas, is not governed by land market conditions.[2] In this context, expansion of cities has occurred mainly through the illegal occupation of land. Therefore, the differences in population

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[1] The less developed regions comprise all regions of Africa, Asia (except Japan), Latin America and the Caribbean, plus Melanesia, Micronesia, and Polynesia.
[2] *Ejidos* are small-scale communal lands that were created as part of Mexico's massive land reform in the postrevolutionary decades of the 1930s and 1940s (Bray *et al.,* 2003).

size and land area between these cities are large. This is highly relevant because a number of urban problems are linked with city size, and their consequences for urban life are sizeable, depending on the planning processes implemented by local government.

Urban planning in Mexico is a task that was assigned to local governments in the 1980s, and even today it is conceived as an unfinished process in the face of the centralization of federal administration. According to the Mexican Association of Municipal Planning Institutes (*Asociación Mexicana de Institutos Municipales de Planeación* [AMIMP for its acronym in Spanish]) just 51 planning institutes have been created in Mexican cities, and at least 10 Mexican States do not have a single institute (AMIMP, 2012). This suggests that in a large number of medium-sized cities, the activities that lead to the expansion of the city and its urban structure are executed in the absence of planning; also the consequences of urban sprawl on population, as well as on the functioning of urban markets such as labor, housing, land, transportation, etc., are not taken into account.

The Northwestern part of Mexico has been characterized by low population densities. The State of Sonora does not have any cities above 1 million inhabitants. Around the 60% of the total population lives in six medium-sized cities (see Figure 1); these have experienced, in recent years, rapid population growth as well as urban sprawl, exceeding the capacity of local government to provide jobs, infrastructure, and attend to social demands.

Hermosillo is the capital city located in the center of the state; according to the Mexican Bureau of Statistics (*Instituto Nacional de Estadística, Geografía e Informática*

[INEGI for its acronym in Spanish]) it is the largest city, with 27% of Sonora's total population. Ciudad Obregon, in the southern part of the state, accounts for 11% of total population (INEGI, 2010). Hermosillo is three times larger than Ciudad Obregon and is a much more densely populated city, with 50 inhabitants per square meter more than Ciudad Obregon. Hermosillo, since 2002, is the only city in Sonora to have a Planning Institute. Ciudad Obregon does not have one, and their decisions about urban topics, such as investments in infrastructure, are taken through a governmental office.

Figure 1. Medium-sized cities in Sonora, Mexico

Source: Elaborated by Liz Ileana Rodríguez-Gámez. February 22, 2012.
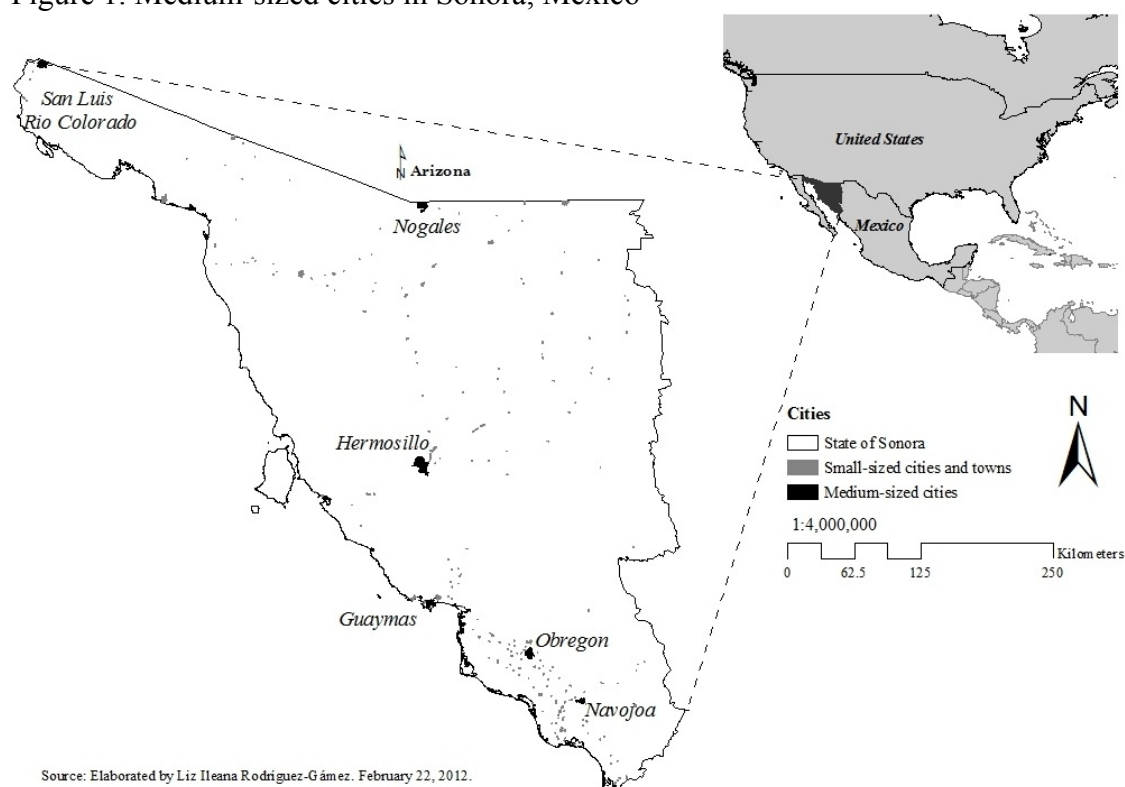
After the signing of the North American Free Trade Agreement (NAFTA) among Mexico, U.S. and Canada, the attractiveness of Northern cities increased. Foreign

investment flows, in particular, rose. Nevertheless, Sonora and its cities have not taken enough advantage of this economic process (Grijalva, 2004; Sobrino, 2002). Nowadays medium-sized cities in Sonora have economies specialized in retailing and wholesale trade as well as in service activities. There is a strong presence of manufacturing, but it takes place mostly in assembly plants usually called *maquiladoras* (Lara *et al.,* 2007; Velázquez and León, 2006). As a consequence of the process of industrialization that took place during the 1990s (Rodríguez-Gámez, 2003), the economy of Sonora is now more vulnerable to international shocks of production in manufacturing (see Figure 2).

Figure 2. Gross Domestic Product (GDP) for Manufacturing in the U.S. and Sonora
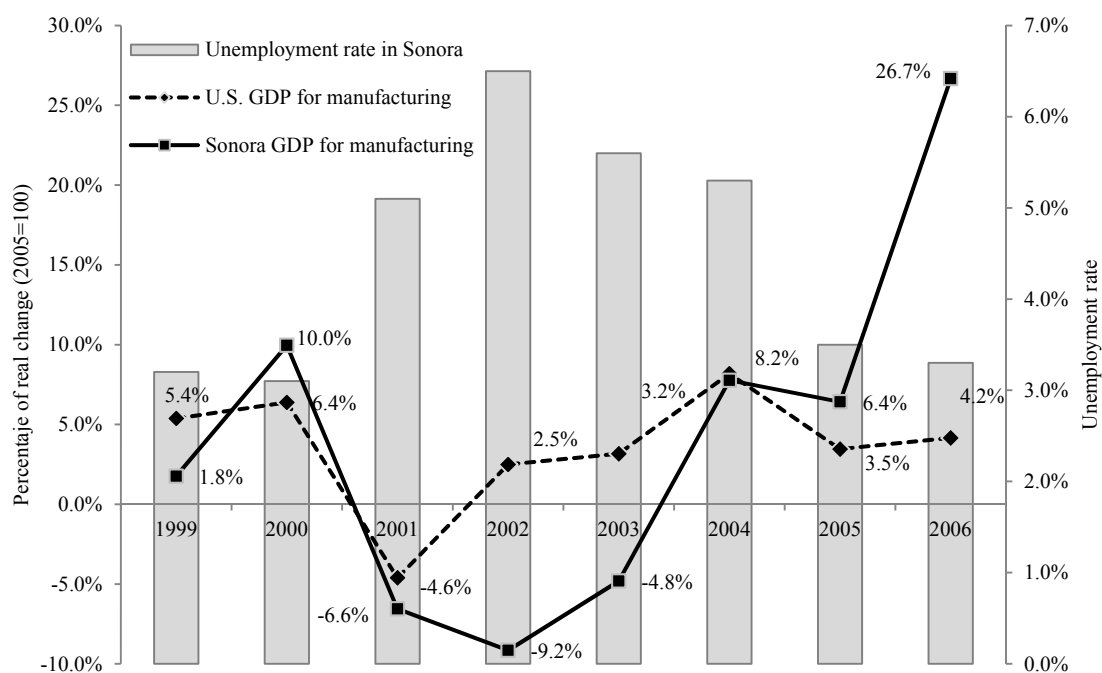
Source: Elaborated based on U.S. Bureau of Economic Analysis and Mexican Bureau of Statistics (INEGI).

The gross domestic product (GDP) for manufacturing in the U.S. showed a fell in 2000-2001 by 4.6%, while in Sonora manufacturing GDP registered a higher 6.6% decrease. Comparing both time series, the fall in manufacturing sector of Sonora was deeper and delayed, as well as lengthier, for last three consecutive years. As a consequence of the U.S. manufacturing crisis, the unemployment rate in Sonora rose. Over the 2001-2004 period, the unemployment rate reached its highest level in 2002 at 6.5%; after that year, employment gradually recovered to the levels registered before the manufacturing crisis. Nevertheless, the adverse effects caused by the manufacturing crisis were deeper for the *Maquiladora* industry than for other industries, and the effects seem to be higher for medium-sized cities, which have concentrated employment in manufacturing as well as in *maquiladoras*. As a consequence the number of plants as well as the employment rates in *maquiladoras* dropped more in Hermosillo than in Nogales (see Figure 3).

Figure 3. Employment growth for *Maquiladora* Industry in Hermosillo, Mexico
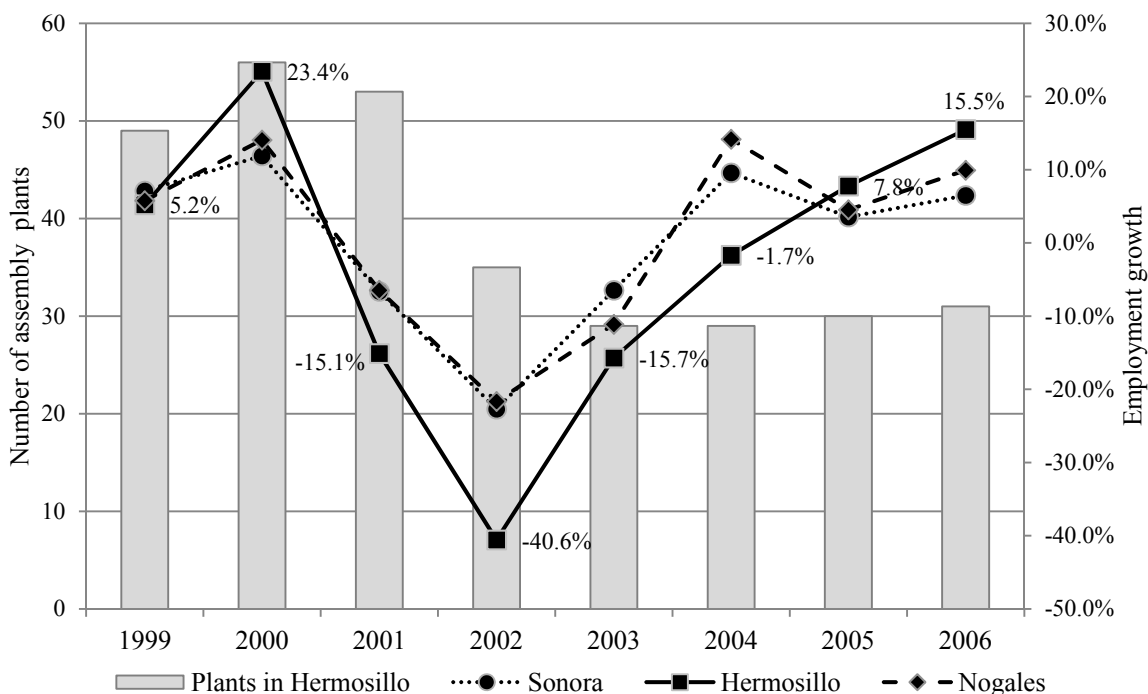
Note: Data for Hermosillo and Nogales correspond to its municipalities.
Source: Elaborated based on INEGI, *Estadísticas de la Industria Maquiladora de Exportación*.

On the other hand, in medium-sized cities of Sonora there are numerous indications that the demand for urban and suburban land use are increasing rapidly, but there are no data available to prove such a trial. The underlying factors are poorly understood, however cartographic comparisons of the two cities show significantly urban sprawl, according to the Mexican Bureau of Statistics (INEGI) and the most recent shape files available. For instance, quinquennial data from Hermosillo indicates that, over the period 2000-2005, there was a 14% increase in the city's areal size. For Ciudad Obregon the increase was smaller, but significant, around 2.1%; while the towns around the city registered an urban sprawl higher than in Ciudad Obregon. As opposed to Ciudad Obregon, Hermosillo does not have a multi-town structure, such as set of suburbs that

plays a key role for population living there. Therefore for a comprehensive understanding of jobs suburbanization, the complexity of commuting patterns needs to be captured.

The study of suburbanization in Mexican cities has been severely hampered by poor data thus far. Furthermore, scholars in Mexico agree on the gaps in the field of urban geography (see Valverde and Kunz 1994; Garza 1996; Schteingart 2001; González-Arellano, 2005; Vilalta, 2008). These are summarized as follows: 1) the studies are merely descriptive and interpretative, 2) few are based on their own surveys, 3) studies with a temporal perspective are scarce, 4) the investigations are focused on some sectors in the city, such as the center, the periphery, or low income neighborhoods, but the studies avoid an overall view of the city; 5) there is a predominance of research on Mexico City, 6) the comparative studies are not abundant, and 7) these have little theoretical argumentation. Summarizing, the urban geography research in Mexico is not theoretically maturing and, as a consequence, the studies are technically weak. For cities in Sonora, the studies are scarce and exhibit the deficiencies listed above.

This investigation seeks to shed light on what is happening, studying how urban structure and employment decentralization affect the jobs distribution in two medium-sized cities in the Northwestern State of Sonora, Mexico; and it makes an attempt to explain the spatial effects associated with employment suburbanization according to the most recent data available. More specifically, this work seeks to answer the following questions:

1) Where is the Central Business District (CBD) and where are the other employment centers in Hermosillo, Mexico? Answering this question will help us

uncover if the city of Hermosillo is experiencing a trend towards employment decentralization.

2) Does the CBD of Hermosillo maintain the traditional attributes of any employment center, namely, attracting activities and influencing the organization of all economic activities around it? Particularly, the research tests if these forces are the same in all directions around the CBD.

For a comprehensive understanding of jobs decentralization, the research explores the spatial distribution of homes and workplaces and the travel patterns that they generate. In order to explore commuting behavior, the study area was switched to Ciudad Obregon. For this medium-sized city, commuting data are available, although, the information is scarce. Based on the above, a third set of questions to be investigated is:

3) What factors explain commuting distance in Ciudad Obregon, Mexico? This information is used to test if commuting distances differs across neighborhoods.

The findings of the investigation were classified in theoretical and methodological contributions, as well as those with urban policy implications. Each set of questions were answered in a publishable paper format, appended to this dissertation. On the overall, the three papers contributes to the field of study providing evidence for medium-sized cities in developing countries, and filling the gaps relating with spatial patterns of employment distribution. Moreover, the dissertation provides evidence for cities with high unemployment rates. Therefore, the local approach to analyze the employment density, one of the most widely issues studied in urban economics, contributes for a better understanding of spatial patterns often masked by global estimations.

The chosen methods, which capture spatial heterogeneity across neighborhoods, provide successful applications and strong evidences for the spatial analysis. Particularly, the research demonstrates that Exploratory Spatial Data Analysis (ESDA) is a useful tool for employment center identification, and validates the use of Geographically Weighted Regression (GWR) and Generalized Multilevel Hierarchical Lineal model (GMHL) to capture spatial effects and uncover spatial patterns in urban contexts. Therefore, the evidence could help urban planners to lead the development with more knowledge and effectiveness. Moreover the spatial patterns uncovered along this dissertation can be used for planning; while the methods applied can be used as guidelines for planning authorities, because these are easily available and easy to use.

1.2 Review of the literature

In order to examine the set of questions described above, the literature review draws upon the literature on urban economics; more precisely those focusing on how suburbanization and employment decentralization affect employment distribution. This section is divided in three parts. The first subsection provides the main ideas to understand the permanence of a CBD and the emergence of new employment subcenters, as well as those studies to analyze if the CBD keeps its traditional economic role and importance. The second takes into account the spatial distribution of employment, analyzing the distribution of homes and workplaces, in order to explore how urban structure influences decisions related to journey to work. These issues of the literature on urban economics illuminate significant

interactions among economic theory and geography. Detailed literature reviews on each topic appear in the three papers appended to this dissertation. Therefore, this section offers just a brief background, stressing the gaps within the scholarly literature.

I. Suburbanization and employment decentralization

The suburbanization process has had an impact on traditional monocentric urban structure, according to which, cities are organized around a Central Business District (CBD) and employment density gradually decreases with distance from it (von Thünen, 1826; Alonso, 1964; Muth, 1969; and Mills, 1972). The monocentric city has only one center, where workers are concentrated and the employment density declines monotonically with distance from the CBD at a constant rate; that means the gradient is the same in all directions. From an economic geography point of view, the trend toward polycentrism implies that the CBD counts for smaller portions of employment than it did in the past (Griffith, 1981; Griffith and Wong, 2007).

The emergence and permanence of a CBD can be explained by the persistent presence of agglomeration economies (see Fujita, 1988; Parr, 2002), as well as by exogenous factors such as the history of the city, the planning decisions by the local government, and the decision of large firms to locate outside the city's core (Redfearn *et al.,* 2008). Once agglomeration leads to higher land prices and wages, and creates congestion problems, the CBD becomes less attractive, and agglomeration of employment can occur in other areas. As such, identifying a single employment center is

trivial (it is the zone with the highest employment density), while identifying

employment subcenters is more challenging. However, the literature offers different

options in order to detect both.

In one of the earliest works on centers identification, Giuliano and Small (1991)

identified an employment center as a cluster of contiguous zones for which total

employment exceeds a predetermined cutoff level (10 jobs per acre and 10,000 jobs for

its adjacent zone). Later, variations in the extent of the cutoff were used (see McMillen

and McDonald, 1998; Giuliano *et al*., 2007). Another set of studies based on non-

parametric procedures has been applied to a variety of large American cities (McMillen

and McDonald, 1997; McMillen, 2001a; McMillen and Smith, 2003). More recently, a

set of studies has relied on new advances in the fields of spatial statistics and spatial

econometrics to formally account for spatial effects in the identification of employment

subcenters (see Baumont *et al*., 2004; Guillain *et al*., 2006).

A number of approaches to analyze the employment spatial patterns in urban

context are applied, especially to identify employment centers and subcenters. However,

the earliest procedures to employment center identification based on cutoff levels have

the weakness of establishing inaccurate cutoffs if researchers do not have a wide

knowledge of local conditions. Moreover, the complexity of non-parametric procedures,

which can capture the spatial effects in the identification of employment subcenters,

encouraged new studies based on more flexible and more spatial procedures.

As a consequence of suburbanization a complex structure of employment

emerges, which can be classified into locally-centralized or dispersed (Gary, 1990).

However, with regards to the latter structure, the urban literature discusses two forms of employment decentralization: the edge city (also called the 'suburban downtown' phenomenon) and the scatteration process (Shearmur *et al.,* 2007). Both of these archetypes exhibit a flat employment density gradient outside the CBD and lack a strong spatial pattern. Although employment has decentralized, the CBDs in developed cities have been able to maintain their traditional economic roles and importance (see, among others, the work of Shearmur and Coffey, 2002, as well as Coffey and Shearmur, 2002, for the Montreal metropolitan region, or Guillain *et al.,* 2006, for the region of Paris, France). In others studies (see as an example McMillen and McDonald, 1998, for metropolitan Chicago), growth is now shared between the CBD and suburban agglomerations, while in other cases the CBD is losing ground to edge cities (see Lang, 2003, who has conceptualized this generalized dispersion based on 13 U.S. metropolitan areas, as well as Gordon and Richardson, 1996, for the case of Los Angeles).

A way to uncover the traditional economic role played by any employment center, such as its attractiveness and its influence on shaping the employment distribution around it, is through a comparative analysis of urban densities. Although a large variety of functional forms have been used to model urban density (for a literature review see Griffith, 1981; McDonald, 1989; Glaeser and Kahn, 2001) the negative exponential function popularized by Clark (1951) is still the most widely used. However, many authors argue that the most appropriate form is the inverse power function proposed by Smeed (1963), contrary to conventional practices (see Batty and Kwang, 1992; Torrens and Alberti, 2000; Chen, 2008) since: 1) the inverse power function has a tendency to

over-predict in areas close to the CBD, while the negative exponential function generally does a poor job predicting central densities; and 2) in Western cities the fall-off in urban density is likely to be great near city boundaries, even higher than the negative exponential function is able to predict.

Not surprisingly, much of the work done in the past decades has concentrated on modeling employment density. Since the pioneering work of Clark (1951), three important conceptual changes have occurred (Griffith and Wong, 2007). The first change focuses on accurately modeling urban density by deriving the best mathematical equation to describe it (see McDonald, 1989). The second change is the re-conceptualization from monocentric to polycentric form (see Griffith, 1981; Griffith and Wong, 2007). The final change offers a more complex model specification considering the presence of spatial autocorrelation and linear weighted regression (see Páez *et al.,* 2001; McMillen, 2001a, 2004; McMillen and Smith, 2003; Guillain *et al.,* 2006; Griffith and Wong 2007; Guillain and Le Gallo, 2009).

Recently, significant scholarly attention has focused on the suburbanization process and, specifically, on employment decentralization outside the CBD. From an economic geography point of view, the relationship has been documented for large American and European cities. However, few studies have been carried out on medium-sized urban areas. Under this approach, suburbanization has drawn very little attention in developing countries like Mexico, and over less attention has been paid if to suburbanization processes taking place in medium or small cities. In fact, to our knowledge, no prior contribution to understand the emergence of new employment

subcenters and the economic role that the CBD plays in a suburbanization context has focused on the case of a medium-sized city located in a developing country.

II.   Employment center/subcenter and travel to work patterns

The suburbanization process in developed cities supports the idea that most people working at employment subcenters live far away from their workplace. Also, employment decentralization has significantly increased the amount of exchange commuting, as the proportion of suburb-to-central city journeys has declined as automobile use has increased (see Cervero and Wu, 1998; Shearmur and Coffey, 2002 for Canadian cities; Aguiléra *et al.,* 2009 and Guillain *et al.*, 2006 for French cities; Vega and Reynolds-Feighan, 2008 for Dublin region). Individual households seek ways to avoid the time penalties caused by the extensive congestion in monocentric urban areas, while firms, also, attempt to escape the disadvantages of high-density locations and find new locations in less congested parts of the city. Therefore, the spatial distribution of employment or, more precisely, the spatial distribution of homes and workplaces and the travel patterns that they generate suggest increasing commute lengths under a suburbanization process.

Whereas polycentrism was accompanied by a decline in the importance of mass transit -as well as of cycling and walking- the importance of the automobile increased (Buchanan *et al.,* 2006; Schwanen *et al.,* 2004; De Palma and Rochart, 1999). Actually the use of motorized vehicles (Gordon and Richardson, 1989; Vega and Reynolds-

Feighan, 2008; Cebollada, 2008), and particularly car ownership, is closely related with a higher probability to obtain a job (Baum, 2009; Sultana and Weber, 2007). For instance, vehicle ownership expands job searches, geographically increasing feasible commuting distance, facilitates employment farther from home, facilitates employment requiring unusual or non-standard work hours, and reduces commuting times relative to those offered by public transportation (Baum, 2009).

As a consequence of greater automobile travel, locations are spatially distributed over a larger area, which forces a more dispersed employment distribution. Commutes are more dispersed in terms of origins (home) and destinations (work), but commuting time/distance can be expected to be lower (Lee *et al.,* 2008; Schwanen *et al.,* 2004). Rising polycentrism does not always match with lower average commuting times or distance (Cervero and Wu, 1998; Van Ommeren and Rietveld, 2005; Kim, 2008; Lee *at al.,* 2008). Some explanations of this phenomenon are residential choice behavior, multiple workers in a household, lags in housing development, or zoning measures (Schwanen *et al.,* 2004). However, another set of factors such as the spatial structure of a city and its size, as well as the population density and employment decentralization (Kim, 2008; Lee *et al*., 2008) play an important role in determining commuting time/distance, although these impacts are not always clear (Cervero and Wu, 1998).

Commuting concerns people´s spatial behavior as a result of the geographic separation of their home and workplace (Rouwendal and Nijkamp, 2004). Therefore the urban economic approaches study commuting behavior through the interaction between three markets: labor, housing, and transportation (Kim, 2008; Rouwendal and Nijkamp,

2004; Gordon *et al.,* 1991). The co-location hypothesis, developed by geographers to study commuters, assumes that in an equilibrium model commuting distance will be a matter of indifference for homogeneous workers who make rational decisions (Levinson and Kumar, 1994; Gordon *et al.,* 1991).

In this case, longer home to work distances imply a trade-off for lower housing prices with workers living farther away from the CBD in order to maximize their welfare (utility). Therefore in a monocentric model, workers, who dislike commuting, must nevertheless, accept residential locations at some distance from their employment location if lower housing prices compensate for the disutility caused by commuting distance (Rouwendal and Nijkamp, 2004). With increasing polycentrism, and as a consequence of co-location, commuting times/distances should exhibit a constant trend, since changes in commutes are small and unperceivable (Ory *et al.,* 2004).

However, assuming that all workers are identical in taste and income is unrealistic, as is the hypothesis that all employment is concentrated in the CBD. Therefore, the New Urban Economics (NUE) has relaxed these assumptions, by considering that income is inversely related to the distance from CBD; thus commuting costs, housing costs and income are considered jointly in order to predict the location of households for different income groups in a city. This suggests that commuting is no longer a matter of indifference, and workers are not indifferent with respect to the location of their jobs (Rouwendal and Nijkamp, 2004). Moreover, in a context of employment decentralization and heterogeneous workers, more than one commuting pattern is possible for the city.

Given the difficulties in finding a good approximation for the commuters' or households' utility function, empirical works have analyzed commuting time or distance. In general, the rate of substitution between commuting cost and living costs is estimated by a ratio of commuters' valuation of time or an objective mobility measure such as commuting distance to commuters' preference for living in a specific area. Therefore, commuting behavior can be visualized as result of a complex set of interactions between travelers' decisions (mode, route, departure time), commuters´ characteristics (gender, income, age, etc.), travel or network characteristics (itinerary, recurrent congestion, travel time, and variability in travel time), and environmental conditions (congestion) (De Palma and Rochat, 1999). Altogether the interactions exhibit an adjustment process based on both on commuter attributes, as well as place characteristics. For an overview about how commuting behavior (measured through commuting time/distance) is affected by those characteristic listed below, see the literature review in Appendix C.

Although the influence of urban structure on commuting behavior has been widely studied in the field of urban economics, it still presents several gaps, especially when one moves to a geographical point of view. Geographers have put forward some relevant hypotheses that attempt to explain the observed regularities with respect to commuting time; although these approaches have some intuitive appeal, they are not embedded in a formal model (Rouwendal and Nijkamp, 2004). Besides, according to Schwanen *et al.* (2004), variations in commuting patterns across metropolitan areas exhibit the following gaps: 1) most investigations of commuting time or distance are based on U.S. data; 2) variations in commuting patterns have been attributable to changes

or differences in the spatial distribution of employment relative to residence place and differences in economic prosperity and employment growth, which have often not been taken into account; and 3) many previous papers do not account for micro-level variation in commuting behavior.

Apparently, the evidence of differences on commuting behavior as a consequence of urban structure for developing urban regions, like Latin American cities, is scarce. One exception is the work of Miranda and Domingues (2010) for Belo Horizonte, Brazil. Although this study is focused on large metropolitan regions, they do not offer insights for medium-sized cities (for the case of a small area in the U.S. see Horner, 2007). In Miranda and Domingues (2010), as well as in Schwanen *et al.* (2004), Bottai *et al.,* (2006), Mercado and Páez (2009), and Zolnik (2009) for developed cities, the authors recognize that the investigation on commuting behavior clearly involves some hierarchical levels of analysis, ranging from individual workers to a metropolitan region (see Figure 4). However, until now, no study has tried to fill the gaps listed below in the context of medium-sized cities in developing countries.

Figure 4. Pictorial representation of the multivariate and multilevel model
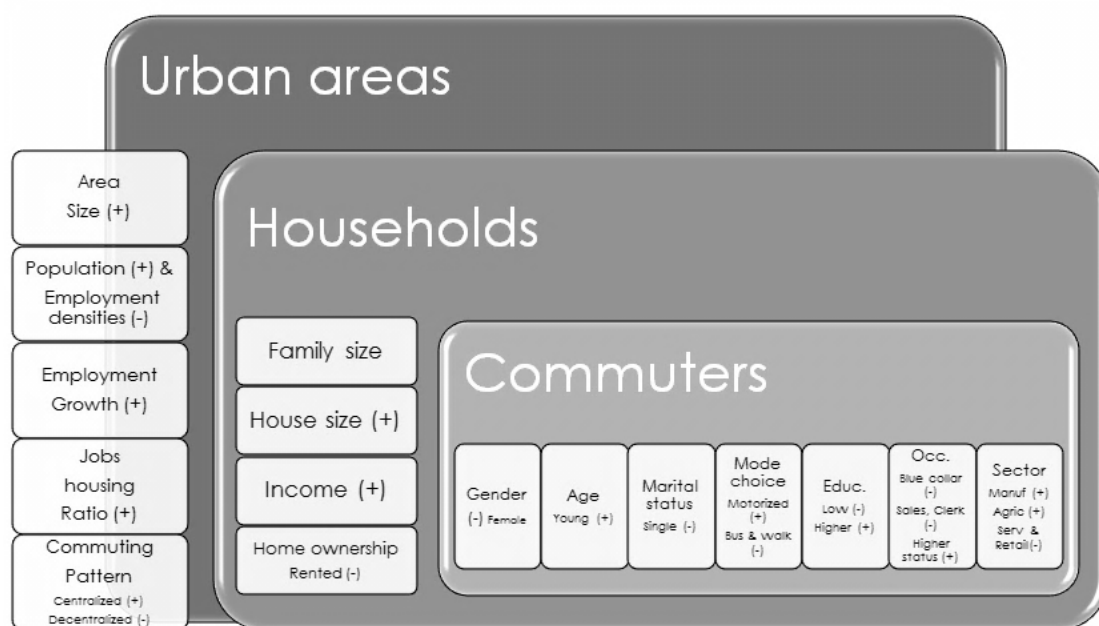
Source: Based on own research.

III. Relevance of the study of spatial effects

The approach of this dissertation is situated in the core of quantitative revolution and

spatial science,[3] which is based on the construction and assessment of formalized

abstractions that involve the application of mathematics, statistics, as well as predictive

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[3] Barnes (2002) identified three stages in the history of economic geography thought. The first stage was the colonialism with an environmental determinism framework (late XIX century); the second was the regionalism (1918-1941) that emphasized the geographical differences; and the third, the quantitative revolution and spatial science (after 1945) with the use of statistical and mathematical techniques. In fact the "new economic geography" is located theoretically on the borderlands between geography, economics, cultural studies, and various kinds of sociology (Barnes, 2001).

and normative approaches.[4] Under this approach, spatial analysis is structured in terms of discrete objects and events, spaces and times, and cause-effect relationships.

As was pointed out in previous subsections, the suburbanization process, which includes urban growth and sprawl, and its impacts on economic change as well as the mobility, are processes of interest in urban analysis. A characteristic of most urban processes is the fact that they are intrinsically spatial and, moreover, space dependent (Páez and Scott, 2004). Spatial data frequently exhibit complex patterns that are difficult to represent and that cannot be explained using global statistics (Getis, 2007; Griffith, 2000; Anselin and Bera, 1998). Employment data and analysis of its patterns across space is not an exception. For instance, the reliability of inferences made using density functions may be affected by the presence of spatial autocorrelation (Griffith and Wong, 2007).

Two main reasons explain the need for a spatially explicit approach. Firstly, most spatial data exhibit spatial dependence (Páez and Scott, 2004). Nearby observations tend to display similar characteristics (Anselin, 1995), therefore testing for spatial autocorrelation and analyzing our data introducing spatial effects produce better statistical practice and avoid misspecification problems, wrong conclusions and erroneous policy recommendations (Anselin and Bera, 1998; Griffith, 2000; Griffith and

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[4]Inside the economic geography new debates have emerged to recover the sense of economic theory from the evolutionary economic geography (see Grabher, 2009) as well as a methodological turn which proposes to emphasize the economic and behavior action using actor network method, triangulation, *in situ* research and deconstruction (see Yeung, 2003).

Wong, 2007). Statistically, many and manifold advantages emerge when spatial

autocorrelation is taken into account (Getis, 2007).[5]

Secondly, the urban process does not always operate in exactly the same way over

space, it often exhibits patterns of spatial heterogeneity (Páez and Scott, 2004), as a

consequence of the fact that some geographical clusters of high or low employment

densities may be present in the city because of differences in the quality of local

amenities, local labor or real estate markets (Anselin, 1995), as well as a result of large-

scale regional effects or administrative subdivision (Páez and Scott, 2004). These

methodological problems were considered for the design and development of the

methodological strategy of this dissertation.

The issue that permeates the three studies of this dissertation is the analysis of

spatial heterogeneity. It is one of the two spatial effects analyzed in the field of spatial

econometrics (Anselin, 1988), but it has been less analyzed compared to spatial

autocorrelation, even when both spatial effects are intrinsically linked with each other

and may be simultaneously present in the dataset. Statistically speaking, "spatial

heterogeneity can be represented as structural variation in the definition of the variance or

as systematic variation in the mean of the process" (Páez and Scott, 2004). Two of the

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[5] According to Getis (2007), if spatial autocorrelation is studied the spatial analysis achieves advantages such as 1) tests on model misspecification, 2) estimations on the strength of the spatial effects on any variable in the model, 3) tests on spatial stationary and spatial heterogeneity, 4) findings related to the possible dependent relationship that a realization of a variable may have on other realizations, 5) insights about the spatial interaction on any spatial autoregressive model, 6) testing the influence that the geometry of spatial units under study might have on the realizations of a variable, 7) tests on the strength of associations among realizations of a variable between spatial units, 8) testing about spatial relationships, 9) valuations to weigh the importance of temporal effects, 10) knowledge based on a spatial unit for a better understanding of effects that it might have on other units and vice versa, that is local spatial autocorrelation; and 11) new insights on the study of outliers.

common methods to deal with spatial heterogeneity, geographically weighted regression

and the multilevel model, will be briefly introduced next.

Geographically weighted regression (GWR) is a locally weighted, linear, and

nonparametric estimation method. Recently, there has been a surge in the use of GWR to

integrate and examine spatial effects from a "local" point of view, as proposed by

Brunsdon *et al.,* (1996). Under this approach, the regression method is able to capture, for

each observation or area, the spatial variation of the regression coefficients based on the

value of the characteristics taken by neighboring observations. The method uses a kernel

function to determine the size window that will produce sub-samples of data around a

specific point. Moreover, the GWR allows estimating local rather than global parameters

through the allocation of weights.

Páez *et al.,* (2002a, 2002b), propose GWR as a model of error variance

heterogeneity called "locational heterogeneity" and use one of the most common

weighted functions based on the concept of distance decay. The variance of the error term

is defined as an exponential function of the squared distance between two observations.

In order to avoid spatial model misspecification, GWR has been extended to include

spatial association components, namely, lagged or error structures (Anselin, 1988). This

has been a useful method to identify the nature of spatial non-stationarity patterns over

the study area (Ertur and Le Gallo, 2009).

Although it has limits, such as the lack of a method to estimate kernel bandwidths

(Wheeler and Tiefelsdorf, 2005; Páez *et al.,* 2002a; 2002b), the mixture of spatial

econometrics and linear weighted regression have been used by Páez *et al.,* (2001),

McMillen (2001 and 2004), McMillen and Smith (2003), Guillain *et al.,* (2006), Griffith and Wong (2007) and recently by Guillain and Le Gallo (2009). This approach offers significant advantages over simple linear regression procedures. One of the primary advantages is the ability to easily map and visualize the local regression coefficients (Wheeler and Tiefelsdorf, 2005; Bitter *et al.,* 2007). But overall, it has a great attractiveness based on its simplicity, the power of its predictions, and the easy way to interpret the results based on all elements and diagnostics of a traditional regression model (Páez *et al.,* 2002a).

Evidence of a parameter of heterogeneity has been found in non-spatial models using different statistic methodologies, such as multilevel models. Under this approach the dependence among observation, as well as the heteroscedasticity on error term, are usually linked to the hierarchical structure of the data (Albright, 2007; Goldstein, 1995). A Multilevel Hierarchical Linear model (MHL) is used to capture the relationships between individual level variables, such as commuters, and variables at a group level, such as households or urban areas. This was proposed in geographical research as a way to model spatial heterogeneity (Duncan and Jones, 2000).

MHL deals with heterogeneity through the covariance matrix where fixed-effects and random-effects are defined. The fixed-effects represent a systemic relationship between the dependent variable and explanatory factors through the intercept and slope, while the random-effects allows for variations around these fixed parts (Goldstein, 1995). Although commuting is usually conceptualized in terms of physical movement of people, the data link events at spatially dispersed locations (Páez and Scott, 2004). Therefore,

spatial interaction is captured at some levels of analysis across the nested structure. The recent empirical evidence on commuting (see Miranda and Domingues, 2010 for Belo Horizonte, Brazil; Zolnik, 2009 for U.S. metropolitan areas; Bottai *et al.,* 2006 for Pisa, in Italy; Mercado and Páez (2009) for Hamilton, Canada; and Schwanen *et al.,* 2004 for The Netherlands) has demonstrated the success of using the multilevel approach for data that has a hierarchized and nested structure.

1.3 Explanation of dissertation format

The research presented in this dissertation is organized into three related studies testing different aspects of the problem and its context focused on questions identified in the introduction and using the background exposed in the subsection "Review of the literature" in the current chapter. The remainder of this dissertation is organized as follows. Chapter 2 presents four subsections related to data, methods, results and the author's contributions. The three individual studies as well as the survey used to collect commuting information were included as appendices in this dissertation. Each study was prepared in the form of publishable papers, which consists of an introduction, methods, results and discussion, and conclusion sections. According to the format, the appended papers are ordered as follows.

Appendix A, titled: "Spatial Distribution of Employment in Hermosillo, 1999 and 2004", was prepared for submission to *Urban Studies*; the paper, co-authored with Sandy Dall'erba, was accepted at the end of 2011, and it is waiting for publication. The study

investigates where the Central Business District (CBD) and other employment centers in Hermosillo, Mexico are. Through an Exploratory Spatial Data Analysis (ESDA) the study tests the presence of spatial dependence and spatial heterogeneity. These spatial effects take the form of clusters of high values of employment around the historical district of the city shaping a huge CBD. Although Hermosillo is still characterized by a monocentric model, two subcenters of high values emerged to the south and to the northwest of the CBD at the end of the period of analysis. The paper shows how the role of the CBD has changed, and offers evidence to help understand the suburbanization process. These results are the first highlights on employment distribution in a medium-sized and developing city, which provide a broader context of the research problem analyzed in the second paper, which appear in Appendix B.

Appendix B, titled "Employment Density in Hermosillo, 1999-2004: A Spatial Econometric Approach of Local Parameters", was submitted for publication to *The Annals of Regional Science* at the beginning of 2012. The paper merited Honorable Mention Status in the 25th Annual Competition for the Charles M. Tiebout Prize in Regional Science, organized by the Western Regional Science Association (WRSA). The paper tests if the CBD of Hermosillo, Mexico maintains the traditional attributes of any employment center, namely, attracting activities and influencing the organization of economic activities around it. The study analyzes the pattern of employment distribution through the 364 districts that composed Hermosillo in 2004, and the 254 areas in 1999. It captures spatial heterogeneity through a Geographically Weighed Regression (GWR) model with spatial effects, and offers evidence for local gradients of employment density

among economic sectors and over time. The results show that the fall in employment density from the CBD does not follow the concentric pattern suggested by global estimations; it varies markedly from one area to the next in different directions. Additionally, local estimators show how, in some sectors, such as services, employment rises rather than falls when distance from the city center is increased. The main contribution of this paper is to provide the first detailed evidence on the role of local spatial effects in the distribution of employment density in a Latin American context, and how global estimations can mask local spatial variations. The spatial heterogeneity exhibited by employment data is also covered in Appendix C.

Appendix C, titled "Commuting in a Developing City: The Case of Ciudad Obregon, Mexico", was prepared for submission to the *Journal of Transport Geography*. This paper, co-authored with Dr. Daoqin Tong, presents an analysis of commuting in the city, based on the survey Employment and Quality of Life (E&QL) conducted by *El Colegio de Sonora* in 2008. Given that the data have a hierarchized and nested structure, the study uses the multilevel approach to measure the impact of a set of explanatory variables, such as demographic and socioeconomic factors, mode choice and regional characteristics, on the commuting behavior in the city; as well, this approach captures interdependencies among different levels of aggregation. The novelty of including the business nature (private business vs. public offices) showed great and positive effect on the length of commuting distance. While some results demonstrated consistency with the existing literatures in developed countries, the income proxy variables showed an opposite effect, and others, such as age, occupation and education, were found to be not

significant. Results indicated that, although space is important for explaining the observed commuting patterns, the worker-related factors at the individual level are stronger. In addition, the inclusion of random-effects to quantify and test contextual variability in commuting behavior indicated that mode choices, university education, and workers in manufacturing contribute differently in explaining the corresponding impacts in various urban areas.

CHAPTER 2. PRESENT STUDY

The methods, results and conclusions of this study are presented in three papers appended

to this dissertation. Therefore the following is a summary of the most important

methodological issues and findings based on the papers appended. Recently scholars have

been incorporating the spatial statistics and spatial econometric approaches, as well as

using Geographic Information Systems (GIS) to analyze social and economic issues

(Páez and Scott, 2004). However, urban geography studies in Mexico, especially related

to the spatial analysis are scare; scientific production of such analysis is not mature, and

the studies are technically weak (Vilalta, 2008; González-Arellano, 2005). Therefore, the

inclusion of the spatial dimension on the analysis of employment distribution, using the

techniques mentioned before, is a relevant and innovative methodological approach in

Mexico.

As contributions to the field of study, the papers appended offer three different

techniques to investigate spatial patterns on the analysis of urban employment. Firstly,

the application of Exploratory Spatial Data Analysis (ESDA) to detect employment

center and subcenters in Appendix A. Secondly, the use of Geographically Weighted

Regression (GWR) models with spatial effects to analyze the employment distribution

complexity in Appendix B. Finally, the application of Generalized Multilevel

Hierarchical Linear models (GMHL) to capture the interaction between labor market and

urban structure in Appendix C.

Although these techniques are not new, their application in the field of urban

geography and regional science is relatively recent. These have been modified to

incorporate spatial effects, to analyze spatial data in a GIS environment to capture spatial

heterogeneity, and to estimate local parameters and represent them through techniques of

geo-visualization. The spatial approach has been used to investigate spatial patterns in

large metropolitan areas in developed cities. Its application has been less frequent in the

case of medium-sized cities in developing countries, where the socioeconomic context is

different to American or European cities. Therefore, the evidence in this study allows

validating the application of these techniques in developing county.

2.1 Data

One of the elements that delayed the advance of the field of regional science as well as

the use of more complex and sophisticated methods on the analysis of employment in

developing countries is the availability of information. Although the approaches to

capture the spatial patterns are substantively great improvements over traditional

approaches to analyze the relationship between employment distribution and urban

structure, two limitations persist: 1) the concerns of the limits of the case studies on

which our current information is built, and 2) urban planners and local governments often

lack sufficiently disaggregated data for their urban areas of jurisdiction. In spite of these

limits, the particular purposes that were analyzed by the three papers appended in the

current dissertation required the creation of two datasets. The first one, the employment

dataset, was used for Appendices A and B for the case of the city of Hermosillo. The

second one, the commuting dataset, was used to conduct the study presented in Appendix

C for Ciudad Obregon. Below, the availability and limits of each datasets are uncovered.

The information included on the employment dataset came from the Mexican

Bureau of Statistics (*Instituto Nacional de Estadística, Geografía e Informática* [INEGI

by its acronym in Spanish]), the main source of information in Mexico. Most of the data,

used as information for context across the dissertation, as well as in the three papers

appended, has been collected through census and surveys conducted by INEGI. The

cartography is also generated by INEGI, based on the smallest unit area for Mexican

cartography (*área geo-estadística básica* [AGEB by its acronym in Spanish]), for which

the main demographic and socioeconomic variables, such as employment data and other

geo-statistical information are available at this level. Beside the employment data

availability, the comparative approach over time is constrained to the most recent data

which is accessible each five years. But it is possible to compare information only since

1999, as a consequence of the change in the classification system of economic activities

and products in Mexico (*Clasificación Mexicana de Actividades y Productos* ([CMAP by

its acronym in Spanish]) into the North America Industrial Classification System

(*Sistema de Clasificación Industrial de América del Norte* [SCIAN by its acronym in

Spanish]) in order to compare statistics among NAFTA partners.

The analysis over time compares results of employment distribution in 1999 and

2004, which are the most recent datasets available at the moment to conduct the

dissertation research. According to SCIAN, the employment information is disaggregated

in subsectors, however, only the information for six subsectors was available at the

AGEB's level.[1] These were: 1) forestry, fishing, hunting, and agriculture support, 2)

mining and oil extraction, 3) water and electricity production, 4) manufacturing 5)

retailing and wholesale, and 6) services, except professional services, related with

subsectors excluded. The information was linked in a geo-database (GDB) with

cartography at the AGEB's level, which also contained area attributes such as AGEB's

size. For 1999, the employment dataset was linked across the 264 AGEBs that composed

Hermosillo, as well as for 364 AGEBs in 2004. After that, the centroids of each AGEB

were generated in a GIS environment to calculate the distance between the CBD and each

urban area or AGEB. Hermosillo's GDB was developed for both years (see Table 1).

Table 1. Thematic layers for employment GDB in Hermosillo

	Layer: **Centroids** *Map use:* house locations as started point of travel *Source:* Will produce using a geo-coding process *Representation*: Point *Spatial relationships:* Points of interest can have one or more addresses *Spatial relationships:* Streets intersect only at endpoints and generally do not overlap *Map scale and accuracy:* Scale and accuracy varies depending upon the data source *Symbology and annotation:* Symbolized according to AGEB´s characteristics
	Layer: **CBD** *Map use:* Workplace location as ended point of travel *Source:* Will produce using a geo-coding process *Representation*: Point *Spatial relationships:* Points of interest can have one addresses *Spatial relationships:* Streets intersect only at endpoints and generally do not overlap *Map scale and accuracy:* Scale and accuracy varies depending upon the data source *Symbology and annotation:* Symbolized according to CBD's characteristics
	Layer: **AGEBS** *Map use:* Management AGEB's maps *Data source:* INEGI *Representation:* Polygons *Spatial relationships:* Districts of the same type do not overlap *Map scale and accuracy:* Scale and accuracy varies depending upon the data source *Symbology and annotation:* Symbolized according to AGEB's characteristics

Source: Based on own research.

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[1] The analysis excluded the subsectors of construction, transportation and storage, financial services, and governmental services; since reporting data of these economic activities at the AGEB's level would reveal the precise location of a particular business and its confidential information if these were geo-referenced. Therefore displaying information related to these subsectors at the AGEB's level transgresses the "principle of confidentiality" of information that INEGI guarantee to its informants.

The commuting dataset, to capture the relationship between labor market and urban structure in Appendix C, required disaggregation at the individual level related to home and workplace locations, mode of transportations, and other complementary information. INEGI and other official sources in Mexico, such as governmental offices, do not collect commuting information. Commuting studies in Mexico (see Fuentes, 2009 and 2008 for the border city of Ciudad Juarez; Brugués and Rubio, 2010 for the cities of Los Mochis and Mazatlan) used local surveys conducted by scholars, in association with planning institutes, and through grants of the National Council of Science and Technology (*Consejo Nacional de Ciencia y Tecnología* [CONACyT by its acronym in Spanish]). In Sonora, the commuting information was first available through the survey Employment and Quality of Life (E&QL) in two medium-sized cities in Sonora: Ciudad Obregon and *Heroica* Nogales. The survey was conducted in 2008 by *El Colegio de Sonora*, a research center in social sciences located in Hermosillo, Sonora, usually called Colson.

Scholars of Colson followed a multistage sampling method to conduct the full survey, which was composed of three modules: home residents (HRs), which collected demographic information, home and household attributes (H&H), and employment (E&QL) to capture quality of life characteristics (see Appendix D). In order to take advantage of Colson's information to analyze the labor market and the urban structure it was necessary to extract the commuting information. The commuters were identified as follows: 1) employees who worked at least one hour during the previous week to the

application of Colson's survey, or all who got a payment for a job, as well as those individuals who helped relatives in a family business; and 2) workers who provided information (name and/or location) about the places where they worked.

The analysis was conducted in a GIS environment. The survey information was organized in a geo-database (GDB) in order to take advantage of data centrally stored and managed, as well as the integrity between the three different components (HRs, H&H, and E&QL) and levels of information (multistage sampling) of the survey, which implied a normalization process.[2] Following the object-oriented approach to activity/travel behavior research proposed by Buliung and Kanaroglou (2004), the commuting reality in Ciudad Obregon were comprised of objects characterized by descriptive attributes or properties, and operations that represent behavior. The steps were: 1) the description of research questions, 2) development of the conceptual modeling of activity/travel survey data, 3) design of the schematic representation of the database with the standards of some type of database technology, and 4) the implementation of a fully documented spatial database.[3]
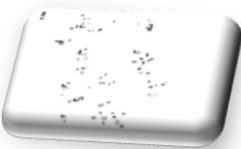
After building two feature classes, one for origin points (house) and the other for destination points (workplaces) (see Table 2), the information at the commuters' level was linked to origin points to compute the commuting distance and associate them with commuter attributes, including variables related to workplaces' characteristics. At the end, the commuter information was linked with AGEB's cartography and its

[2] It is the process of organizing, analyzing, and cleaning data to reduce redundancy and remove inconsistencies, considering that this survey was not designed in a geographic perspective (Longley *et al.,* 2005).

[3] The approach took into account the feedbacks in the research process, as well as, the iteration of the entire process or specific components of the process.

socioeconomic attributes in order to complete the GDB. Hence, as a consequence of the

multistage sampling, the hierarchical dataset structure has 505 commuters, nested in 374

households in 39 urban areas or AGEBs sampled in Ciudad Obregon (see Figure 5).

Table 2. Thematic layers for commuting's GDB in Ciudad Obregon

Layer: **Origin**
Map use: house locations as started point of travel
Source: Will produce using a geo-coding process
Representation: Point
Spatial relationships: Points of interest can have one or more addresses
Spatial relationships: Streets intersect only at endpoints and generally do not overlap
Map scale and accuracy: Scale and accuracy varies depending upon the data source
Symbology and annotation: Symbolized according with commuters attributes

Layer: **Destination**
Map use: Workplace location as ended point of travel
Source: Will produce using a geo-coding process
Representation: Point
Spatial relationships: Points of interest can have one addresses
Spatial relationships: Streets intersect only at endpoints and generally do not overlap
Map scale and accuracy: Scale and accuracy varies depending upon the data source
Symbology and annotation: Symbolized according to economic sector

Layer: **AGEBS**
Map use: Management AGEB's maps
Data source: INEGI
Representation: Polygons
Spatial relationships: Areas of the same type do not overlap
Map scale and accuracy: Scale and accuracy varies depending upon the data source
Symbology and annotation: Symbolized according to AGEB's attributes

Source: Based on own research.

Figure 5. Pictorial representation of nested data in the survey E&QL

Source: Based on own research.

2.2 Methods

The three studies, integrated as a whole, explored the distribution of employment in

urban contexts; therefore the spatial statistics and spatial econometrics are the main

methods to analyze the employment data. Table 3 shows the objectives, variables and

methodological steps involved in each paper appended to this dissertation. Altogether, the

methods stress the local model as opposed to global ones to detect spatial complex

patterns in spatial data that are inexplicable by global statistics and models. However,

under spatial analysis, both approaches -global and local- have their own merit; global

indicators show us the inefficacy to model spatial data forcing us to move away from

global models, study local relationships and discover local heterogeneity (Páez and Scott,

2004; Lloyd, 2007). Therefore global and local estimations are complementary approaches.

In order to know if the city of Hermosillo is experiencing a trend toward employment decentralization or still follows the traditional monocentric hypothesis, Appendix A "Spatial Distribution of Employment in Hermosillo, 1999 and 2004" identifies where the Central Business District (CBD) and other employment centers are. To answer the research questions, the paper shows the results of ESDA to test the presence of spatial effects over time and across the economic sector according to the employment dataset described above. In order to investigate the spatial dependence and spatial heterogeneity, the spatial connectivity among AGEBs was defined through a weight matrix (*W*) based on k-nearest neighbor's criteria. Several weight matrixes were used to test the sensitivity of the results, but *k4* (the average number of neighbors in Hermosillo) shows the robustness estimators of global spatial autocorrelation. Moreover, taking advantage of ESDA's technique the identification of employment subcenters was conducted by Local Indicators of Spatial Association (LISA) according to two attributes: 1) it is an AGEB (or a set of neighboring areas) for which the employment per hectare is significantly higher than the average employment density in Hermosillo and, 2) it is an AGEB (or a set of neighboring areas) surrounded by AGEBs for which the average employment density is significantly lower. The ESDA's analysis was conducted on the open source version of GeoDa 0.9.5-i5 developed by the Spatial Analysis Laboratory of the University of Illinois at Urbana-Champaign under the direction of Luc Anselin. Moreover, in order to get insight about subcenter characteristics and uncover their degree

of specialization and diversification, the final methodological step was to calculate the
location quotient and regional diversity index.

Appendix B, "Employment Density in Hermosillo, 1999-2004: A Spatial
Econometric Approach of Local Parameters", explores the characteristics of employment
subcenters and stresses the CBD's attributes in Appendix B. The research questions focus
particularly on investigating if Hermosillo's CBD maintains traditional attributes: to
attract activities and influence the organization of all economic activities around it. In
order to detect the appropriate form of spatial autocorrelation, the contiguity matrix
showed the robustness estimations for the Lagrange Multiplier (LM) test, proposed by
Anselin and Florax (1995). After that, global density gradients for total employment and
each economic sector under study were estimated through a Maximum Likelihood (ML)
method for 1999 and 2004, according with the spatial error model specification. The
significance level and the sign were used to test the attractiveness and the influence of
CBD, respectively. Alternatively the paper goes on local approach of employment
gradients which were estimated through a GWR model with spatial effects, proposed by
Páez *et al.,* (2002a; 2002b), to test if the CBD's forces of attraction and organization are
the same in all directions. Added, local heterogeneity was tested as well as the
appropriate form of spatial autocorrelation through LM test. Both estimations, global and
local gradients, were computed using the Spatial Econometric Toolbox in Matlab
(LeSage, 1999) and codes provided by Antonio Páez and adapted to the employment
dataset described above, respectively. The codes were run in Matlab©, version 7.9.0
(R2009b), a numerical computing environment developed by Math Works, Inc. In order

to find the patterns of CBD's attributes, the local gradients were mapped using the

ArcGIS© Desktop, version 10.3, developed by ESRI, Inc.

Table 3. Research questions and methods

	Research questions	Variables	Method	Software	Methodological steps
Appendix A	Is the city of Hermosillo experiencing a trend towards employment decentralization? Where is the Central Business District (CBD) and where are the other employment centers?	• Employment density • Economic specialization	• Exploratory Spatial Data Analysis (ESDA)	• ArcGIS • GeoDa	• Spatial autocorrelation (Moran's I) • Spatial heterogeneity (LISA maps) • Subcenter identification • Specialization and diversification indices
Appendix B	Does the CBD of Hermosillo maintain the traditional attributes of any employment center, namely, attracting activities and influencing the organization of economic activities around it? Are these forces the same in all directions around the CBD?	• Employment density • Distance to CBD	• Spatial econometrics • Geographically Weighted Regression (GWR) with spatial effects	• ArcGIS • Matlab	• Test the form of spatial autocorrelation. • Global estimations of employment density gradients. • Local estimations of employment density gradients. • Geo-visualization of local gradients.
Appendix C	What factors explain commuting distance in Ciudad Obregon, Mexico? Does the commuting distance differ across neighborhoods?	• Commuting distance • Mode choice • Demographic information • Socioeconomic attributes • AGEB's characteristics	• Generalized Multilevel Hierarchical Linear (GMHL) model	• ArcGIS • MLwiN	• Develop a Geographic Information System (GIS): a) Identify O-D points b) Compute distance • Define levels • Calculate the interclass correlation. • Descriptive analysis. • Multilevel analysis of commuting behavior.

Source: Based on own research.

Appendix C, "Commuting in a Developing City: the Case of Ciudad Obregon,

Mexico", draws on the commuting patterns based on the evidence from survey E&QL

conducted by Colson (see Appendix D) to answer two questions. First, the question of

how much the commuting distance -the output variable to measure the interaction between urban structure and employment- differs across neighborhoods (AGEBs), and thus, more specifically, does space matter? This was answered through a hierarchical intercept-only model. This model estimates residuals or deviations from the fixed intercept for each AGEB, in order to calculate the intra-class correlation coefficient (ρ) or the intra- AGEB variance. Second, in order to investigate what the explanatory factors (focus on its significance level) are, and their relationship with commuting distance (depending of the sign of its relation), commuting behavior was modeled through a full model with random intercept and slopes estimated following a GMHL model. The regression model was estimated using the software MLwiN© version 2.24, developed by the Center for Multilevel Modeling, University of Bristol.

For commuters and households, variables come from the Colson's survey and can be classified into mode choice, demographics, and socioeconomic attributes, while the AGEB's variables were estimated based on INEGI information (see Table 4). In order to classify the journeys to work according to Van der Laan's typology (1998),[4] the paper uncovers where was located the CBD, following the method used in Appendix A. Next, a step-by-step method was used to develop the GMHL model. Our strategy of analysis follows the recommendation of building up multilevel models by starting with a basic model in which all parameters are fixed and then adding random coefficients (Raudenbush and Bryk, 2002; Twisk, 2006). In particular, there was an interest in

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[4] The journey to work is a centralized trip if commuters go to the central area of the city (i.e., the CBD and its area of influence defined by a HH clusters according to LISA), while the trip is decentralized if residents commute between non-central areas; otherwise the trip is safe-contained (into the same area or AGEB) or an exchange commuting (if commuters go to towns around the city).

including random-slopes on mode choice variables to uncover if differences in

commuting distances differ by mode choice among AGEBs.

Table 4. Variables to model commuting in Ciudad Obregon

Commuter's variables (level 1)				
Dependent	OD_DISTln	Log of commuting distance	Double	-----
Demographics	SEX	Man vs. woman	Nominal	Code [0,1]
	YOUNGER	Adult vs. younger people	Nominal	Code [0,1]
	OLDER	Adult vs. older people	Nominal	Code [0,1]
	MARRIAGE	Marriage vs. single	Nominal	Code [0,1]
	FAM_SIZE	People living in house	Nominal	Code [0,1]
	NUM_HOUSEHOLDS	One households vs. more than one	Nominal	Code [0,1]
Mode choice	NOCAR	Car ownership vs. no car	Nominal	Code [0,1]
	MT1	Car vs. bus	Nominal	Code [0,1]
	MT2	Car vs. walking	Nominal	Code [0,1]
	MT3	Car vs. bike	Nominal	Code [0,1]
	MT4	Car vs. shuttle	Nominal	Code [0,1]
	COMMTYPE1	Centralized vs. decentralized commuting	Nominal	Code [0,1]
	COMMTYPE2	Centralized vs. other commuting	Nominal	Code [0,1]
Socioeconomics	HOME_RENT	House ownership vs. rented house	Nominal	Code [0,1]
	HOME_SIZE	Number of rooms	Double	-----
	APPLIANCES	Amount of appliances in home	Double	Max 13
	EDUnone	Basic vs. None education	Nominal	Code [0,1]
	EDUhigh	Basic vs. High School education	Nominal	Code [0,1]
	EDUniversity	Basic vs. Under & Graduate education	Nominal	Code [0,1]
	OCCUP_no_skills	Low-skilled jobs vs. No skills	Nominal	Code [0,1]
	OCCUP_mod_skills	Low-skilled jobs vs. Moderately skilled	Nominal	Code [0,1]
	OCCUP_high_skills	Low-skilled jobs vs. Highly skilled	Nominal	Code [0,1]
	SEC2	Workers in services vs. in manufacturing	Nominal	Code [0,1]
	SEC1	Workers in services vs. in agriculture	Nominal	Code [0,1]
	PRIVATE_D	Private business vs. public offices	Nominal	Code [0,1]
	D_SIZE	Small vs. big enterprise	Nominal	Code [0,1]
	EMPLOYEE	Employee vs. employer	Nominal	Code [0,1]
	WORKTIME	Daily vs. nightly work time	Nominal	Code [0,1]
	EARNINGS	Salary vs. profits	Nominal	Code [0,1]
AGEB's variables (level 2)				
AGEB's characteristics	AREAln	Log of AGEB's size (square meters)	Double	-----
	SCHOOLING	Years of schooling (AGEB's average)	Double	-----
	JHR	Job Housing ratio	Double	-----
	POPDEN05	Population density in 2005	Double	-----
	EDEN09	Employment density in 2009	Double	-----
	DIF_EMP	Gain / loss employees per ha (2009-2005)	Double	-----

Source: Based on Appendix D.

2.3 Results

The studies, integrated as a whole, explored how urban structure and its expansion in the context of developing countries have affected the spatial distribution of employment in medium-sized cities. Results and conclusions of the individual studies comprising this dissertation are presented in the three appendices of this study. Therefore, this section summarizes the scopes of each paper, which are described, briefly, as follows.

Appendix A: "Spatial Distribution of Employment in Hermosillo, 1999 and 2004"

Based on evidence from employment dataset in Hermosillo, Mexico, analyzed through ESDA, this paper identifies where the CBD and other employment centers are. The results reveal important findings. First, the Moran´s I and Moran's scatterplot reveal a significant presence of global spatial autocorrelation. The increase in the Moran's I values over time suggests that, on average, the employment density in each AGEB has become more similar to the one of its neighbors. The results also indicate that positive spatial autocorrelation is not present in all the sectors; it is an increasingly important element for employment in manufacturing, retail and wholesale, as well as services.

Secondly, after conducting the methodology of subcenter identification for 1999 and 2004 based on the employment density data, the results showed that employment is significantly clustered around the CBD for both years, which indicate the presence of spatial heterogeneity in the city. Therefore, the High-High (HH) cluster (observation with

high values surrounded by similar neighbors) as defined by the results of LISA (observations with a high value surrounded by high values) was the tool used to identify the employment center and subcenters. The biggest HH cluster (integrated by 25 AGEBs) is located in the center of the city, around the CBD –that is the AGEB with the highest employment density which is also the historic and retailing center of the city. It is more extensive in 2004 (composed of 34 AGEBs), which indicates that the CBD is spreading over time. The method also allows identifying two subcenters of employment in 2004. One of them located northwest of the CBD in 1999; it has moved northward in 2004, and now it is composed of three AGEBs. In addition, a new cluster made of two HH AGEBs emerged in the southern part of the usual CBD at the final period.

Finally, the results of the degree of specialization and diversification show that the historical CBD is specialized in retailing and wholesale, while the CBD (HH cluster) is specialized in services; moreover, a spreading CBD is associated with high values of the regional diversity index. Although the Northwestern subcenter specialized in manufacturing as well as in retailing and wholesale, it kept its degree of diversity over time. In contrast, the southern subcenter was more diversified in 2004, while its trend to specialization was moving from manufacturing to service activities.

The results listed below allow concluding that Hermosillo is experiencing a trend towards employment decentralization in conjunction with increasing spatial dependence between neighboring spatial entities, while the CBD has remained the densest area in terms of employment. Despite this suburbanization process, Hermosillo is still a monocentric city. Undoubtedly this result contradicts the idea of polycentrism that

Hermosillo's Planning Institute supports. Their misconception might come from the absence of consideration for spatial effects in the methodology they rely on.

Appendix B: "Employment Density in Hermosillo, 1999-2004: A Spatial Econometric Approach of Local Parameters"

Based on findings in Appendix A, the paper in Appendix B investigates the attractiveness of the CBD and its influence on organizing the economic activities around it. In order to test these attributes, the employment gradients were estimated following a global approach, according to a spatial econometric model based on Spatial Error Model specification (SEM), as well as through a local point of view using a GWR. Using the employment dataset, the paper also uncovers differences in the attractiveness and influence of the CBD across economic sectors and over time. The results are displayed below according to global and local estimations of employment gradients.

Global results confirm the attractiveness of CBD and its influence to organize the economic activity around it; the density gradient (γ) for total employment is negative and strongly significant. Moreover, low values of γ mean that a suburbanization process took place in the city between 1999 and 2004. However the CBD's attractiveness depends on the economic activity under study. For instances in retailing and wholesale as well as services, the CBD still influences the distribution of employment and it is attractive for employees; while for manufacturing, the CBD is not attractive. For other economic activities, the city's CBD does not show attractiveness, but it is governed by the distance

from the CBD in farming, hunting, fishing and agriculture support; mining and oil extraction, and water and electricity production. On the other hand, the value of the spatial coefficient (λ) that measures the intensity of spatial dependence across residuals is statistically significant, but less important, in 2004 than in 1999. All these results are consistent over time and suggest that, overall, the fall in employment density from the CBD follows a monotonic pattern (the change is the same in all directions).

The analysis of local heterogeneity and the geographical distribution of local gradients display different patterns of falls in employment density (γ) with different distances and/or directions from the CBD. The local results show the CBD is attractive and influences the distribution of employment in Hermosillo; however the fall in total employment density is not uniform in all directions around it. For instance, in 2004 the local employment gradients are less pronounced to the north and along the northeast corridor from the CBD, and the density gradients increase more rapidly to the south and the west of the CBD. Worse, the employment decentralization pointed out by global results contradicts the trend toward polarization of jobs suggested by local gradients.

The CBD's influence and attractiveness by AGEB, likewise in global estimations, differ by economic sector. Although small differences persist, the geographical distribution of local gradients for retailing and wholesale is quite similar to that of total employment. However, the employment density for services showed a lack of attractiveness in the city center (positive local gradient) and along the northeast corridor from the CBD, drawing different patterns to different directions. This repellent effect was not observed through the global results that showed a decay pattern in this sector for all

areas. In the case of manufacturing, the CBD does not have any influence organizing this activity and also shows a repellent effect. For other economic sectors, the local heterogeneity was not statistically significant. A broader description of employment patterns over time, as well as their geo-visualization, can be browsed in Appendix B.

As final conclusion, the results indicate the CBD still has a significant and widespread influence on employment densities in Hermosillo, and the CBD's attractiveness has been present in the most important economic sectors in the city, such as retailing and wholesale, services, and manufacturing, which constituted 98.7% of total employment. Moreover, the spatial error autocorrelation indicates that the CBD dominates the spatial patterns of employment (distance-decay), but its influence varies across space, economic sector and, even, over time. The local point of view is highly relevant in the analysis of employment, since global estimations mask local patterns.

Appendix C: "Commuting in a Developing City: The Case of Ciudad Obregon, Mexico"

The paper in Appendix C shows the results of modeling commuting behavior in Ciudad Obregon through a GMHL model. The commuting dataset is nested in three levels of analysis, however, the multilevel model only includes commuters (level 1) clustered in AGEBs (level 2), since the design effect did not allow using an intermediate level (household) because the number of commuters nested in households is fairly similar. The first conclusion draws on the importance of space to explain differences on commuting behavior. Based on a two level model, 15% of variations in commuting distance are

explained by regional differences across AGEBs or urban areas. To illustrate how the

commuting distance varies among the 39 AGEBs, the residuals from the fixed intercept

were plotted and arranged from those with the smallest residuals on the left to those areas

with the largest residuals on the right. These results reported that eight areas have

residuals significantly different from zero.

Based on two levels of analysis, the commuting behavior was modeled for each

commuter as a function of its own attributes as well as AGEB's characteristics. When a

random-intercept and fixed-effects were included, the commuting data fit better to

explain variations among AGEBs; the changes in χ^2 support this preliminary conclusion.

Since most of the commuter attributes have been captured through categorical data and

coded as dummy variables, the reference categories are married workers (male) who used

car as mode of transportation, those who lived in their own house with car ownership,

those with basic education and low-skilled occupation, and those who worked in a small

private business and received salary for working during the daytime in services sector

(including retailing).

The results suggested that, in general, the effects of demographic and

socioeconomic variables as well as mode choice are consistent with expectations. With

our reference group, the highest effect on commuting distance is produced by walking

mode choice (-), other commuting type such as safe-contained and exchange commuting

(-), workers in agriculture (+), biking mode choice (-), workers who gain some type of

profits (-), occupation (moderately skilled jobs +), followed by public offices (+),

employers (-), commuters who rent a house (-), bus mode choice (+), workers in

manufacturing (+), female (-), decentralized commuting trip (-), single workers (-), AGEB's size (+), JHR (-), schooling (-), house size measure through the number of rooms (-) and employment density in 2009 (-).

These findings enrich the empirical evidence in the field. The introduction of new variables related to workplaces contributes to the literature in providing additional explanation for commuting distances, such as the business nature (private business vs. public offices), which was found to have a great effect on the length of commuting distance. Moreover, it is interesting to note that in the case of age (younger and older commuters), education (with the exception of elementary education), and categories of occupation, such as highly skilled, are not statistically significant for explaining commuting behavior, while these are often important factors that have been identified in the commuting literature. On the other hand, the income proxy variables, such as house size and years of schooling, show an opposite effect on commuting comparing with what existing studies suggest.

Results also show that commuting variation at the individual level was much stronger than that introduced by the structure of the city (level 2). This is partly because the commuting patterns, such as centralized, decentralized, self-contained and exchange commuting were captured at individual worker level, while in other studies (see Schwanen *et al.,* 2004) they were reported at a higher level of aggregation such as urban area. When random-effects were introduced and extended to regression slopes, the geographical variation characterized by AGEBs provided a better explanation in the overall commute variation. Actually, when the intercept goes up the slope decreases for

bus and walking and increases for biking. The random part of the slope for bus increases

with an increase in the slope for walking or a decrease in the slope for biking. For

walking there are no significant random-effects on its slope. Hence these results

suggested that the association of these variables with commuting differed with various

AGEBs. For a broader description of covariance matrix see Appendix C.

2.4 Contributions

This section points to the contributions of the current dissertation to our field of study.

The contributions have been classified into three main categories as follows:

I. Employment descentralization in developing contexts

a)   Whereas, to our knowledge, no prior contribution has focused on the case of a

medium-sized city located in a developing country, the paper in Appendix A

"Spatial Distribution of Employment in Hermosillo, 1999 and 2004" makes a

contribution in fills this gap and provides evidence for comparison according to

the following:

- Whether the medium-sized city is developed or it is developing, its CBD can

  be identified as a HH cluster centrally located, highlighting its monocentric

  structure; nevertheless a developed city can be more monocentric when

  compared with a developing city. Over time the trend toward the expansion

of CBD in Hermosillo was throwing back, while the number of employment subcenters increased in developed cities.

- As a consequence of different degrees of development, employment centers and subcenters in developing cities specilize in very different sets of economic activities. Therefore, further studies must consider increasing the level of sectoral disagregation on retailing and services, the main sectors in developing cities, like Hermosillo.

- As shown in the case of Hermosillo, employment decentralization occurred over the 1999-2004 period, and the influence of the city center on the location of employment increased during that period. The logical question to ask is if the findings will be consistent within the next five year period (2004-2009), which might mean that employment decentralization is an ongoing process. Future work aims at updating our results, in order to verify over a ten-year period how the city sprawled across space, if new centers have emerged, and if the CBD still influences the distribution of employment.

- Clearly, in developing cities the environmental conditions impose limits on the form of the city and its expansion, as well as to the way in which new employment centers will arise in forthcoming years, and thus how employment decentralization will impact daily life as expressed through commuting patterns. It is important to note that Hermosillo is one of the four Mexican cities in a water crisis, according to Mexican Water Commission (*Comisión Nacional del Agua* [CONAGUA by its acronym in Spanish]) and

although increasing investment in water infrastructure, the problem has not been fully solved; instead, the city still continues sprawling. Therefore in order to get a comprehensive view of suburbanization, future studies should include "environmental factors" such as the main sources of water in the city, and pumping plants. These will be key elements to determine the urban growth, the expansion of employment centers and potential locations for new employment subcenters.

b) Appendix B "Employment Density in Hermosillo, 1999-2004: A Spatial Econometric Approach of Local Parameters" allows primary findings to be drawn as to how the international literature studies the employment distribution with respect to medium-sized cities in developing countries.

- First, with respect to the medium size city of Hermosillo, the negative power density gradient implied by the standard urban model fits the data quite well, contrary to conventional practice in large and developed cities.

- Second, according to the standard urban model, the density gradients of cities become flatter with distance from the CBD, but the "local gradients" show different patterns to different directions.

- Third, the geographic patterns displayed allow identifying some forces of attraction and repulsion that have operated among AGEBs; even so, global estimations masked those patterns.

- The main contribution of this paper to the field of study is to make evident that employment density does not decrease monotonically. However, there

are many land use controls that affect sprawling and employment

decentralization, which should be controlled and taken into account for a

comprehensive understanding of spatial patterns.

c)   Contributions related to Appendix B are important because they present the first

detailed evidence on the role of local spatial effects in the distribution of

employment density in a medium-sized Latin American city and at the same time

enrich the evidence in our field of study.

d)   Empirical evidence on commuting behavior showed in Appendix C "Commuting

in a Developing City: The Case of Ciudad Obregon, Mexico" allow us to make

the following points:

- In general, the effects on demographics and socioeconomic variables, as well

  as mode choice are consistent with those suggested by economic urban

  literature. These findings enrich the empirical evidence on the field and

  provide insights about the commuting behavior in developing countries.

  However, further studies should investigate the effects of some interaction

  terms such as age and gender, and its association with education and

  occupation.

- The commuting model is novel in including variables related with

  workplaces, which have been neglected by other studies. The results indicate

  that business nature (private business vs. public offices) has a large and

  statistically significant effect on the length of commuting distance. To test the

  validity of this contribution, further research on commuting can be developed

in *Heroica* Nogales, a medium-sized city for which Colson conducted the same survey.

- Despite the commuters' rationality preliminary findings in medium-sized cities in developing countries reveal the importance of the government (the public sector) as an employer. Therefore the location of public workplaces has a great influence on commuting distance.

- The results evidenced the importance of public transportation and non-motorized modes in medium-sized cities, which are common modes of transportation in developing countries, while in U.S. cities the car is the main mode for all purposes. Besides, further research on this topic should include an analysis of public transportation that is a more important mode choice for certain group of commuters, rather than the use of cars.

e) In developing countries is hard for urban residents find a job since the conditions of the local labor market are characterized by increasing unemployment rates and the few positions available are often low-pay occupations. In a situation of excess of workers, logically, variables associated with education level are not significant to explain commuting patterns, like in Ciudad Obregon's case. Moreover, in developing countries, finding a job is more important no matter how far the employees must commute, even for those highly educated. These findings contrast with those in developed cities where education and occupation explain differences on commuting.

f)   Our commuting dataset compiled from the survey conducted by Colson is the

most comprehensive information available for examining the commuting patterns

in Ciudad Obregon, as well as to get insights about commuting behavior in the

medium-sized cities of Sonora.

II. Methodological suitability

a)   Appendix A showed evidence to support that ESDA is a useful tool for the

identification of centers and subcenters, as well as a tool to uncover the spreading

and suburbanization phenomenon over time. However, it is necessary to increase

the disagregation level of analysis among sectors to uncover the spatial effects of

an specific economic activity, as well as new data for 2009. That is extremely

important because, in a comparative perspective, deep differences in

specialization can be observed.

b)   The study of medium-sized cities, instead of large metropolitan areas, allows

highlighting the relevance of the local approach used in Appendix A and B for the

analysis of urban processes, as well as identifying an incipient trend toward

decentralization of employment cities, which have more often a monocentric

structure.

c)   Further methodological applications based on the approach used in Appendix B

should be able to detect the appropriate spatial structure, which could be lagged or

error model, in each urban area or AGEB, instead of assuming that all the areas that compose the city exhibit the same spatial form.

d)   No evidence has been found about the application of a local approach with spatial effects to analyze other urban processes in Mexico. The disagregation level of analysis among sectors must be increased in order to uncover the patterns of an specific economic activity, as well as to incorporate new data for 2009 in forthcoming studies. However, to the extent that the spatial database grows over time, it is necessary to incorporate space-time analysis for a better understanding of the dynamics of cities.

e)   The inclusion of random-slopes in mode choices, showed in Appendix C, is a relevant contribution because it is important to distinguish different modes of transportation, since quite different policy incentives may be needed for workers of different education levels and for different economic sectors where commuters work. Usually, commuting studies based on the multilevel approach (see Miranda and Domingues, 2010; Zolnik, 2009; Mercado and Páez, 2009; Bottai *et al.,* 2006 and Schwanen *et al.,* 2004) include random elements around the intercept, but these do not take into account the random-slopes.

f)   The process to compile the commuting dataset also offered insights and lessons to conduct further OD surveys in Mexican cities, like in Hermosillo. At least two points must be considered.

- First, OD surveys should include a more accurate way to capture commuting time, as well as commuters' income. Moreover, it can include questions

related with departure times, number of trips, and multi-purpose trips for a
better understanding of congestion on commuting.

- Second, in order to capture the spatial effects on commuting behavior in a
better way, further OD surveys must take into account commuters dispersed
in all areas of the city (AGEBs) to model the contiguity across urban areas
and gain insights about autocorrelation and heterogeneity associated with
commuting data.

III. Policy insights

a)   Appendix A demonstrates that ESDA is a helpful tool for the Hermosillo's
Planning Institute (*Instituto de Planeación Municpal* [IMPLAN by its acronym in
Spanish]). While our results seem to confirm the predictions of IMPLAN (2006)
related to the emergence of subcenters located on the western boundary of the
extended CBD, no evidence was found to support the emergence of other
employment subcenters across the city. Worse, some of IMPLAN's subcenters are
located inside the Low-Low (LL) clusters (low values surrounded by low values).

b)   Although the consequences of urban expansion on employment decentralization
have usually been examined by the urban policy and planning, the effects of urban
expansion have been often neglected by Mexican policy makers. Therefore,
results in Appendices A and B should help public authorities influence and

organize the decentralization of economic activities across space. This discussion has at least two important implications.

- First, these papers demonstrate the necessity of a comprehensive urban policy, which must include the spatial effects in its diagnosis, as well as in the design of it.

- Second, the availability of information confirms the idea that the AGEBs are the main unit of analysis for planning purposes. Therefore a planning urban program based on AGEBs is a wise suggestion.

c) A comprehensive understanding of the complexity of commuting behavior in Appendix C is important for planners in order to:

- Draw new routes for bus and bus stops as well as biking routes based on commuter behavior described in Appendix C.

- Provide the infrastructure to support current and future travel demand.

- Plan urban development, oriented towards mass transit in denser settlements, and discourage urban sprawl in other areas.

d) Even if workers show economic rationality in many of their individual decisions, their overall commuting behavior depends also on the interaction of housing market and labor market, as well as the policymakers' decisions on public transportation and land uses. Therefore, in order to get a comprehensive understanding about the dynamics of urban processes in a city with high expectative of growth and sprawl, Ciudad Obregon requires a Planning Institute to deal with urban growth.

The relationship of urban structure and employment distribution is of interest to economist and geographers alike. The partial review of the literature that has been presented here, as well as the evidence and findings of each paper appended to this dissertation, shows that much useful work has been done in the past decades, but also that much remains to be done. For instance the "New Perspectives on the Spatial Analysis of Urban Employment Distribution and Commuting Patterns" analyzed in this dissertation can be combined to provide light on whether the observed suburbanization of jobs in Hermosillo is associated with the dispersion resulting from households and workplaces. To the extent that these results are disseminated to the academic community and among governments and policy makers, I hope they realize of the importance of spatial effects. Until spatial effects are taken into account in urban planning, the progress of regional science and urban economics can be fully evaluated in developing cities, which is hard to do without Planning Institutes like in Ciudad Obregon, or without a clear view of urban planning, such as in the city of Hermosillo. Therefore, Mexican scholars still have a long way to go.

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APPENDIX A.- SPATIAL DISTRIBUTION OF EMPLOYMENT IN HERMOSILLO, 1999 AND 2004

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Abstract

While the suburbanization process has been well documented in some large cities of several developed countries, much less attention has been devoted to the case of small and middle sized cities of developing countries. As such, we perform here an exploratory spatial data analysis (ESDA) to investigate where the central business district (CBD) and other employment centers are in Hermosillo, Mexico. Our results reveal the significant presence of spatial dependence and spatial heterogeneity, although their extent varies with the sector under study. These spatial effects take the form of a persistent cluster of high values of employment around the historical district of the city shaping a huge CBD, even if a subcenter of high values emerges to the South and to the Northwest of CBD in 2004. Overall, Hermosillo is still characterized by a traditional monocentric model but the role of its CBD has changed.

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1. Introduction

In recent decades, one of the most documented phenomena in the urban structure of many developed countries has been the process of suburbanization of both the population and economic activities. This phenomenon has had an impact on the traditional monocentric urban structure according to which cities are organized around a central business district (CBD) and employment density gradually decreases with distance from it (von Thünen, 1826; Alonso, 1964; Muth, 1969; and Mills, 1972). Nowadays, cities are increasingly experiencing a polycentric structure. As a consequence, the CBD counts for smaller portions of employment than it did in the past (Griffith, 1981; Griffith and Wong, 2007).

In developed metropolitan areas, the CBD has been able to maintain its traditional economic role and importance (see, among others, the work of Shearmur and Coffey, 2002, Coffey and Shearmur, 2002, for Montreal metropolitan region, or Guillain *et al.*, 2006, for the region of Paris, France). In others studies (see as an example McMillen and McDonald, 1998, for metropolitan Chicago), growth is now shared between the CBD and suburban agglomerations, while in other cases the CBD is losing ground to edge cities (see Lang, 2003, who has conceptualized this generalized dispersion based on 13 US metropolitan areas, as well as Gordon and Richardson, 1996, for the case of Los Angeles). However, the degree to which agglomeration economies in subcenters are high enough to attract employment is still an open question (Gordon and Richardson, 1996).

Empirical work on medium-sized cities is scare. A notable exception is the work of Baumont *et al.* (2004) who focus on Dijon, France, and find emergent subcenters

outside of the CBD, but they did not have a significant impact on employment
distribution. However, to our knowledge, no prior contribution has focused on the case of
a medium-sized city located in a developing country. The goal of this paper is therefore
to fill this gap and provide evidence for comparison. As such, we investigate whether
Hermosillo, the largest city in the Northern Mexican state of Sonora, is experiencing a
trend towards employment decentralization or whether the distribution of employment
still follows the traditional monocentric hypothesis.

Officially established in 1741, Hermosillo is a middle-size city according to
Mexican standards (between 500,000 and 1 million inhabitants). The current urban plan
(2006-2009), elaborated by the city's Planning Institute (IMPLAN, 2006), claims that
Hermosillo has experienced until the late seventies a monocentric structure. This is
because most of its employment density is registered close to the CBD, the oldest part of
the city that still holds the commercial center, the civic center, the government center,
and the university center based on the University of Sonora. However, IMPLAN also
affirms that a form of polycentrism has characterized the city over the last three decades.
The veracity of this finding is questionable since the Planning Institute does not provide
the methodology it uses to reach its conclusion. In addition, it does not define the specific
boundaries of the CBD nor pays any attention to the potential presence of spatial
dependence across observations.

A polycentric form implies the presence of agglomeration economies outside the
traditional CBD and, as a consequence of it, should be reflected in the spatial patterns
associated to the distribution of the employment data. For that reason, our second

contribution consists in identifying the employment center and subcenters based on the tools of exploratory spatial data analysis (ESDA). The first spatial effect this technique allows us to uncover and measure is spatial heterogeneity which comes from the fact that some geographical clusters of high or low employment densities may be present in the city because of differences in the quality of local amenities, local labor or real estate markets. Spatial autocorrelation, the second spatial effect, reflects the facts that nearby observations tend to display similar characteristics (Anselin, 1995). Moreover, these provide the necessary statistical tests to indicate whether global and local spatial associations are significant. In the present case study, another advantage of ESDA lies in its capacity to identify the location and extent of employment centers without defining a priori and arbitrary employment cutoffs (Guillain *et al.,* 2006).

In order to get more insights into the recent evolution of the spatial distribution of employment density across the 364 districts that compose Hermosillo, this paper will be organized as follows: section 2 provides a review of the theoretical literature and related empirical studies that highlight how employment subcenters emerge as well as different procedures to identify them. Section 3 describes the study area and the data. Section 4 uses an exploratory spatial data analysis where we first describe the spatial weight matrix and then perform the appropriate measurements of both global and local spatial autocorrelations. Finally, the conclusion summarizes our results and point out similarities or differences with other medium-sized cities.

2. Spatial distribution of employment and subcenter identification

The spatial concentration of economic activities and jobs in the CBD is explained by the history of the city (in the case of Hermosillo, the historical CBD is also the current one) and the persistent presence of agglomeration economies (see Fujita, 1988; Parr, 2002). On the other hand, the CBD may become less attractive when increasing agglomeration leads to higher land prices, wages and create congestion problems. As a result, agglomeration can occur in other areas because of economies of scales due to information spillovers, better accessibility to local inputs, and a specialized local labor pool (Parr, 2002; Coffey and Shearmur, 2002). In addition, an employment subcenter can emerge because of improved infrastructures that reduce transportation costs. Following Redfearn *et al.* (2008), the emergence and growth of employment centers is also explained by exogenous factors such as planning decisions by the local government or the decision of large firms to locate outside the city's core.

On the other hand, Gary (1990), the urban employment structure can be classified into two main categories: locally-centralized employment and dispersed employment. In the first structure, firms are clustered in the CBD to exploit agglomeration economies, while in the second structure employment is clustered in some subcenters or along major transportation corridors. With regards to the latter structure, the urban literature discusses two forms of employment decentralization: the edge city (also called the 'suburban downtown' phenomenon) and the scatteration process (Shearmur *et al.,* 2007). Both of them exhibit a flat employment density gradient outside the CBD and a lack of spatial

urban pattern (absence of or little spatial dependence with high agglomeration diseconomies pushing toward employment decentralization). However, the 'scatteration' process is a generalized dispersion of employment at relatively low densities, rather than the dispersed agglomeration structure proposed by Gary (1990).

Previous contributions define an employment center as a cluster of activity which must have 1) a significantly larger employment density than nearby locations, and 2) a significant effect on the overall employment density function (McMillen and McDonald, 1998; McMillen, 2001a). As such, identifying a single employment center is trivial (the zone with the highest employment density), while identifying employment subcenters is more challenging. However, the literature offers different options in order to detect both. In one of the earliest works on centers identification, Giuliano and Small (1991) identified an employment center as a cluster of contiguous zones for which total employment exceeds a predetermined cutoff level (10 jobs per acre and 10,000 jobs for its adjacent zone). Later, variations in the extent of the cutoff were used (see McMillen and McDonald, 1998; Giuliano et al., 2007), but without any accurate criterion such as the size of the urban area under study nor any knowledge of local conditions that would help establish more appropriate cutoffs.

Another set of studies uses non-parametric procedures to identify potential employment subcenters. They use locally weighted regressions (LWR) (McMillen and McDonald, 1997), a two-stage approach combining LWR and a semiparametric procedure (McMillen, 2001a), or even a combination of McMillen (2001a) and Giuliano and Small's (1991) methods (McMillen and Smith, 2003). These procedures have been

applied to a variety of large American cities and some empirical regularities are evident: large cities have more subcenters than smaller cities, and subcenters tend to develop near freeway intersections and in old satellite suburbs (McMillen and Smith, 2003).

More recently, a set of studies has relied on recent advances in the fields of spatial statistics and spatial econometrics to formally account for spatial effects in the identification of employment subcenters. Those are Baumont *et al*. (2004) who focus on the case of the city of Dijon, France, and Guillain *et al*. (2006) for the region Ile-de-France. Both studies use local indicators of spatial associations (LISA) to identify potential subcenters. This is the methodological approach we decide to rely on in our work because we feel it gives us more flexibility than previous procedures.

3. Study area and data

Hermosillo is both the largest and the capital city of the Northwestern Mexican state of Sonora. It is a middle-size city located 271 kilometers south of the US Border (see figure 1) and was home to 641,791 inhabitants in 2005 (26.8% of the state's population) (see table 1). In 2005, the city spread over an area of 15,480 hectares divided in 364 areas or agebs (área geoestadística básica) which are the smallest spatial scale for census track. Because the population growth outpaced the city's sprawl, Hermosillo's density has actually increased from 40.1 to 41.4 inhabitants per hectare over our study period (see table 1).

The population and the size of the city grew in several steps. During the 1980s, the size of the city grew by 98.3% and then by 61.0% over the next decade. It was the most important growth since the 1950s when the city tripled its size because of a growing agricultural activity in the coastal valley (IMPLAN, 2006). IMPLAN's projections indicate that the city will experience a 60% increase and an 84% increase in its area and population respectively over 2000-2030. Local authorities have understood the consequences in terms of urban development and planning, creating in 2000 the Planning Institute of Hermosillo of which goal is to provide expertise on urban planning to local decision-makers. It marks a significant change compared to previous practices when the lack of planning led to an anarchic and explosive city growth.

Hermosillo represents roughly one third of the state's total employment, value added and number of firms. In Mexico, the employment data can come from the population census (where each respondent indicates its place of work) or from the economic census (where each firm reports where the employees work). In this study, we use the latter which come from the Mexican Bureau of Statistics (Instituto Nacional de Estadística, Geografía e Informática - INEGI) and have been collected every five years since 1980. However, only the 1999 and 2004 results are available at the ageb level in a harmonized dataset.[1]

Following NAFTA's signature in 1994, the northern cities of the country have experienced an increase in foreign investments, in employment as well as the

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[1] This is a consequence of the 1997 change in the classification system of economic activities and products in Mexico (Clasificación Mexicana de Actividades y Productos - CMAP) into the North America Industrial Classification System (NAICS or SCIAN in Spanish) in order to compare the statistical information with NAFTA partners.

consolidation of an industrial strategy based on *maquiladora* (Rodríguez-Gámez, 2003).[2]

According to the Economic Census, 109,628 people worked in the city in 2004 (see table

1), they specialized mostly in services and in retail & wholesale. Recently, the share of

manufacturing (mostly *maquiladora*) in Hermosillo's economy has decreased.

Hermosillo's economy is closely tied to the one of the US, and the latter has experienced

a 24.1% fall in its manufacturing production in 2000-2001 in conjunction with a decrease

in services (-16.1%). In addition, in Hermosillo, professional services and new national

and foreign investments in retail and wholesale activities have surged (Lara *et al*., 2007).

However, it is the primary sector (forestry, fishing, hunting & agriculture support) which

experienced the highest increase in the number of workers over 1999-2004.

Our variable of interest to analyze the employment distribution across the urban

areas of Hermosillo is gross employment density (the average number of jobs per unit of

area). It would be tempting to use the employment-to-population ratio as Guillain *et al*.

(2006) did but we cannot. Indeed, employment and population data come from two

different datasets based on different collection methodologies and different years. Other

indicators, such as net employment density (employment in sector i divided by land used

by sector i), cannot be used either because the information needed is not available.

Because so few people live in the historical CBD, we feel that net and gross employment

densities are very similar there. But it is not the case for the peripheral areas where

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[2] *Maquiladora* is a type of industry. It is the predominant mode of production in the Northern regions of Mexico. The factories (which use jobs intensively) assemble and "re-export" manufactured products free of tax (Barajas *et al.,* 2009).

people live, hence where gross employment density would be lower than net employment density.

4. Identification of employment subcenters by ESDA

Following the contributions of Baumont *et al*. *(*2004) and Guillain *et al*. (2006), we also use the area (ageb) with the highest density of workers for our definition of the CBD. In the case of Hermosillo, as in Guillain *et al.* (2006), the CBD is also the historical center. In 1999 the CBD registered 116.5 employees per hectare, but decreased to 101.7 in 2004 (see figure 2). This fall in employment density is explained, partially, by raising unemployment in the city as a whole as well as by an increase in employment density around the CBD.

For exploratory purposes we choose 25 employees per hectare (approximately 10 jobs per acre suggested by Giuliano and Small, 1991) as a cutoff to define a subcenter. From the maps in figure 2, we note that the subcenters are located along the major streets and intersections of the city, and some of them were located outside of the CBD. We can see how also in a developed and bigger city such as Ile-de-France (Guillain *et al.,* 2006) high employment areas follow the main highways or streets. Based on it, in 2004 just 26 agebs were identified as potential subcenters while in 1999 we found 29 areas. It appears that these subcenters lost their employees whereas the center of the city still experienced a high density of workers (see figure 2).

However, it is difficult to figure out if nearby agebs are subcenters or if these are part of a subcenter's adjacent area. In fact, we cannot assume the cutoffs established for the Los Angeles's case (Giuliano and Small, 1991), because it has a unique polycentrism that Hermosillo does not have. Therefore, we define Hermosillo's CBD boundaries, analyze if their fringe have changed over time and test for the presence of spatial autocorrelation by means of exploratory spatial data analysis (ESDA). It is a collection of techniques that describe and visualize spatial distributions, discover patterns of spatial association, clusters or hot spots, and suggest spatial regimes (Anselin *et al*., 2007).

4.1 Spatial weight matrix

The section above provides us with a description of the distribution of employment across agebs and its evolution over time, but it does not account for the eventual presence of spatial effects that several previous studies have highlighted at the urban level (McMillen, 2001a, 2004; Baumont *et al*., 2004; Guillain *et al*., 2006; Guillain and Le Gallo, 2009). In order to investigate both spatial autocorrelation and spatial heterogeneity, the starting point consists in defining a weight matrix (W) to define the spatial connectivity between our observations. In this matrix, each observation is connected to a set of neighboring observations according to a spatial pattern defined exogenously (Baumont *et. al.,* 2004). As usual in the spatial statistics literature, the diagonal elements of the weight matrix are set to zero whereas the off-diagonal elements indicate the way locality i is spatially connected to locality j (Cliff and Ord, 1981;

Anselin, 1995; Anselin *et al.*, 2007). These elements are non-stochastic, non-negative, and finite. In order to normalize the outside influence upon each unit, the weight matrix is standardized such that the elements of a row sum up to one.

While there is very little formal guidance on the choice of the "correct" spatial weights in any given application, we decided to adopt a *k*-nearest neighbor's weight matrix which implies that each spatial unit is connected to the same number *k* of neighbors, wherever it is localized. This approach avoids us to define arbitrarily a distance cutoff and it is particularly indicated when the spatial distribution of points or areas exhibit a high degree of heterogeneity (Anselin, 2002), which is the case of Hermosillo. Another advantage of a *k-nearest* weight matrix is its capacity to ensure that each observation has the same number of neighbors no matter the size of its territory. A similar matrix has been used by Baumont *et al.* (2004) and Guillain *et al.* (2006) while contiguity or great circle distance based matrices have been used in Nijkamp *et al.* (2009) and Helsel (2008). The general form of a *k*-nearest neighbor's weight matrix $w(k)$ is defined as follows.

$$\begin{cases} w_{ij}^*(k) = 0 & i = j, \forall k \\ w_{ij}^*(k) = 1 & \text{if} \quad d_{ij} \le d_i(k) \quad \text{and} \quad w_{ij}(k) = \dfrac{w_{ij}^*(k)}{\sum_j w_{ij}^*(k)} \\ w_{ij}^*(k) = 0 & d_{ij} < d_i(k) \end{cases} \qquad (1)$$

where $w_{ij}(k)$ is an element of the standardized weight matrix, and $d_i(k)$ is a critical cutoff distance defined for each unit *i*. More precisely, $w_{ij}(k)$ is the kth order smallest distance

between unit i and all the other units such that each unit i has exactly k neighbors. Based on contiguity criteria, the average number of neighbors in Hermosillo in 1999 was 4.12 and 4.5 in 2004. As a result, we choose to build several weight matrices ($k2$, $k4$, $k5$, $k10$) to perform our ESDA and test the sensitivity of our results to the specification of the matrix.

4.2 Global spatial autocorrelation

There are a number of ESDA techniques that can be used to study spatial autocorrelation in a geo-referenced dataset. The most widely used statistics to test for the presence of global spatial dependence are the Geary' C and Moran's I.[3] Given its simplicity and popularity, we will use the latter for our study. It measures the degree of linear association between observed values and its spatially lagged values (Moran, 1948; Hongfei *et al.,* 2007; Anselin *et al.,* 2007). Values of Moran's I larger (smaller) than the expected value [$E(I) = -1/(N-1)$] indicate positive (negative) spatial autocorrelation and/or neighborhood similarity (neighborhood dissimilarity). A value close to 1 indicates neighborhood similarity, while -1 indicates neighborhood dissimilarity. A coefficient close to 0 indicates spatial randomness or independence. Formally, Moran's I is defined as follows:

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[3] Geary's C was developed by Roy C. Geary in 1954. This measure is inversely related to Moran´s I. Geary's ratio is similar to Moran's I, but here the cross-product term compares two neighboring values with each other directly instead of using the mean (Helsel, 2008).

$$I = \frac{N \sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\left(\sum_i \sum_j w_{ij} \right) \sum_i (x_i - \bar{x})^2} \qquad (2)$$

where N is the total number of areas, w_{ij} is the spatial weight measure of contiguity, x_i and x_j denote the observed values for areas i and j, respectively, and $\bar{x}$ is the average of the attribute values. Based on the $k4$ weight matrix, the Moran's I values for Hermosillo in 1999 and 2004 are 0.549 and 0.661 respectively and are significant (*p-value = 0.001*), which confirms the presence of spatial autocorrelation in the distribution of employment density (see table 2).[4] This supports our previous results: in Hermosillo, spatially adjacent regions tend to display similar levels of employment density. The 20.35% increase in the Moran's I values over time suggests that, on average, the employment density in each ageb has become more similar to the one of its neighbors. Previous contributions complement its ESDA approach with an outlier analysis; however in our case it is not a very informative analysis. Figure 2 shows us that employment-rich areas are in the center of the city (upper outliers), while employment-poor areas are localized toward the outskirt of the city (lower outliers).

Table 2 also indicates that positive spatial autocorrelation is not present in all the sectors. The results are not significant in 1999 for the following sectors: forestry, fishing, hunting, & agriculture support, mining & oil extraction, water & electricity production. In 2004, only the statistics for water & electricity production was not significant. That year,

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[4] The measures of spatial dependence such as Moran's I showed the highest (and significant) values and the most robust results using k4 matrix.

all the other economic activities registered a positive and significant global spatial

autocorrelation, which indicates that areas with similar values of employment density

tended to be spatially clustered in Hermosillo. In terms of location choice, spatial

dependence means that the city exhibits a homogeneous behavior about location choice,

which can be observed in the most important sectors and over the two time periods.

The statistics for manufacturing (+6.8% over 1999-2004), retail & wholesale

(+18.8%), and services (+11.1%) increase over the study period, showing that spatial

dependence is an increasingly important element for these sectors. Retail and wholesale

activities have become more concentrated in the CBD and central areas. In the case of

Dijon, France, its CBD is also a group of areas which are centrally located (see Baumont

et al. 2004). This is because they provide the most accessible location for workers as well

as customers. This may also be because these sectors need to take advantage of

economies of scope (such as in Phoenix metropolitan area, see O'Huallachain and Leslie,

2007), while economies of agglomeration are more important for services (for instance

Ile-de-France is specialized in professional and financial services, see Guillain *et al.,*

2006) and manufacturing activities (see McMillen, 2001b, for the case of the industrial

city of Milwaukee).

4.3 Local spatial autocorrelation

Since the Moran's I statistic does not allow us to identify employment subcenters, we

switch to a local approach which has been increasingly used to analyze the heterogeneity

present in spatial processes. The local indicators of spatial autocorrelation (LISA statistics) allows us to uncover if the concentration of high or low employment density is significantly greater in some contiguous agebs than predicted in a spatial homogeneous distribution (global autocorrelation). LISA statistics are defined as follows:

$$I_i = \frac{(x_i - \bar{x})}{s_x^2} \sum_j \left[w_{ij}(x_j - \bar{x}) \right] \tag{3}$$

where $s_x^2 = \sum_j^n (x_i - \bar{x})^2 / n$ is the variance and other notations are the same as in equation 2. One way to explore the autocorrelation in space is by means of Moran's scatter plot. The scatterplot displays the distribution of local spatial autocorrelation according to four quadrants, and the global Moran´s I statistic corresponds to the value of the slope in a Moran scatterplot (Anselin, 1995). For instance, observations in the lower left have low values surrounded by low values (LL) and the upper right quadrant contains all the observations with a high value surrounded by high values (HH), thus representing potential spatial clusters (values surrounded by similar neighbors). On the other hand, observations in the upper left quadrant have a low value and are surrounded by observations with high values (LH) while the lower right quadrant (HL) shows high values surrounded by low values (HL). These last two options suggest potential spatial outliers (values surrounded by dissimilar neighbors).

Figure 3 shows the Moran's scatter plot which provides additional information on the spatial structure of the data. It plots the standardized employment density in each ageb against its spatial lag for 1999 (figure 3a) and 2004 (figure 3b). Both scatter plots confirm a positive spatial autocorrelation. This spatial pattern characterizes many areas in

Hermosillo, even if many areas have a value close to the average of the sample. The Moran scatterplot can also help us identify the agebs that deviate from the global pattern of positive autocorrelation (LH and HL observations).

The LISA statistics can be classified according to the four categories of the Moran scatterplot (Anselin *et al.,* 2002) and mapped in a LISA cluster map (figure 4). The results are all significant at the 5% level (based on a permutation approach with 9,999 permutations) and are consistent with those obtained earlier.[5] Therefore, the HH cluster as defined by the results of LISA is the tool we use to identify the employment center and subcenters. A similar approach is proposed in Guillain *et al.* (2006) and Baumont *et al.* (2004). According to them, a subcenter is defined by two attributes: 1) it is an ageb (or a set of neighboring areas) for which the employment per hectare is significantly higher than the average employment density in Hermosillo and, 2) it is an ageb (or a set of neighboring areas) surrounded by agebs for which the average employment density is significantly lower.

The number of areas in the cluster of high employment density values (HH) was 27 in 1999 vs. 39 in 2004 (see table 3). The biggest HH cluster (integrated by 25 agebs) is located in the center of the city – around the CBD (see figure 4a) in 1999, but it is more spread in 2004 (conformed by 34 agebs), which indicates that the CBD is spreading (see figure 4b). It is also the case in Dijon where its CBD was identified as a HH cluster of areas centrally located (Baumont *et al.,* 2004). Also we note that the incipient subcenter

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[5] All our results are consistent with the use of other spatial weight matrices such as k2, k4, k10, queen contiguity as well as distance cutoff of 2 kilometers.

identified Northwest of the CBD in 1999 (see figure 4a) has moved northward in 2004, and now it is composed of 3 agebs.

In addition, we note that a new cluster made of 2 HH agebs emerged in the Southern part of the usual CBD at the final period. It can be interpreted as an employment pole or subcenter (see figure 4b). In 2003, IMPLAN identified several subcenters which should have led to an agglomeration of activities. They are included in figure 4b for comparisons purposes. Five of them are localized along *Solidaridad*, the main North-South corridor of the city, i.e., on the Western boundary of the extended CBD. While our results seem to confirm the predictions of IMPLAN for these subcenters, we do not find any evidence of high employment density agebs around the other subcenters anticipated by IMPLAN. Worse, we actually discover that some of them are surrounded by LL-type agebs. It seems that their location along one of the city's main corridor was not a sufficient condition to support their development.

Other forms of local spatial association include a LL cluster located in the periphery of the city for both years, 7 LH-type agebs located on the East, South, Northwest and West sides of the CBD in 1999, even though only 3 (located in the East and South sides) keep their significance in 2004. Finally only one HL-type ageb appears in 1999 and it is located in the Southeast of the city (the industrial area with a specialization in various manufacturing sectors but principally in the production of automobile and automobile parts for exports). However it lost its statistical significance in 2004 (as well as a great percentage of employment), as a consequence of the fall in US manufacturing in 2000-2001 (see figure 4a). As such, it is not a local competition effect

that drove the changes in this ageb. No other ageb specializes in automobile production nor can provide enough space for its plants.

Table 3 summarizes the four different patterns of local spatial autocorrelation. In 1999, 32.6% of the observations were characterized by significant positive spatial association (22% in LL and 10.6% in HH clusters) and concentrated 36.4% of employment. In 2004, significant positive spatial autocorrelation characterized 39.3% of all areas (28.6% in LL and 10.7% in HH clusters) and concentrated 46.9% of total employment. These results indicate that the agebs have become more similar to their neighbors over time. This is confirmed in table 3 which shows that the average level of local spatial autocorrelation among the significant results has increased between 1999 and 2004. As a consequence, negative spatial autocorrelation has decreased both in terms of number of significant results and intensity.

Now that the spatial locations of the CBD and subcenters have been identified, we can rely on the value of a location quotient and regional diversity index to uncover their degree of specialization and diversification with regards to the city itself.[6] This methodology has also been used in an urban context by Carrol *et al.* (2008), and Guillain *et al.* (2006), as well as Duranton and Puga, (2000). In essence, one area is considered specialized in one sector if its location quotient for that sector is above one. From table 4 we can observe that historical CBD is specialized in retailing & wholesale, and the CBD (HH cluster) is specialized in services. Over time, we can observe a link between the diversification of Hermosillo's CBD and its expansion: a spreading CBD is associated

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[6] We thank an anonymous referee for suggesting this point.

with high values of regional diversity index. This relationship is opposite to the relationship found in Ile-de-France (see Guillain *et al.,* 2006), its center extends while specializing. The Northwestern subcenter specialized in manufacturing as well as in retailing & wholesale, kept its degree of diversity over time. In contrast the southern subcenter was in 2004 more diversify, while its trend to specialization was moving from manufacturing to services activities.

5. Concluding remarks

In this paper, we contribute to the urban economics literature by focusing on the spatial distribution of employment density in Hermosillo, a middle-sized city in Mexico, under the lens of spatial statistics. Our results confirm our expectations about the dynamics of the city's employment distribution: while the CBD has remained the densest area in terms of employment, a process of suburbanization in conjunction with increasing spatial dependence between neighboring spatial entities has been taking place between 1999 and 2004, the only two years for which data are available.

The results of the Moran´s I and Moran's scatterplot reveal a significant presence of global spatial autocorrelation and that employment is significantly clustered around the CBD for both periods, which indicates the presence of spatial heterogeneity in the city. This paper shows that ESDA is a useful tool for the identification of centers and subcenters: first, it allowed us to detect the CBD and its northwestward extension rather

than the supremacy of the historical CBD. Secondly, it helped us identify the emerging

subcenters located to the Southern as well as to the Northwestern part of the city.

Whether the middle-sized city is developed or developing its CBD can be

identified as a HH cluster centrally located, highlighting its monocentric structure;

nevertheless a developed city can be more monocentric, holding all other factors

constant, compared with a developing city (Dijon vs Hermosillo). Over time the trend

toward the CBD's sprawl, observed in Hermosillo as well as in Ile-de France, was

throwing back and the number of employment subcenters increased in developed as well

in developing cities. However deep differences in specialization of employment centers

are consequence of its degree of development.

Therefore, even though a recent employment decentralization process has been

taking place, we can conclude that Hermosillo is still a monocentric city. Undoubtedly

this result is in contradiction with the idea of polycentrism that Hermosillo's Planning

Institute supports. We believe their misconception comes from the absence of

consideration for spatial effects in the methodology they rely on.

Future work aims at updating our results with the data of the 2009 economic

census which will be released at the end of 2011. Our goal will be to verify if

employment decentralization in Hermosillo is a lasting phenomenon or whether it only

reflects the economic crisis that took place in 2000-2001. Finally, we intend to use spatial

econometric techniques to estimate the density gradient which reflects by how much

employment density decreases with distance from the CBD (as in McMillen, 2001a and

2004; and Guillain and Le Gallo, 2009). This should complement our current results

about the influence of the CBD and subcenters on the spatial distribution of employment in Hermosillo.

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Table 1. Physical, social and economic characteristics in the city of Hermosillo			
Variable	1999/2000	2004/2005	Growth (%)
	Surface Characteristics [1]		
Areas (number of AGEBs)	254	364	43.3%
City size (Hectares)	13,619.30	15,511.70	13.9%
	Demographic Characteristics [1]		
Population [1]	545,928	641,791	17.6%
Inhabited Households	133,283	168,204	26.2%
Inhabitants per House	4.1	3.8	-6.8%
Population Density (Hectares)	40.1	41.4	3.2%
	Economic Characteristics [2]		
Number of Firms	16,538	17,082	3.3%
Firm's Size Average	6.9	6.4	-6.9%
Total Employment [3]	113,956	109,628	-3.8%
Forestry, fishing, hunting, & agriculture support	29	213	634.5%
Mining & oil extraction	136	365	168.4%
Manufacturing [4]	30,624	23,244	-24.1%
Water & electricity production	756	884	16.9%
Retail & wholesale	32,366	42,957	32.7%
Services [5]	50,045	41,965	-16.1%
Total employment density (jobs per hectare)	8.4	7.1	-15.5%

[1] Data are based on population census and population survey for 2000 and 2005, respectively.

[2] The information correspond to 1999 and 2004 Economic Census elaborated by INEGI.

[3] The information are disaggregated by sector (two digits) according with North America Industrial Classification System (NAICS).

[4] As consequence of confidentiality agreement the data exclude employment in construction.

[5] Include professional services, but exclude services related with construction, transportation & warehousing, finance, insurance & real estate, as well as government services.

Note: Elaborated based on INEGI.

Table 2. Moran´s I statistics (standardized values) in Hermosillo in 1999 and 2004
(with weight matrix k4)

Economic sector	1999		2004	
	Moran's I	p-value	Moran's I	p-value
Forestry, fishing, hunting, & agriculture support	-0.006	0.640	0.118	0.006
Mining & oil extraction	-0.010	0.632	0.070	0.026
Manufacturing	0.196	0.001	0.210	0.001
Water & electricity production	-0.002	0.812	-0.001	0.952
Retail & wholesale	0.339	0.001	0.403	0.001
Services	0.646	0.001	0.718	0.001
Total Employment	0.549	0.001	0.661	0.001

Note: Calculations performed on GeoDa 0.9.5-i5 (1998-2004). Luc Anselin and The Regents of The University of Illinois. All Rights Reserved.

Table 3. Summarizing LISA results, 1999-2004

Cluster	1999			2004			Change in the number
	Number	%	% E	Number	%	%E	
High – High	27	10.6	32.6	39	10.7	44.4	12
High – Low	1	0.4	6.4	0	0.0	0.0	-1
Low – Low	56	22.0	3.8	104	28.6	2.5	48
Low – High	7	2.8	1.8	3	0.8	0.6	-4
Not significant	163	64.2	55.4	218	59.9	52.5	55
Total Agebs	254	100.0	100.0	364	100.0	100.0	110
	Areas	Avg.	StdDev	Areas	Avg.	StdDev	Cluster
HH based on 1999	27	3.500	4.355	39	2.542	3.842	HH
HH Based on 2004	27	6.226	6.363	39	4.689	5.872	
LL based on 1999	56	0.349	0.051	104	0.331	0.068	LL
LL based on 2004	56	0.172	0.075	104	0.258	0.033	

Note: Elaborated base on local Moran´s I results.

Economic sector	Historical CBD		CBD		Subcenter 1 (Northwest)		Subcenter 2 (South)	
	1999	2004	1999	2004	1999	2004	1999	2004
Forestry, fishing, hunting, & agriculture support	---	---	1.976	0.910	---	---	---	---
Mining & oil extraction	---	---	1.592	1.271	---	---	---	---
Manufacturing [2]	0.557	0.036	0.288	0.457	1.549	10.418	2.152	0.758
Water & electricity production	---	---	---	---	---	---	---	---
Retail & wholesale	1.539	1.825	1.029	0.925	1.430	3.156	0.612	1.377
Services [3]	0.941	0.719	1.430	1.394	0.404	0.571	0.563	0.779
Regional diversity Index [4]	3.266	1.543	2.527	3.291	1.854	1.843	1.613	3.377

Table 4. Locational Quotient of employment in Hermosillo by econocmic sector [1]

[1] High locational quotient (above 1) indicate that a region is relatively specialized in a particular sector.

[2] As consequence of confidentiality agreement the data exclude employment in construction.

[3] Include professional services, but exclude services related with construction, transportation & warehousing, finance, insurance & real estate, as well as government services.

[4] Calculated in base on Duranton-Puga index. High index values represent a high degree of diversification in an area and inversely.

Note: Elaborated based on INEGI.

Figure 1. Location of the City of Hermosillo, Mexico
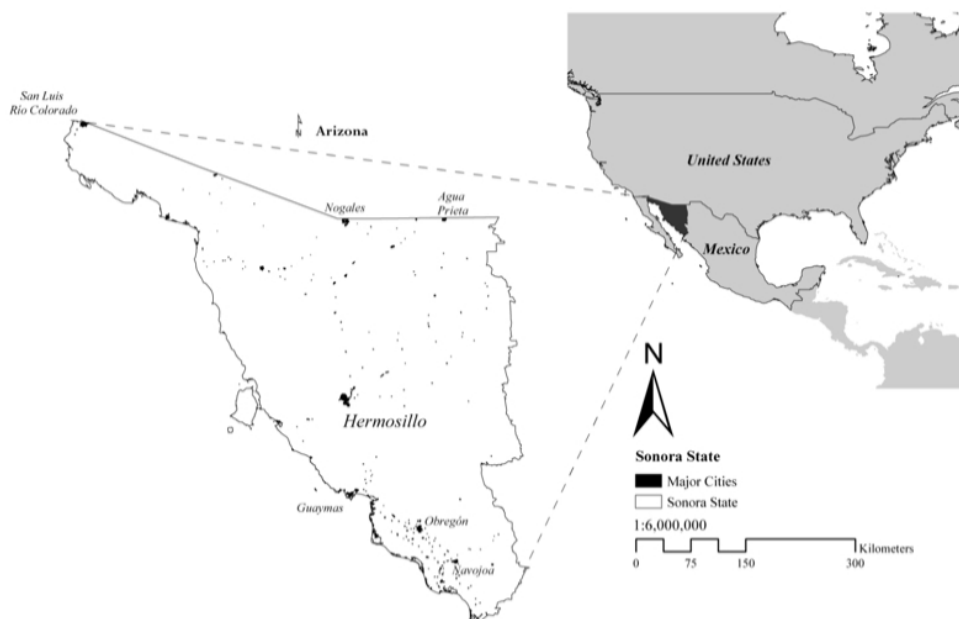
Figure 2. Spatial distribution of total employment in Hermosillo, 1999 and 2004

a) Total employment density in 1999

b) Total Employment Density in 2004

Figure 3. Moran's scatter plot of employment density in 1999 and 2004
(based on the weight matrix k4)
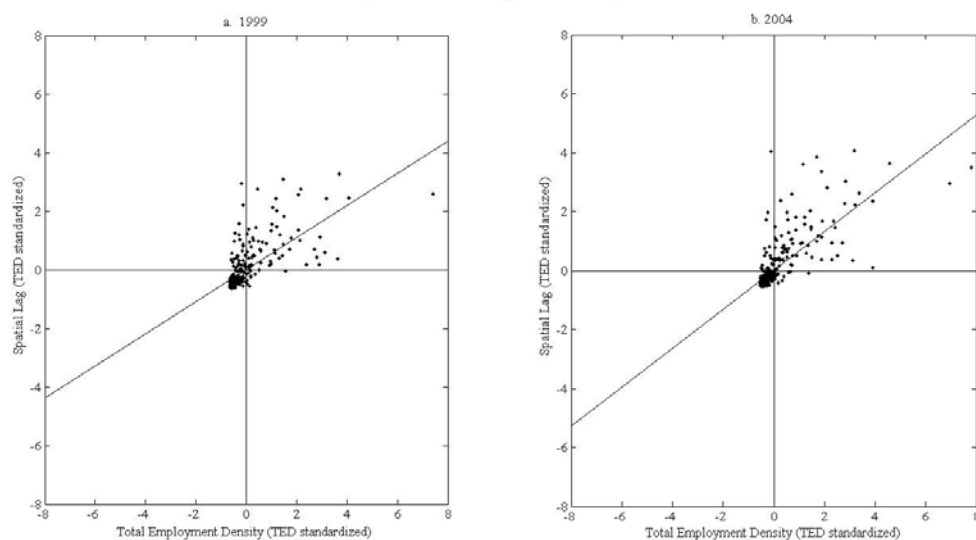
Source: Elaborated base on Moran's I results, performed on Matlab© 1984-2009, The MathWorks, Inc.

Figure 4. LISA Maps of employment densities in 1999 and 2004 (based on k4 matrix)

a) Total employment density in 1999

b) Total Employment Density in 2004

☆ CBD core
◯ IMPLAN's subcenters
━━ Main streets
Employment density
LISA's Clusters
☐ Not significant
■ High - High
▨ Low - Low
▧ Low - High
▨ High - Low

N

1:150,000

Kilometers
0   3   6   12
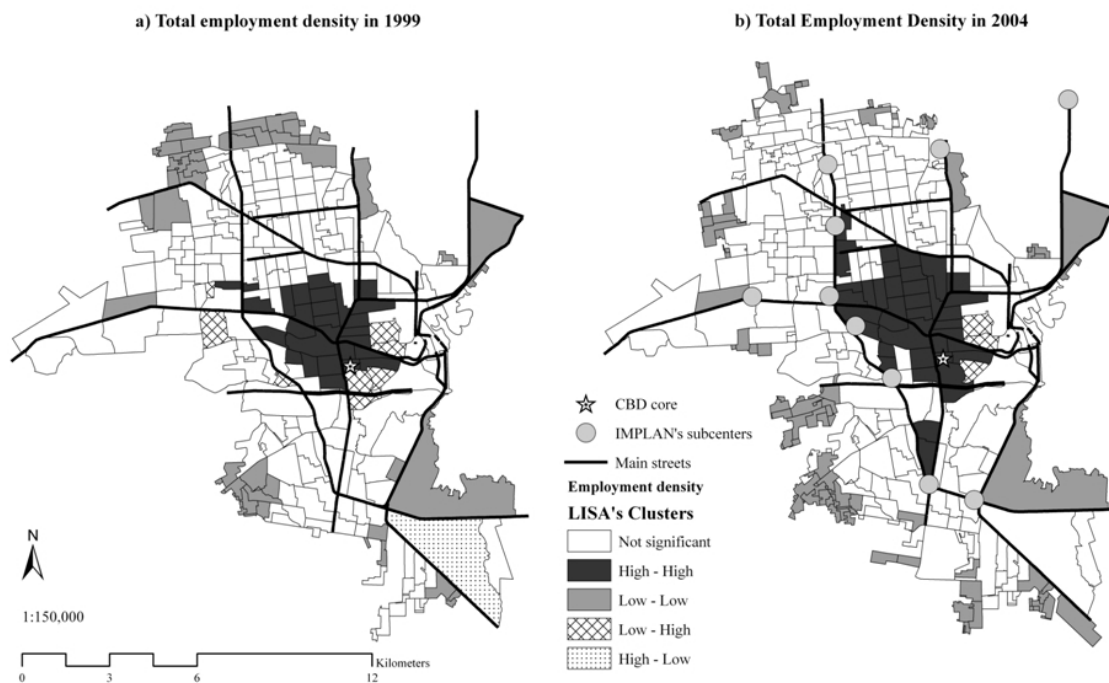
Note: Inference is based on the conditional permutation approach with 9999 permutations.

APPENDIX B.- EMPLOYMENT DENSITY IN HERMOSILLO, 1999-2004: A SPATIAL ECONOMETRIC APPROACH OF LOCAL PARAMETERS

Liz Ileana Rodríguez-Gámez[*/]

(Submitted to *The Annals of Regional Science*)

Abstract

This paper is an application of Geographical Weighted Regression (GWR) and the spatial econometrics approach in order to test if the Central Business District (CBD) of Hermosillo, Mexico maintains the tradition attributes of any employment center, namely attracting activities and influencing the organization of all economic activities around it. Therefore it analyzes the pattern of employment distribution through the 364 urban areas in 2004 and 254 areas in 1999. The Lagrange Multiplier (LM) tests suggest significant spatial autocorrelation in a Spatial Error Model (SEM), which is taking account to captures the local spatial heterogeneity. Through the GWR-SEM approach employment gradients were calculated among economic sectors, for global estimations, as well as, for local gradients over time. The evidence shows that CBD influences the economic activities in Hermosillo for total employment as well as for employment in retailing and wholesale, services and manufacturing. However, the fall in employment from the CBD does not follow the concentric pattern suggested by global estimations; it varies markedly

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from one area to the next in different directions. Additionally, local estimators show how in some sectors, such as in services and manufacturing, the employment rises rather than falls with distance from the city center. The main contribution of this paper is to provide the first detailed evidence on the role of local spatial effects in the distribution of employment in a Latin American city, as well as show that the lack of attractiveness and the spatial variations in the fall of employment density were masked by global estimations.

Key words: GWR, local parameters, spatial econometrics, employment density.

1. Introduction

Modeling employment density has been a popular topic in the field of urban economics, but recently the studies have brought interesting contributions such as the addition of spatial effects and the local approach. The combinations of both effects have the advantage of uncovering the relationship between employment density and distance from the Central Business District (from now on CBD) for each specific location. In other words, it measures whether the employment density gradient is uniform in all directions or not. There are few applications of this framework and they have mostly focused on large metropolitan areas in the US (see for instance McMillen, 2004; McMillen and Lester, 2003) and in Europe (see for instance Guillain and Le Gallo, 2009 for Ile-de-France). The only application for a medium or small size city is McMillen (2001), which focuses on Milwaukee, WI.

Spatial data frequently exhibits complex patterns that are difficult to capture, to represent, and that cannot be explained using global statistics (Getis, 2007; Lloyd, 2007; Griffith, 2000; Anselin and Bera, 1998). As such, in recent years there has seen a surge in the use of Geographically Weighted Regression (GWR) models to integrate and examine the spatial effects from a "local" point of view, as proposed by Brunsdon *et al.,* (1996). This method is helpful to demonstrate how a phenomenon varies markedly from an area to the next and how global estimations may mask this spatial variation. However to solve the problem of the presence of spatial heterogeneity in spatial data, which implies a gross misspecification of reality, Páez *et al.,* (2002a; 2002b) developed a general framework to incorporate spatial effects into the GWR approach, such as 1) GWR with a spatially lagged or Spatial Autoregressive Model (GWR-SAM) and 2) GWR with autocorrelation in the Spatial Error Model (GWR-SEM). That framework implies a model of "locational heterogeneity" or non-stationarity in a specific geographic location (focal point *o*).

Based on this framework, local employment gradients can be calculated in order to test if the CBD maintains the tradition attributes of any employment center, namely attracting activities and influencing the organization of all economic activities around it, regardless of whether the city is monocentric or polycentric. While the urban economy theory suggests that in a suburbanization context the influence of the CBD declines (Mills, 1972; Muth, 1969), several studies argue that, in developed metropolitan areas, suburbanization reinforces the supremacy of the CBD (see Shearmur and Coffey, 2002, Coffey and Shearmur, 2001, for Canadians cities, or Guillain *et al.,* 2006, for the region of Paris, France).

The study is focus on the influence of the CBD in shaping the employment distribution in a medium-sized Latin American city: Hermosillo, Mexico. Given a previous work, based on spatial statistics, Rodríguez-Gámez and Dall'erba (2010) indicated the presence of both spatial association and spatial heterogeneity in the distribution of employment density across urban areas or AGEBs (*área geo-estadística básica*) according to Mexican Bureau of Statistics (*Instituto Nacional de Estadísitica, Geografía e Informática* [INEGI by its acronym in Spanish]). It reveals the shaping of a huge CBD, as well as the emergence of new high employment areas to the northwestern and southern parts of the CBD, according with the most recent data (1999 and 2004) analyzed by the authors. In spite of these findings, it is difficult to draw any general conclusion about Hermosillo's CBD influence on organization of economic activities inside the city. As such, I intend to uncover whether the CBD´s influence has been the same for all sectors and in all directions around the CDB.

To evaluate the CBD´s influence in shaping the economic activities as well as its attractiveness across the urban areas in Hermosillo, this paper is organized as follows. Section 2 provides a review of employment distribution functions, as well as how the GWR and spatial econometric approaches can be incorporated to analyze the urban employment density. Section 3 describes the study area, the data and the weight matrix used to model spatial effects. Section 4 shows global estimators for employment density gradient to test the CBD's influence using a spatial econometric approach. Section 5 proposes a spatial and local econometric approach that measures the "local" employment density gradients in each area. The paper ends with summary and concluding comments.

2. The urban density function

Geographic distribution of employment and its spatial relation can be better understood by modeling urban density and its declining pattern with distance from the CBD, as a single explanatory variable in a monocentric city (Alonso, 1964; Mills, 1972; Muth, 1969). Even when a large variety of models have been developed to characterize urban density (see for instance McDonald and Bowman, 1976; McDonald, 1989; Smith, 1997; Anas *et al.,* 1998; and Glaeser and Kahn, 2001, for a literature review), the main candidates to measure the density are the negative exponential function (see equation 1) popularized by Clark (1951), and the inverse power function (see equation 2) proposed by Smeed (1963) (Torrens and Alberti, 2000; Chen, 2008). Both exponential and power functions are based on the assumption that density declines monotonically (the change is the same in all directions) at a rate of -γ. These two equations can be described as follow:

$$\mathbf{D_i} = \mathbf{D_{CBD}}\mathbf{e}^{-\gamma \mathbf{u_i} + \varepsilon_i} \qquad (1)$$

$$\mathbf{D_i} = \mathbf{D_{CBD}}\mathbf{u}^{-\gamma + \varepsilon_i} \qquad (2)$$

where D_i is the employment density of observation i (area) measured as the number of employees per hectare, D_{CBD} is a constant of proportionality, γ is the density gradient which measures the proportional rate at which employment density falls with distance u_i between area i and the CBD; in equation 1 the constant D_{CBD} is the employment density

at the CBD which is equal to the central density (u_i=0), however it does not have the

same meaning in equation 2.[1] The random error term, ε_i, is assumed to follow the usual

properties (*iid*). All distances are measured in straight-line from the CBD´s centroid to

the centroids of each area *i*.

According to the literature, the inverse power function leads to a more precise

interpretation of γ than the negative exponential parameter, but its role is similar. Under

an exponential function, the value of -γ is the percentage decline in density per unit

distance (i.e., one mile or one kilometer), while under the power function the value of -γ

can be interpreted as elasticity: the ratio of the percentage change in the density over the

percentage change in the distance from an area. However, in both cases γ represents a

measure of attenuation of density across space, and allows us to compare gradients.

Under negative exponential function a lower intercept and flatter gradient over time

characterize the urban sprawl and the suburbanization trend. While using an inverse

power function, γ can be interpreted as a measure of degree of sprawl (Torrens and

Alberti, 2000). Therefore, a lower employment gradient mean a high degree of sprawl

and, consequently, a suburbanization process can be taking place over time.

There is no answer to the question of which function is more appropriate to the

measurement of density gradient. For many authors the inverse power function is the

most appropriate form (Batty and Kwang, 1992; Torrens and Alberti, 2000; Chen, 2008)

contrary to conventional practices, which are largely based upon the negative exponential

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[1] The function cannot be evaluated when u_i=0, because the function D_i (0) is infinite at this value. This has been one of the main reasons for researchers preferring the negative exponential function (see Batty and Kwang, 1992). However problems can easily be dealt with by translating the origin of system to a value of $u_i > 0$ (i.e., $u_i = 1$), which means percentages of change when distance changes 1%.

function. According to Batty and Kwang (1992), two reasons explain why the inverse power function is the most appropriate functional form. First, the inverse power function has a tendency to over-predict in areas close to the CBD, while the negative exponential function generally does a poor job at predicting central densities; it is an important attribute to model employment densities because jobs are distributed around the CBD and not in a single area. Second, in Western cities the fall-off in the urban density is likely to be great near city boundaries, even higher than the negative exponential function is able to predict. This is also coherent with the spatial structure in Latin American's cities, in which an important amount of employees are localized in peripheral subcenters such as the industrial area, the zone of the airport, etc. (Griffin and Ford, 1980). Therefore the inverse power function must be used to model peripheral urban densities (Torrens and Alberti, 2000).

2.1 Geographically weighted approach and spatial effects

According to Griffith and Wong (2007), three important conceptual changes have occurred since the pioneering work of Clark (1951). The first change focuses on accurately modeling urban density from deriving the best mathematical equation to describe it (see McDonald, 1989). The second change is the re-conceptualization from monocentric to polycentric form (see Griffith, 1981; Griffith and Wong, 2007). The final change offers a more complex model specification considering the presence of spatial autocorrelation and linear weighted regression (see Páez *et al.,* 2001; McMillen, 2001,

2004; McMillen and Smith, 2003; Guillain *et al.,* 2006; Griffith and Wong 2007; Guillain and Le Gallo, 2009).

Studies mentioned above incorporate in their methodology the use of non-parametric approaches which offer significant advantages over simple linear regression procedures. Geographically weighted regression (GWR) is a locally weighted, linear, and non-parametric regression method aimed at capturing, for each observation (area), the spatial variation of the regression coefficients. This approach works by assigning a weight to each location depending on its distance (concept of distance decay) from a specific geographical location (the focal point). It is made operational through a kernel function to determine the size window that will produce sub-samples of data around specific points. Specifically, Páez *et al.,* (2002a, 2002b), proposes the GWR as a model of error variance heterogeneity with a precise geographical interpretation called *locational heterogeneity.* In order to avoid spatial model misspecification the GWR has been extended to include spatial association components (lagged and error structure) to conduct local spatial analysis and modeling.

Generally speaking, spatial models incorporate spatial lag operators through a weight matrix, the objective of which is to relate a variable at one point in space to the observations for that variable in the other spatial units in the system (Anselin, 1988). For instance, a spatial lag or Spatial Autoregressive Model (SAM) incorporates a spatially lagged dependent variable (WY) on the right hand side of the regression model (see equation 3), while spatial autocorrelation or Spatial Error Model (SEM) is modeled through a spatial autoregressive process for the error term ($W\varepsilon$) as in equation 4.

According to Anselin's notation (1988), the global spatial models are described as follows:

$$\mathbf{Y} = \rho\mathbf{WY} + \mathbf{X}\beta + \varepsilon \quad (3)$$

$$\mathbf{Y} = \mathbf{X}\beta + \varepsilon \qquad (4a)$$

$$\varepsilon = \lambda\mathbf{W}\varepsilon + \mu \qquad (4b)$$

where Y is the vector of dependent variable (nx1), X is the vector of independent variables (nxK), β is the vector of parameters corresponding to K explanatory variables (Kx1). The spatial autoregressive parameter is ρ which captures the extent of spatial autocorrelation between various observations, while λ captures the impact of the errors (e.i. random shocks) taking place in neighboring areas. W is an interaction matrix (nxn) defined by some geographical criteria (no stochastic and row-standardized). Finally ε and μ are error terms, spatially autocorrelated and independent [$\mu_i \sim N(0,\Omega)$], in contrast to the variance homogeneity [$\mu_i \sim N(0,\sigma^2 I)$]; the general covariance structure is given by the diagonal elements (w_{ii}) in the matrix $\mathbf{\Omega}$ which imply variance heterogeneity.

To model error variance heterogeneity under local perspective Páez *et al.,* (2002a) proposed a precise geographical interpretation through GWR to model *locational heterogeneity* that may result in parametric variation of estimators across space. Locational sub-index *o* (*o=1…m*) is adopted to indicate that parameters are location specific (*m* is the number of local models being estimated). The diagonal elements in

matrix Ω_o at a focal point o (see equation 5) is given by w_{oi} in equation 6; where d_{oi} is the distance between a focal point o and area i ($i=1...n$) assuming a distance-decay function (n is the number of areas in each sub-sample). In this case, the variance is a function of two parameters, σ_o^2 and α_o called kernel bandwidth, when $\alpha_o = 0$ the model reduces to the usual constant variance assumption. In order to test the heteroscedasticity for each focal point o, Páez $et\ al.,$ (2002a, 2002b) suggest compute the Lagrange Multiplier test (LM). Therefore spatial effects and locational heterogeneity are both considered in Páez's approach.

$$\Omega_o = \sigma_o^2 \mathbf{G}_o \qquad (5)$$

$$w_{oi} = \sigma_{oi}^2 \exp(\alpha_o, d_{oi}^2) \qquad (6)$$

The GWR model with spatial autoregressive structure, labeled GWR-SAM is described in equation 7; while a GWR model with spatial error structure, labeled GWR-SEM is described in equation 8. The GWR uses a moving window (weighted according to geographical distance in equation 6) over spatially distributed observations to produce sub-samples of data around specific points (focal point o). The LM test can be easily computed for locational heterogeneity evaluation and test if the parameters of the model depend on location. The notation for local employment density analysis is performed taking logs in both sides of equation 2 and incorporating the spatial effects (equations 3 and 4), which are described as follows:

$$\ln \mathbf{D}_i = \rho_o \sum_{j=i}^{n} \mathbf{W}_{oj} \ln(\mathbf{D}_i) + \mathbf{D}_{CBD} - \gamma_o \ln(\mathbf{u}_i) + \varepsilon_o \qquad (7)$$

$$\ln \mathbf{D}_i = \mathbf{D}_{CBD} - \gamma_o \ln(\mathbf{u}_i) + \varepsilon_o \qquad (8a)$$

$$\varepsilon_o = \lambda_o \sum_{j=1}^{n} \mathbf{W}_{oj} \varepsilon_j + \mu_o \qquad (8b)$$

where ρ_o and λ_o are spatial parameters in each focal point o and areas in the sample ($i=1...j$ the number of observations used for each regression) according to the kernel bandwidth. The error terms ε_o and μ_o in GWR-SAM and GWR-SEM respectively have a variance structure as in equation 6. Note that the distance matrix to model variance-covariance matrix of the error terms in ε_o and μ_o is also a weight matrix itself but it obeys to a different criterion: it is based on a weight matrix (mxn) of distances from m focal points to n observation (see equation 6). At the same time a geographically weighted specification is needed to model spatial dependence (see equations 3 and 4); it is a weight matrix (nxn) interaction to model spatial dependence which is determined exogenously and defined on the basis of the geographical configuration of the observation and some interaction criteria.

There is one important technical limitation to the GWR, which is the lack of a method to estimate kernel bandwidths (Wheeler and Tiefelsdorf, 2005; Páez *et al.,* 2002a; 2002b). However methods of calibration which control the size of the window and the number of observations in the sub-sample, are more important because GWR is sensitive to the choice of bandwidth, as well as weighting procedures (Bitter *et al.,* 2007). On the

other hand, one of the primary advantages of GWR is its ability to easily map and visualize the local regression coefficients (Wheeler and Tiefelsdorf, 2005; Bitter *et al.,* 2007). Also, the tool is very useful to detect spatial outliers (intense spatial association) and to reveal spatial patterns (Páez *et al.,* 2002a). The simplicity and power of the model is particularly attractive and is easy to interpret based on all elements and diagnostics of a traditional (global) regression model (Páez *et al.,* 2002a). Moreover, GWR models explain considerably more variance than Least Square methods (Ogneva-Himmelberger *et al.,* 2009).

3. Study area and data

Hermosillo is the capital city of Sonora, a Northwestern Mexican State (see map 1). Established in 1741, Hermosillo is a medium size city with a population of 715,061 inhabitants in 2010 (INEGI, 2011). According with the projections of Hermosillo's Planning Institute (*Instituto de Planeación Municipal* [IMPLAN by its acronym in Spanish]) the population density has actually increased by 23%, from 39 to 48 people per hectare, while over the next two decades the projections indicate that the city will experience a 39% increase and 27% increase in its urban surface and population, respectively (IMPLAN, 2006). Considering the percentage of employment by economic sector in the city the most important activities in 2004 were retail and wholesale (39.2%), services (38.3%), and manufacturing (21.2%) (Rodríguez-Gámez and Dall'erba, 2010).

In face of the incipient employment suburbanization process that took place in Hermosillo during the period of study, the CBD keeps its importance, in spite of the emergence of two employment subcenters to the southern and to the northwester parts of the CBD in 2004, as well as its expansion over time (Rodríguez-Gámez and Dall'erba, 2010).[2] As the authors pointed out, these findings are result of a positive spatial autocorrelation, which is an increasingly important element over time, especially for retail and wholesale activities. However, how the CBD and these subcenters impact and influence the economic activity in the city is not considered by IMPLAN.

Our data come from the Economic Census published by the Mexican Bureau of Statistics (*Instituto Nacional de Estadística, Geografía e Informática* [INEGI by its acronym in Spanish]). The latter data available, at the urban level, are from 1999 and 2004. It reports how many and where the employees work based on each firm´s information (INEGI, 2007). This dataset was joined with the most recent cartography available, which divide the city into 364 areas or AGEBs (the smallest spatial scale for the economic census) in 2004, and 254 AGEBs in 1999. It contains information of an AGEB's surface, measure in hectares (*Ha*), in order to calculate the employment density in each area while distances are measured in kilometers as a straight-line between each AGEB and the CBD. Also, to obtain a general picture of the distribution of employment in Hermosillo the analysis includes the employment density for total employment as well as for the following economic sectors: 1) forestry, fishing, hunting, and agriculture

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[2] The study uses the Exploratory Spatial Data Analysis (ESDA's tools) to investigate where the CBD and other employment centers are. The paper uses Local Indicator of Spatial Association (LISA) to identify an employment center and potential subcenters.

support, 2) mining and oil extraction, 3) water and electricity production, 4)

manufacturing, 5) retail and wholesale, and 6) services.[3]

Finally, in order to test the presence of spatial dependence and implement the

appropriate spatial econometric analysis, spatial interactions between areas need to be

modeled. The general measure of the potential interaction between two spatial units is

expressed in a row-standardized spatial weight matrix. The specification of the weight

matrix is, to some extent, a matter of some arbitrariness and is often cited as a major

weakness of the lattice approach (Anselin, 2002). Although choosing the appropriate

weight matrix in any given situation remains an empirical matter, but in most

econometric applications the neighbors are contiguous spatial units (Anselin, 2002).

Therefore the selection of this criterion, based on the binary contiguity option (*queen*

weight matrix), comes to the fact that it is the original measure of spatial dependence, as

well as from the robustness of our results when testing the appropriate spatial dependence

structure.

4. Global results

The previous work of Rodríguez-Gámez and Dall'erba (2010) suggested the presence of

spatial dependence and spatial heterogeneity in employment distribution in the city of

[3] The information is disaggregated by subsector (two digits), according with North America Industrial Classification System (NAICS); however, data at the AGEB's level exclude information in construction, transportation and postal activity, as well as services related with construction, transportation and warehousing, finance, insurance and real estate, and government services.

Hermosillo. However, as Griffith and Wong (2007) pointed out the reliability of

inferences made using density functions may be affected by the presence of spatial

autocorrelation. Therefore the first task is to investigate the presence of some form of

spatial dependence: SAM or SEM. In order to detect the appropriate form of spatial

autocorrelation, the Lagrange Multiplier (LM) test suggested by Anselin and Florax

(1995) for lag (LM-LAG) and error (LM-ERR) models and their robust version (R-

LMLAG and R-LMERR respectively) were calculated, following the decision rule

described by Anselin *et al.,* (1996).[4] The LM tests for total employment, retail and

wholesale, as well as services suggest the presence of spatial error autocorrelation rather

than a spatial lag (see table 1) while the LM tests for the rest of the sectors are not

conclusive.

The next step consists in estimating the employment density based on spatial error

model (SEM), as in equation 4a and 4b. The global spatial results are presented in table 2

based on inverse power function, for both years and for the six sectors under study. The

density gradient (γ) for total employment is negative and strongly significant, which

confirms the attractiveness of CBD and its influence to organize the economic activity

around it. In 2004, the value of γ indicates that employment density decreases by 62.1%

($\gamma = -1.621 + 1 = -62.1\%$) when the distance from the CBD changes (i.e., in 100%),

while in 1999 employment density decreases by - 82.5%; as a consequence the CBD is

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[4] If LM-ERR (resp. LM-LAG) is more significant than LM-LAG (resp. LM-ERR) and R-LMERR (resp. LM-LAG) is significant where R-LMLAG (resp. LM-ERR) is not, then the most appropriate model is the SEM (resp. SAM). If the LM test is no conclusive, then OLS is sufficient for modeling the spatial dependence.

attractive for total employment (see table 2).[5] If γ is interpreted as an attenuation of

density, lower employment densities mean that a suburbanization process took place in

Hermosillo between 1999 and 2004.

However the CBD's attractiveness depends on the economic activity under study.

For retailing and wholesale (- 36.3% in 1999 and - 15.7% in 2004), as well as for services

(- 54.8% in 1999 and - 21.7% in 2004) the CBD still influences the distribution of

employment. Moreover the CBD was also attractive for both years, 1999 and 2004, and

these sectors had been experiencing a decentralization of employment. In manufacturing,

the density gradient suggested that the CBD influences the distribution of employment.

However in 1999 the employment density for manufacturing registered an increase (γ = -

0.551 + 1 = + 44.9%) rather than a decrease; which means that the CBD is not attractive

for manufacturing, the same tendency was observed in 2004 (+ 31.3%). In other sectors

the CBD was not attractive for employment, although it is governed by the distance from

the CBD. Overall, retailing and wholesale registered the higher degree of sprawl

(decentralization of jobs).

On the other hand, the spatial coefficient λ measures the intensity of spatial

dependence across residuals. It was always significant at the 95% confidence level in

2004 and 1999 for the most important economic sectors in the city. However the value of

λ was not always positive: a negative value of λ which indicates a competitive effect

between neighboring areas for activities that are place-based (i.e., dependent on the

location of a production site which are not everywhere). The value of spatial

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[5] As was mentioned before, the D_{CBD} cannot be interpreted as the central density. Our variable of interest is the density gradient (γ), from which the gradient interpretation is γ+1 (first derivative).

autocorrelation phenomenon was greater for total employment than for the six sectors under study. Over time λ was less important in 2004, especially for manufacturing which registered the highest decrease in the value of λ (see table 2).

Even when the significance level and the sign of the global estimated density gradient is the expected one, in the most important sectors, a local analysis of density gradients is still relevant. Actually, it is important to know if the CBD's influence and attractiveness suggested by global gradients may mask large local disparities in γ and λ due, for instance, to different patterns along with different distances and/or directions from the CBD. Additionally the decentralization process that took place between 1999 and 2004, as well as the polarization of jobs suggested by the values of global gradients, can adopt different patterns in the city, which are interesting to uncover. These patterns were captured through GWR with spatial effects in the next section.

5. Local results

The way in which locational heterogeneity and spatial dependence are captured in one area can be completely different across space, sector, and even over time. When spatial heterogeneity is unknown, the Lagrange Multiplier (LM) can be conducted to know the dominant spatial effect according to the adjustment proposed by Páez *et al*., (2002a).[6] The size of the LM tests in table 3 suggests the SEM is the dominant effect that took place in Hermosillo, over 1999 and 2004, for total employment as well as for

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[6] Thanks Antonio Páez for his knowledge and sharing the Matlab programs used to estimate local models, as well as Julie Le Gallo for her invaluable comments during this stage.

manufacturing, retail and wholesale, and services; while the LM tests for other sectors were not significant for all areas. Although the small differences among LM tests for lag and error models, local results for LM tests were consistent to what was found with global models.[7] The LM tests for locational heterogeneity (LM-LH) were also significant, as a consequence the variance and all the other parameters of the model depend on location. It means that GWR-SEM describes the data significantly better than global or other local spatial regression models.

In order to get insights about the attenuation of density (γ) in all directions from the CBD, the local gradients were calculated based on GWR-SEM (see equations 8a and 8b). Now the employment density function is better specified and it incorporates locational heterogeneity in the analysis. It was calculated for total employment in each AGEB as well as for the three sectors in which local heterogeneity was statistically significant (i.e., estimated parameters depend on location). The analysis was also conducted for both years to draw comparisons over time and conclude about the degree of sprawl.

The variable of interest is the value of local gradients (γ), which indicates the attenuation of density at a rate of γ, as one moves from the city center to the periphery; therefore the expected values of gradient will be higher in the peripheral areas. Based on the local gradients for total employment density (see map 2), the results showed a negative and significant employment gradient for all AGEBs at 95% significance level

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[7] The tests were statistically significant at 95% level, for all areas and for total employment, as well as for manufacturing, retail and wholesale, and services. These economic sectors concentrate 98.7% of total employment in the city.

(for those areas with a significant locational heterogeneity). Therefore the CBD was attractive and influenced the distribution of employment in Hermosillo in 1999 and 2004.

The geographic distribution of local gradients suggests that the fall in total employment density was not uniform in all directions around CBD. The overall pattern was more concentric in 2004 than in 1999 (see map 2). In 2004, the local employment gradients are less pronounced to the north and along the northeast corridor from the CBD (toward northern exit that connects the city with the international road No.15). Moreover, the density gradients increase more rapidly to the south and the west of the CBD (i.e., toward the zone of the airport, where population is concentrated).

Comparing the results over time, if a local gradient registers a higher (resp. lower) absolute value, this indicates a quick (resp. slow) attenuation of density, or a tendency towards concentration (resp. suburbanization) of employment. Based on this interpretation, important findings on the geographic distribution of local gradients were found. First, for each area in 1999 the value of the gradient was less than what it was in 2004: gradients in 1999 oscillated between 53.86% and 70.96% while this range was 68.94% to 105.18% in 2004 (see map 2). In other words, the global result masks important heterogeneity in terms of direction and sectors of employment.

Second, in 1999 the local gradients increased slowly and without deep differences to the northwester side of the CBD toward the outskirts of Hermosillo, while the local gradients increase quickly to the southwest of the CBD. However, in 2004 the local gradients, in the same areas, showed a more pronounced fall of employment density, they were deeper along the northwest corridor. Third, local employment gradients to the

southeast of the city, where industrial area is located, showed higher gradients in 2004 than in 1999. It indicates that employment in that area and between their neighbours was more polarized in 2004. Moreover, in 1999 the decay pattern of employment density to the southeast of the CBD was not progressive. Local gradients showed that, even when distance governs the employment density from the CBD, clear differences can be observed in the same direction. However this pattern was reversed in 2004.

The same analysis was performed at the sectorial level in order to determine whether the CBD's influence and attractiveness differs by economic activity. Effectively the situation was very different from one sector to another. Firstly, the CBD influenced the spatial organization of employment in retailing and wholesale activity for both years of analysis, and it was attractive for employment. The geographical distribution of local gradients for these economic activities is quite similar to that of total employment over time (see map 2 and 3). However, the percentage of change in local gradients for this sector did not increase to the west as quickly as for total employment, but the highest decreases of employment density for retail and wholesale employment were localized to the southern part of the city and the zone of the airport in 2004, contrary to the northwestern outskirt in 1999. Apparently this change in highest gradient's pattern indicates more retailing activities developing to the northwest at the end of the period of study. Again, the distribution of local employment gradients, for retailing and wholesale, showed low values to the northeast of the CBD and its distribution was concentric, especially to the northwest and south of the CBD. Moreover all areas in the city had

higher gradients in 2004 as was observed for total employment, which indicate a polarization of jobs.

Secondly, the CBD influenced the spatial distribution of employment in services, following a concentric pattern (see map 4). However, in 2004 some central areas showed a lack of attractiveness (positive local gradient); and the CBD's attractiveness showed a different pattern to different directions from it (see map 4). However the CBD and its zone of influence, around 2 km radio from it, as well as along its northeast corridor, showed positive local gradients. This indicates that the employment density in services increases rather than decrease: these changes oscillated between 0 and 40.6%. In those areas, the CBD was not attractive for employment in services; this repellent effect was not observed through the global results that showed a decay pattern in this sector for all areas.

The higher decreases in employment density for services were registered to the northwest and along the north-south corridor, but local gradients were higher to the north and northwest of the CBD rather than to the south. In contrast to previous geographical distribution of local gradients, the employment density in the zone of the airport (i.e., to the west side of the city) showed in 1999 less percentage of change compared to the neighboring areas. This employment subcenter for services broke with the pattern observed to the northwestern of the city. Moreover deep differences were observed to the southeast of the CBD, as one move from the city center to the industrial area. Comparing both years, the changes in local gradients suggest that more employment in services were

(re)located to the south or in other more concentric areas rather than to the northwest; therefore a polarization of jobs was taking place outside the central area of the city.

Finally, the geographical distribution of local gradients for manufacturing reveals some interesting findings too (see map 5). Although LM-LH tests were strongly significant for all areas, the overall pattern indicates a weak influence of CBD, as well as a lack of attractiveness. The CBD had a weak influence in the distribution of employment for manufacturing, only 38.2% of total local gradients (97 AGEBs) in 1999 were significant at the 95% level, and in 2004 this influence almost disappeared. The lack of significance, across AGEBs, might be result of the US manufacturing crisis in 2000-2001; as a consequence of its closely tied, the employment in Hermosillo registered a fall of -24.1% over 1999-2004 (Rodríguez-Gámez and Dall'erba, 2010).

The geographic distribution of local density gradients show that employment was mostly located to the west, southwest and south of the CBD in 1999; while the industrial area (i.e., to the southeast of the city) was not statistically significant. These results imply that the CBD had influenced the location of employment in manufacturing but just for medium or small factories, which assemble and "re-export" manufactured products free of tax (*maquiladora* industry) and can be (re)located easily in any location around the city.

On the other hand, the positive sign of local gradients showed that the CBD was not attractive for employment in manufacturing and the CBD's influence was not the same in all directions (see map 5). As a consequence of the repellent effect, the employment density increased more rapidly to the west of CBD and less pronounced to

the southeastern part of the city. Moreover, the employment density rose more quickly

(highest gradients) to the north and northeast of CBD than in any other direction. In this

case, global results masked the direction of CBD's influence, as well as the differences

presented when one moves to the south of CBD.

6. Conclusion

Employment distribution in Hermosillo exhibits complex patterns because employment

density is spatially conditioned, that means the density of employment in one location is

partially affected by the density in neighboring locations. After conducting a LM test to

uncover the appropriate structure of spatial dependence, the spatial error model was

calculated using a maximum likelihood approach. In order to analyze the influence and

attractiveness of the CBD on the distribution of employment density, this paper calculates

global and local gradients over time (1999 and 2004) and among economic sectors.

The global results indicate the CBD had a significant and widespread influence on

employment densities in Hermosillo; moreover, the CBD's attractiveness was registered

in the most important economic sectors in the city. This was also true for retail and

wholesale, services, and manufacturing which were the most important economic sectors

in the city since these concentrated the 98.7% of total employment. The estimations

indicated that the CBD dominates the spatial patterns of employment (distance-decay),

but its influence varies across space, among economic sector, and over time. The results

of global gradients showed that a suburbanization process took place for total

employment from 1999 to 2004. Over time and across sectors, the spatial error autocorrelation parameter lost its importance, indicating that a random shock in one area, which affects the area in which it takes place and also all the other areas of our sample, is small.

However these global results were masking local patterns. The geographic distribution of local gradients showed different patterns between years at different directions of CBD. Mostly, local results displayed a concentric pattern which decreased progressively towards the north-south corridor in 2004 rather than in 1999. Moreover, the density gradient for retail and wholesale decreased more quickly in the south of the city. In the case of services the global gradient suggested a decentralization of employment when the analysis at the local level displays a low degree of sprawl (i.e., concentration of employment), as well as a mixed pattern of attractiveness in 2004: around CBD and to the northwest of it the employment density increases, otherwise the employment falls.

For manufacturing both global and local analyses suggest that a decentralization of employment had been taking place to the point where the CBD did not influence the distribution of employment in manufacturing anymore in 2004. Added the spatial parameter becomes more important (highest diffusion effect across error term). The analysis at the local level also shows that the influence of the CBD was present only to the west, southwest and south to the CBD; and its attractiveness had deep differences along southeast corridor, probably due to the increasing influence of another employment center in the industrial area. This lack of attractiveness in manufacturing and in services can obey the relationship between personal services and manufacturing activity.

These results are important because they present the first detailed evidence on the role of local spatial effects in the distribution of employment density in a medium-sized Latin American city. Our results should help public authorities to influence and organize the decentralization of economic activities. The paper shows that the influence of the CBD increased during the period of study, but we do not know whether this reflects a permanent process or whether it was a consequence of the crisis in manufacturing. As such, future research could provide a deeper understanding of the suburbanization process by testing whether Hermosillo exhibits a polycentric urban form. Also, the new researches need update the analysis with the most recent and disaggregated employment data, based on the 2009 economic census which will be available in 2012. This approach will help to confirm if employment polarization in the city is a permanent phenomenon or not, as well as to capture better all the differences among economic sectors.

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Map 1. Location of the city of Hermosillo, Mexico
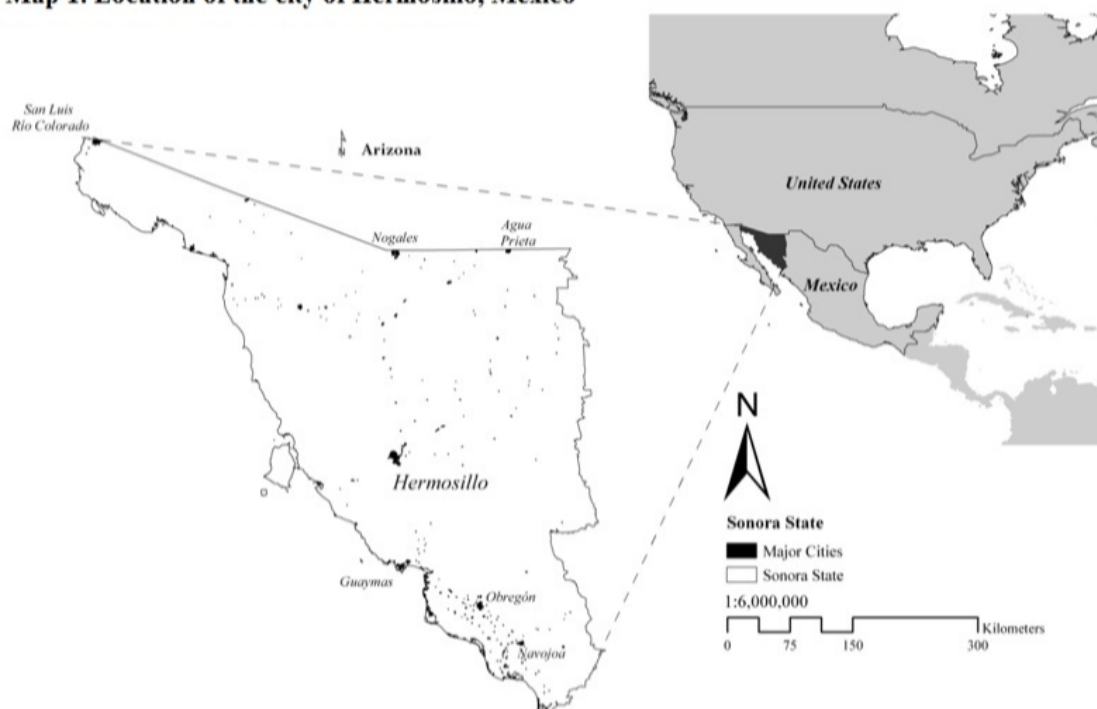
Map 2. Geographic distribution of local gradients for total employment

Map a. Local density gradients in 1999
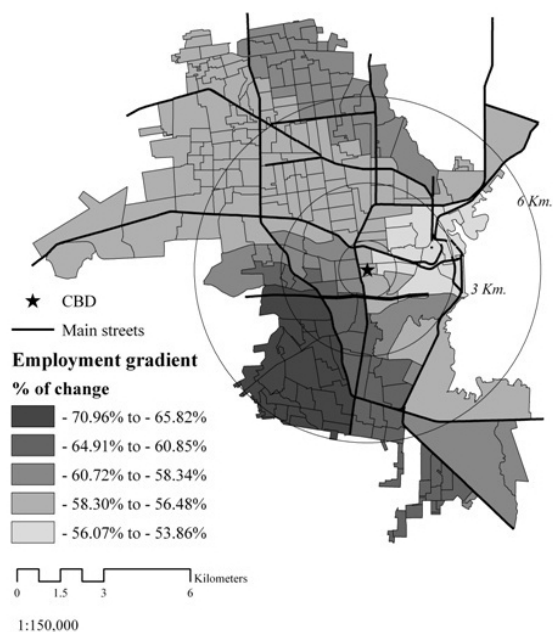
Map b. Local density gradients in 2004
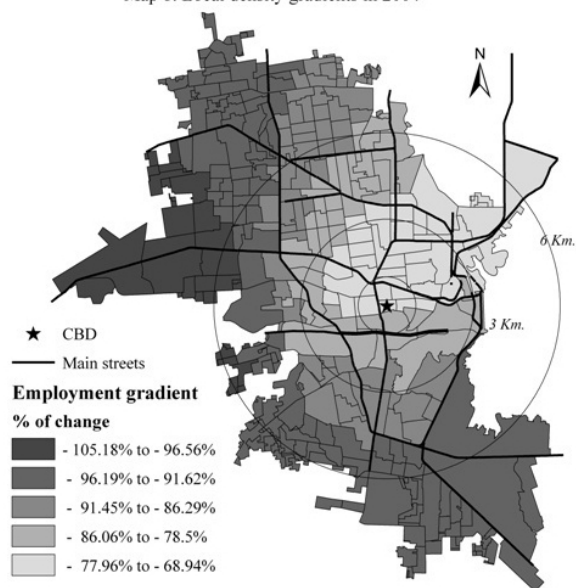
Note: All employment gradients are significant at 95% confidence level.

Map 3. Geographic distirbution of local gradients for retail and wholesale employment

Map a. Local density gradients in 1999   Map b. Local density gradients in 2004
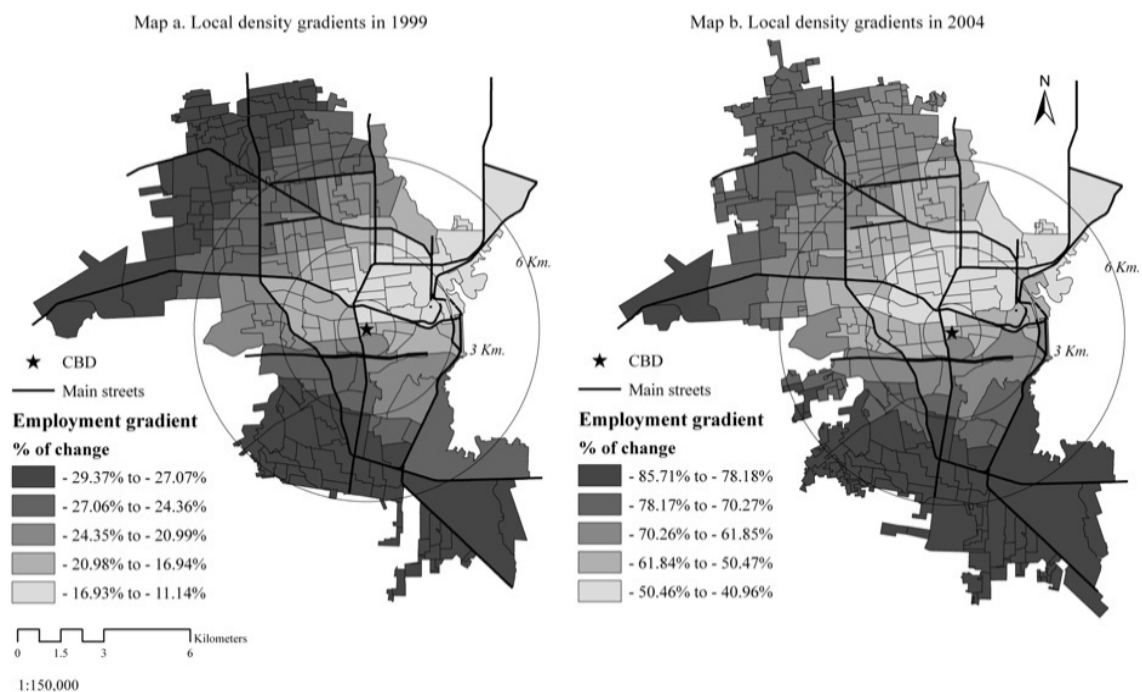
Note: All employment gradients are significant at 95% confidence level.

Map 4. Geographic distribution of local gradients for services employment

Map a. Local density gradients in 1999   Map b. Local density gradients in 2004
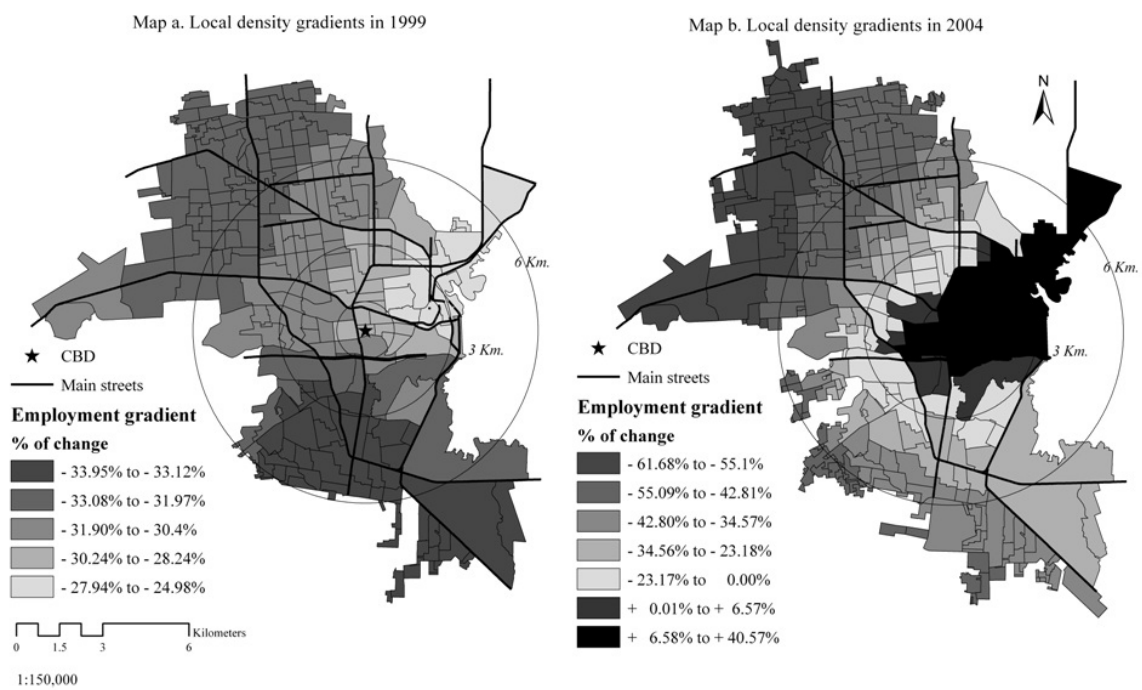
Note: All employment gradients are significant at 95% confidence level.

Map. 5 Geographic distribution of local gradients for manufacturing employment

Map a. Local density gradients in 1999

Map b. Local density gradients in 2004
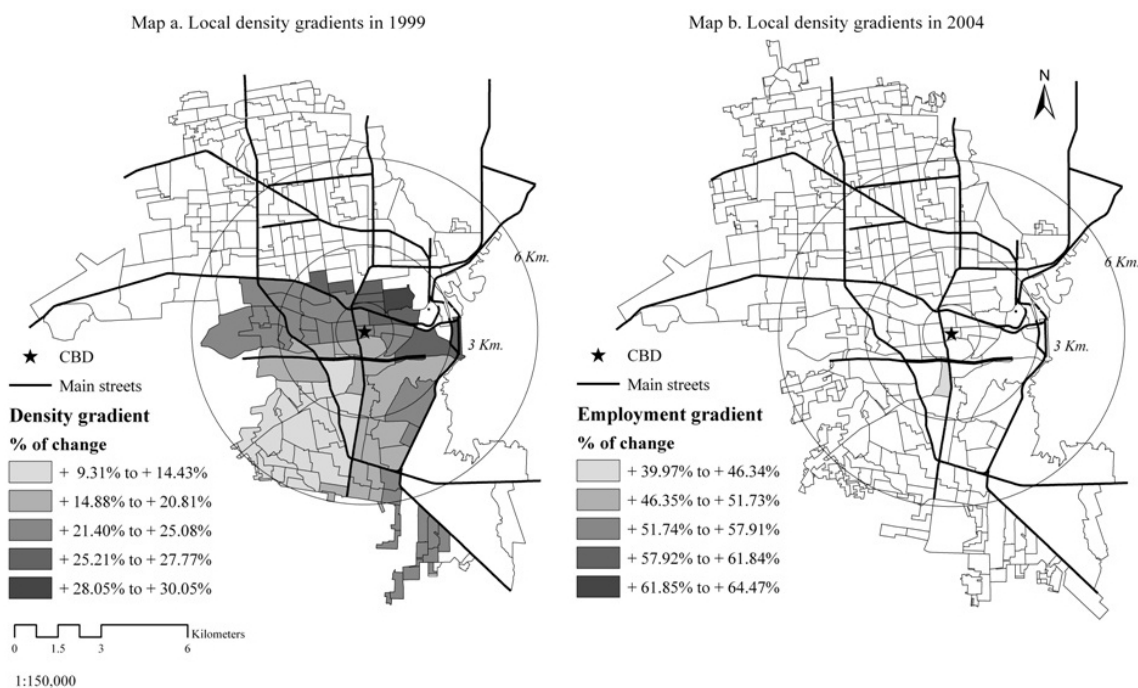
Note: Significant local gradients (95% confidence level) were mapping.

Table 1. Lagrange Multiplier (LM) tests for total employment and economic sectors in Hermosillo

		Total	Forestry, fishing, hunting, and agriculture support	Mining & oil extraction	Water & electricity production	Manufacturing	Retail & wholesale	Services
1999	LM-LAG	152.976 (0.000)	0.071 (0.789)	0.188 (0.644)	0.283 0.595	30.821 (0.000)	142.658 (0.000)	126.266 (0.000)
	R-LMLAG	0.487 (0.485)	(0.000) (0.981)	0.196 (0.658)	0.511 (0.474)	0.090 (0.764)	1.466 (0.226)	0.224 (0.636)
	LMERR	159.979 (0.000)	0.071 (0.789)	0.200 (0.654)	0.297 (0.586)	30.774 (0.000)	149.912 (0.000)	134.363 (0.000)
	R-LMERR	7.490 (0.000)	0.000 (0.985)	0.207 (0.649)	0.525 (0.468)	0.043 (0.835)	8.720 (0.003)	8.320 (0.004)
2004	LM-LAG	299.803 (0.000)	4.445 (0.035)	0.150 (0.900)	0.266 (0.605)	131.405 (0.000)	227.282 (0.000)	266.900 (0.000)
	R-LMLAG	0.046 (0.829)	1.659 (0.198)	0.133 (0.714)	7.608 (0.006)	4.306 (0.038)	2.168 (0.141)	0.170 (0.679)
	LM-ERR	307.752 (0.000)	4.321 (0.037)	0.018 (0.891)	0.305 (0.580)	128.226 (0.000)	235.756 (0.000)	279.215 (0.000)
	R-LMERR	7.995 (0.005)	1.534 (0.215)	0.137 (0.711)	7.647 (0.005)	1.127 (0.288)	10.639 (0.001)	12.486 (0.000)

Note: *P-values* in round brackets. LM-LAG stands for Lagrange Multiplier test for a spatial lag and R-LMLAG is its robust version. LMERR stands for Lagrange Multiplier test for spatial error and R-LMLAG is its robust version.
Source: Elaborated based on INEGI (2007).

Table 2 Maximum Likelihood (ML) estimations for global employment density functions with spatial error model (SEM)[*/]

	Parameter	Total	Forestry, fishing, hunting, and agriculture support	Mining and oil extraction	Water and electricity production	Manufacturing	Retail and wholesale	Services
1999	D_{CBD}	4.599**	0.048**	0.079**	0.035*	1.464**	3.387**	3.562**
	γ	– 1.825**	- 0.021*	– 0.036**	– 0.016	– 0.551**	– 1.363**	– 1.548**
	λ	0.843**	0.124*	0.034	– 0.038	0.666**	0.783**	0.797**
	σ^2	0.283	0.005	0.008	0.007	0.186	0.244	0.154
2004	D_{CBD}	4.470**	0.011*	0.027**	0.039*	1.802**	2.982**	3.555**
	γ	– 1.621**	- 0.005*	– 0.012*	– 0.018	– 0.687**	– 1.157**	– 1.417**
	λ	0.768**	- 0.045*	– 0.104*	– 0.040*	0.477**	0.736**	0.695**
	σ^2	0.393	0.000	0.002	0.010	0.425	0.255	0.281

*/ Inverse power density function was used.

Note: Symbol ** denote significance level greater than at 99%, while * indicates significance level between 95-99%, otherwise not significant.

Source: Elaborated based on INEGI (2007). Calculations were performance in MATLAB 7.9.0 (R2009b), using Spatial Econometrics Toolbox in Matlab (LeSage, 1999).

Table 3 LM tests (maximum) of spatial autocorrelation in GWR and locational heterogeneity (LH) in GWR-SEA model

Sector	1999			2004		
	LM-LAG	LM-ERR	LM-LH	LM-LAG	LM-ERR	LM-LH
Total Employment	2,525.80	2,534.30	2,022.70	2,615.80	2,733.20	2,217.40
Manufacturing	8,210.30	8,213.50	7,185.60	5,709.50	5,718.40	4,754.50
Retail & wholesale	2.423.7	2,430.00	2,498.40	2,738.30	2,798.80	2,755.60
Services	2,717.30	2,729.30	2,730.10	2,803.50	2,823.40	2,619.70

Notes: In 1999 the total number of observations was 254 and 364 for 2004. All the LM tests were significant at 95% level. LM-LAG is the LM test for an omitted spatial lag in the GWR model, LM-ERR is the LM test for an omitted spatial error autocorrelation in the GWR model and LM-LH is the LM test for locational heterogeneity in the GWR-SEA model.

Source: Elaborated based on INEGI (2007). Calculations were performance in MATLAB 7.9.0 (R2009b), following the codes elaborated by Antonio Páez, according to Páez, *et. al.* (2002b).

APPENDIX C.- COMMUTING IN A DEVELOPING CITY: THE CASE OF CIUDAD OBREGON, MEXICO

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(For submission to *Journal of Transport Geography*)

Abstract

While extensive studies have been conducted on commuting patterns in cities in developed countries, very few have investigated the complexity of commuting in developing countries. As a contribution to the commuting literature, this paper presents an analysis of commuting in Ciudad Obregon, Mexico, based on the survey Employment and Quality of Life (E&QL) conducted by *El Colegio de Sonora* in 2008. Given that the data has a hierarchical and nested structure, we use a multilevel approach to 1) measure the impact of a set of explanatory variables, including demographic and socioeconomic factors, mode choice and regional characteristics, on the commuting behavior in the city; and 2) capture the interdependences among different levels of aggregation. In particular, we included workplace characteristics (e.g., size, the business nature, and work time) in the analysis to gain insights into the associated effects on commuting, which are often neglected in existing studies. The novelty of including the business nature (private business vs. public offices) showed great and positive effect on the length of commuting

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distance. While some results demonstrated consistency with the existing literatures in developed countries, income proxy variables showed an opposite effect, and others, such as age, occupation and education were found to be not significant. Results indicated that, although space is important for explaining the observed commuting patterns, the worker-related factors at individual level are stronger. Meanwhile, the inclusion of random-effects to quantify and test contextual variability in commuting behavior indicated that mode choices, university education, and workers in manufacturing contribute differently in explaining the corresponding impacts in various urban areas.

Key words: commuting, multilevel analysis, developing cities, travel mode choice, OD patterns.

1. Introduction

One challenge confronting urban planners today comes from the complexity of commuting due to the increasing geographic separation of homes from workplaces. With an increase in polycentric distribution of people and employment, commuting patterns become less predictable and stable. Although over the past decades commuting has been widely studied in urban economic literature, there still exist several gaps. First, existing studies primarily focus on explaining commuting variations without any reference to their workplaces' characteristics (see Schwanen *et al.,* 2004 as an exception). Second, although commuting behavior clearly involves some hierarchical levels of analysis,

ranging from individual workers to the metropolitan region, it is still drawn from aggregate level statistics alone. Notable exceptions are the studies of Miranda and Domingues (2010) for Belo Horizonte, Brazil; Zolnik (2009 and 2011) for U.S. metropolitan areas; Bottai *et al.,* (2006) for Pisa, in Italy; Mercado and Páez (2009) for Hamilton, Canada; and Schwanen *et al.,* (2004) for The Netherlands. Finally, most investigations are based on US or European cities, whereas evidence from Asia or Latin America is scarce. For developing countries, few studies have used a quantitative approach to analyze commuting behavior (see Medina and Domingues for the metropolitan area of Belo Horizonte, Brazil; Song Lee and McDonald, 2003 for South Korea; Alpkokin *et al.,* 2008 for Istanbul, Turkey; Zhao *et al.,* 2011, for Beijing; and Pan *et al.,* 2009, for Shanghai). However, to the best of our knowledge, no research has examined the case of a medium-sized city in a developing country, like Mexico.

The lack of studies on commuting behavior in Mexico is mainly due to the unavailability of the data needed. The Mexican Bureau of Statistics (*Instituto Nacional de Estadística, Geografía e Informática* [INEGI for its acronym in Spanish]) doesn't collect the information related to identify commuting patterns, such as mode choice, time, frequency and length of trips, on the demographic and socioeconomic attributes of commuters. As a result, studies in medium-sized cities have been conducted based on their own commuting data, often collected through local surveys. Such surveys are often designed by scholars and/or in association with City's Planning Institutes (see Fuentes, 2009, for the city of Juarez, Chihuahua, as well as Brugués and Rubio, 2009, for the cities of Los Mochis and Mazatlan in Sinaloa). However, these studies pay no or little attention

to spatial effects, such as spatial autocorrelation and spatial heterogeneity, on commuting behavior. Therefore, the lack of commuting information is one of the biggest challenges at the urban level.

In order to uncover the increasing complexity in commuting behavior, our analysis seeks to fill the aforementioned gaps and contributes to the field of study by providing new evidence on commuting behavior in Ciudad Obregon, Mexico using commuting data that are for the first time available for the city. Regardless of the importance of commuting in urban daily life, commuting is not a key issue on the Mexican policy-makers' agenda. Moreover, Ciudad Obregon does not have a Planning Institute to guide the urban planning process in the city. Therefore, our study will provide important information for urban transportation planning and more broadly provide guidance for a sustainable urban sprawl.

In this paper, we aim to 1) study the commuting characteristics in Ciudad Obregon, Mexico, and factors that can be used to explain the patterns, and 2) explore differences in commuting behavior by areas across the city. Our data comes from Employment and Quality of Life (E&QL) Survey, conducted by *El Colegio de Sonora* (research center in social sciences located in Hermosillo, Sonora, usually called Colson) in 2008. The survey used a multistage sampling strategy with data hierarchically organized. Commuting behavior is likely dependent on the characteristics of workers within a household, as nested in urban areas or AGEBs (*áreas geo-estadística básica*). Therefore, a multilevel approach was used to model the commuting behavior in the city

in order to disentangle the effects of demographic, socioeconomic, and spatial attributes on aspects of the journey to work.

The article is organized as follows. Section 2 provides a review of theoretical explanations of commuting, as well as empirical evidence on factors accounting for differences in the commuting length between groups of employees and areas. Section 3 describes the study area, with a focus on urban characteristics, employment distribution, modes of transportation and general commuting information in Ciudad Obregon. Section 4 details the survey implementation and data, as well as the methodological approach used for analyzing the commuting data. The results are then presented in Section 5 to explain the commuting behavior and differences across commuters and areas. Finally, a brief summary of results and final remarks about differences between US and Mexican cities are provided.

2. Background

2.1 Commuters' characteristics

A consistent finding on commuting is that women have, on average, shorter commutes than men (Zolnik, 2009; Rouwendal and Nijkamp, 2004; Schwanen *et al.,* 2004; Song Lee and McDonald, 2003). The household responsibility hypothesis offers arguments why women in households with children commute not only much less than men, but also considerably less than other women. Other explanations about women's shorter

commutes include the spatial segmentation of the labor market, as well as the observation that women hold other types of occupations and lower wages jobs than men (Weinberger, 2007). Particularly, married women have shorter commutes than single women, whereas single workers, as well as two-worker couples, have longer commutes (Winberger, 2007; Song Lee and McDonald, 2003; Schwanen *et al.,* 2004). Moreover, the empirical evidence shows that older women have shorter commute distance than younger women and men (Schwanen *et al.,* 2004; Levinson, 1998). While some studies show that worker mobility decreases with age, other empirical studies show that younger workers commute shorter distances compared with older groups (Song Lee and McDonald, 2003).

Higher income levels are found to be correlated with longer commuting distance (Levinson, 1998; Song Lee and McDonald, 2003, Ory *et al.,* 2004).While workers with higher income tend to buy a home and relocate their place of residence closer to their workplace to reduce the commuting distance, commuters can exhibit a lack of rational behavior because they enjoy much more the neighborhood's attributes rather than shorter commutes (Rouwendal and Nijkamp (2004). When income information is not available, home ownership, number of rooms in the home or education have been used as proxies for income. For instance, workers who own homes have longer commutes because their residential mobility is low (White, 1988; Song Lee and McDonald, 2003; Zhao *et al.,* 2011). Commuters who live in smaller houses have shorter commutes than those who stay in bigger ones (Song Lee and McDonald, 2003). Those arguments are also supported by institutionalist theory, where housing provision or land regulation plays a key role in commuting behavior in developing countries (Zhao *et al*., 2011).

Workers with lower levels of education as well as low-skilled jobs have shorter commuting distances than those with higher levels of education or higher skills level (Song Lee and McDonald, 2003; Levinson, 1998), because these jobs are in general available closer to commuters' house. Work status (salaried employee, owner, self-employed, or unpaid family worker, and part-time or full-time) plays a key role in commutes; however, the differences by occupation and industry are sizeable (Song Lee and McDonald, 2003). First, differences by sector show that workers in manufacturing and agricultural industries have longer commutes than others, such as workers in retailing and services activities, as a consequence of land use differences (Song Lee and McDonald, 2003; Vega and Reynolds-Feighan, 2008; Weinberger, 2007). Second, differences by occupations suggest that clerical, sales and service workers which are often female-dominated occupations, as well as blue-collar workers have shorter commuting distances; while workers with high-skilled jobs travel longer distances. However, blue-collar workers can commute longer distances in some situations, because manufacturing seeks, outside the core of the city, large amount of open and cheap land, as well as better infrastructure (Vega and Reynolds-Feighan, 2008; Hakim, 2009).

Considering the mode of transport, ownership of an automobile or other motorized vehicle increases a worker's mobility, because a car could expand the job search radius and increase the possibility to find a job (Gautier and Zenou, 2010; Baum, 2009). Moreover, the automobile is associated with short trips from home to work than public transportation, cycling or walking (Gordon and Richardson, 1994; De Palma and Rochart, 1999; Van Ommeren and Rietveld, 2005; Vega and Reynolds-Feighan, 2008,

Cebollada, 2009). Bus commutes are longer for those who live in outlying areas, where public transport is less efficient given the low population densities in these areas, than those who live in central locations (Vega and Reynolds-Feighan, 2008). A positive relationship between income and motorized vehicles has been documented (Sultana and Weber, 2007; Pan *et al.,* 2009). The importance of mass transit, as well as the cycling and walking have declined in polycentric cities, whereas the importance of car travel increases (Schwanen *et al.,* 2004).

2.2 Places' characteristics

It is generally believed that city size plays an important role in affecting commutes, but its impact is not clear (Cervero and Wu, 1997). The complexity of the city size effect can be explained by residential choice behavior, multiple workers in a household, lags in housing development, or zoning measures (Schwanen *et al.,* 2004). For U.S. cities, little or no effect of urban size has been found on commute distance or time (Gordon *et al.,* 1989; Levinson and Kumar 1994), but in European cities, studies have shown that commute distance increases when urban areas become larger (Coombes and Raybould 2001; Schwanen *et al.,* 2004). Population density is also an important factor: people living in high-density areas tend to make fewer and shorter car trips (Schwanen *et al.,* 2004; Newman and Kenworthy, 2000). However, the effect on travel times is open to discussion, since high densities also lead to higher levels of congestion (Levinson and Kumar 1994).

As a consequence of polycentrism, commuting distances are found to have a decreasing trend; empirical studies for U.S. cities (see, among others, Kim, 2008; Lee *et al.,* 2008; Keserű, 2010; Gordon *et al.,* 1989; Levinson, 1998), as well as for European cities (see Rouwendal and Vlist, 2005; Van Ommeren *et al.,* 1998) corroborate the trend. However, polycentrism does not necessarily reduce commutes: people who work in a subcenter often live somewhere else (see, for instance, Sööt *et al.,* 2006 for the Chicago case; and Aguiléra *et al.,* 2009 for French metropolitan areas). Housing and land market imperfections (Soot and DiJohn, 2003; Wachs *et al.,* 1993; and Taylor and Ong, 1995) as well as the definition of polycentrism (Veneri, 2010; Aguiléra, 2005; Yang, 2005; Schwanen *et al*., 2004), explain the reverse trend.

Moreover, commuting distances can increase as a result of imperfect labor markets, which are often less organized, as in many developing countries. In this regard, Houston (2005) points out some situations commonly observed in those cities: 1) employers in inaccessible locations might need to pay higher wages in order to attract workers; 2) there is an excess of labor supply even in less accessible locations, 3) low-wage labor is spatially immobile, and 4) commuting patterns are affected by employment changes. As a result, commuting times have declined even with an increase of employment (see Alpkokin *et al.,* 2008 for Istanbul, Turkey), in contrast to cases in U.S. cities (see Cervero and Wu, 1997 for San Francisco; and Gordon *et al.,* (1991) for several cities). Thus, in labor markets with high-unemployment and low-wage, commuting becomes a stronger barrier to getting a job. Long commutes can also be found in

employment growth areas, since new residential neighborhoods are not immediately

developed close to these areas (Schwanen *et al.,* 2004).

Some other factors that are less directly related to the spatial location of

employment and population are also worthy of consideration. For example, the ratio of

total employment in an urban area to the labor force (also known as job housing ratio –

JHR) is negatively correlated with commuting times. On the other hand, if the number of

jobs in a urban area is relatively low, workers may find it difficult to find a suitable job

near their residential places, resulting in an increase in the average commute distance (see

Levinson 1998; Lee *et al.,* 2008; Cervero, 1989). In balanced or job-rich areas (equal or

higher number of employees per residents), workers with higher skills levels have a better

chance to find a nearest jobs , which increases the unemployment rate for low-skilled

jobs and, consequently, increases the length of commuting distance for workers with low

skills levels (Immergluck, 1998).

3. Study area

Established in 1906, Ciudad Obregon is the second largest city in the Northwestern

Mexican State of Sonora (see Figure 1). With a population below 300,000 in 2010, the

city is considered a medium-sized urban area according to Mexican standards. In the last

decade, the city has spread considerably and the population density has decreased (see

Table 1). This significant expansion suggests that journey to work has become more

dispersed in terms of origins (homes) and destinations (workplaces). Moreover, during

the decade the number of workers per household increased due to population growth as well as the rising participation of women in the labor force. For instance, the number of households with 3 or more residents who have a job increased at a 6.2% annual rate (see Table 1). This means a short journey to work trip for one household member might come at the cost of another's long commuting distance. Commuting has been further complicated by the multi-towns structure of the city and its economic interactions.[1]

Since its founding, the city has been an important agricultural pole for the region, and now it offers activities related to retailing and services as well as to supporting manufacturing; these account for 99.5% of total employment in 2009 (see Table 1). Due to its monocentric structure, a high percentage of these jobs are located inside a unique Central Business District (CBD) or around it, thus the employment growth in the past decade (2.6% yearly) allows us to infer that significant proportion of new jobs are located outside the traditional CBD. The CBD is centrally located and still holds the commercial center, the civic center as well as the government center. The city is relatively new and does not have a historical center. Therefore, the civic center (namely Civic CBD) registered the highest employment density (122 employees per hectare), which is even higher than Hermosillo, the capital city of Sonora. The civic CBD is specialized in retailing and wholesale as well as in services; while the entire CBD (cluster of high employment density areas) is specialized, at the end of the period (2000-2010), only in

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[1] The city has spread over 56.1 km^2 inside the Municipality of *Cajeme* and accounts for 72% of the overall population surrounded by a few regional towns. The two towns, *Esperanza* and *Pueblo Yaqui*, account for 9% and 4% of the total municipal population, respectively (see Figure 1).

services (see table 2).[2] Over time the Civic center has become more diversified and the

CBD more specialized. Finally an important employment subcenter was identified to the

Southeast of the CBD, which is specialized in manufacturing.

Population growth has been overtaken by the growth of motorized vehicles

registered in the past decade (4.7% yearly). With the growth of multiple-car households,

autos (e.g. car, trucks and vans) continue gaining importance in Ciudad Obregon (see

Table 1). A 2008 study showed that the car was the most common commute mode choice

in Mexico (used by 57.5% of commuters), followed by buses (30%) and walking (11%)

(OECD, 2009). As for Ciudad Obregon, cars (including carpools) and buses were the first

and the second most commonly used modes of transportation (45.1% and 31.6%,

respectively) with cycling the third (11.6%) (see Table 2). This high use of cycling in

Ciudad Obregon demonstrates its significant importance as opposed to 0.7% at the

national scale (OECD, 2009).

At the national level, Mexican workers spend on average 11% of their time

commuting, and for a single trip the commuting ranged from 25 to 30 minutes in 2009;

over time, commuting time has decreased 15 minutes on average (INEGI, 2010).[3] For

workers in Ciudad Obregon, the average commuting time in the city was about 31

minutes (see Table 3). A closer examination shows that commute times differ by modes

of transportation and by departure schedules, as also shown in Table 3. For example,

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[2] The CBD was identified through an Exploratory Spatial Data Analysis (ESDA), as a cluster of high employment density areas or AGEBs surrounded by high values of employment density, according to the methodology tested for other medium-sized city in Sonora (see Rodríguez-Gámez and Dall'erba, 2012).
[3] INEGI has been collecting data on time management, including commuting time, through the National Survey on Time Use (ENUT by its Spanish acronym) conducted in 2002 and 2009. Commuting time is reported weekly. In our analysis we calculated the commuting time per one single trip in a weekday.

although the overall commuting times by car and public transportation are similar, afternoon (3pm to 8 pm) commuting by car, and noon commuting by bus, are much higher than other times of day. Morning walking trips (4am - 9pm) are found to be longer than noon ones (9am to 3 pm). Overall, shorter commuting times were observed for motorcycles and walking (around 20 minutes on average) compared with cycling (43.3 minutes average).

4. Methodology

4.1 Data

Our dataset comes from the survey "Employment and Quality of Life" (E&QL) designed by researchers of *El Colegio de Sonora* using a multistage sampling strategy and data were collected in the cities of Ciudad Obregon and *Heroica* Nogales in 2008.[4] The main assumption regarding the commuting data is that origins and destinations are distributed over the urban space as a result of rational behavior for balancing costs and benefits to firms and households. In our study, the most suitable and objective variable for modeling commuting is commuting distance, because commuting time shows inconsistencies and is not available for the entire dataset, as the main goal of E&QL was not to collect daily travel information.

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[4] The sampling size was determined using a multistage method: each AGEB was first stratified by wellbeing level (nine groups) and block and houses (three per block) were then randomly selected. Three questionnaires were conducted: home residents (HRs), home and household (H&H), and employment and quality of life (E&QL) (Colson, 2009).

In order to examine the geographic separation of homes from workplaces, we selected workers who provided information (name and/or location) about the workplaces as well as the commuting mode choice. Therefore, our reference population includes workers who have a formal job, as well as those who are self-employed. In total, 336 workplaces and 544 houses were identified as destinations points and origin points, respectively, in our spatial dataset. The Euclidean distance metric was used to measure commuting distance in a Geographic Information System (GIS).[5] In this study, we considered three hierarchical levels in the analysis of commutes: 505 commuters, nested in 374 households in 39 urban areas or AGEBs. When selecting the appropriate number of levels for analysis, we calculated the design effect (see Snijders, 2005).[6] In our case, since we do not have enough individuals in each household group to make inferences at the household level aggregation, a two-level model is more appropriate, with individual commuters (level 1) nested in AGEBs (level 2).

4.2 The model

The literature review as well as the survey's structure reveal why an approach involving multiple aggregation levels is preferable, to address: 1) the dependence among observation, and 2) the correlation of heteroscedasticity on error terms with the

[5] We used the Euclidean distance as a proxy of the true commuting distance due to the lack of network information in the study area. However, we don't expect big differences in our results since there are no significant terrain changes or obstacles in the city (Newell, 1980).
[6] The design effect is approximately equal to 1 + (average cluster size - 1)*inter-class correlation; a design effect greater than 2 indicates that the clustering in the data needs to be taken into account during estimation (Snijders and Bosker, 1999).

explanatory variables (Albright, 2007; Goldstein, 1995). In order to overcome the

limitations of ordinary least squares (OLS) estimations, a generalized multilevel

hierarchical linear model (GMHL) was used to capture the relationships between

individual level variables, such as commuters, and variables at group level, such as

households or urban areas. Each level in the data structure is formally represented by its

own submodel, and these are statistically linked according to a predetermined structural

model (Raudenbush and Bryk, 2002).[7] A basic two-level model can be described as

follows:

$$Y_{ij} = \beta_{0ij} + \beta_1 X_{ij} + e_{0ij} \qquad [1]$$

$$\beta_{0ij} = \gamma_0 + u_{0j} \qquad [2]$$

$$\beta_{1ij} = \gamma_1 + u_{1j} + e_{1ij} \qquad [3]$$

where Y_{ij} is the dependent variable (e.g., commuting distance) for individual i at level 1

(e.g., commuters), nested in area j (level 2). This basic structure can be easily extended to

include additional levels. In equation 1, the intercept β_0 is the value of the outcome

variable when the explanatory variable or a set of independent variables X_{ij} at the

individual level is zero, and β_1 is the estimated regression coefficient or β's vector for X_{ij}.

The random term e_{ij} is the usual error term capturing the random variations among

individuals, with $E(e_{0ij}) = 0$ and $var(e_{0ij}) = \sigma^2_{e0}$. In multilevel models the regression

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[7] We chose restricted maximum likelihood (REML) as a multilevel estimation procedure because it produces more accurate estimations of random variances whereas maximum likelihood (ML) produces more accurate estimates of fixed regression parameters (Twisk, 2006; Hox, 1995).

coefficients of the level-1 models are regressed on the level-2 explanatory variables. Therefore, the MHL deals with heterogeneity through the covariance matrix, where fixed-effects and random-effects are included.

In our model, the term β_{0ij} has a fixed mean, γ_0, the intercept, and its variation around this mean among level 2 (i.e., AGEBs) is captured by the random term u_{0j} (see equation 2). If the model only adopts random variations around the intercept (β_{0ij}), it is called an *intercept-only model*. Often times, variations are also present in the coefficients of independent variables ($\beta_1 X_{ij}$). It is called *random-slope models*, where β_1 is a combination of a set of random variables, γ_1, the fixed mean slope coefficient, and u_{1j}, the random variation around this mean among areas (see equation 3). An additional random term (e_{1ij}) could be introduced if we assume an existence of a random variation at the individual worker level.

Since the distribution of the dependent variable (commuting distance) is skewed to the right, a logarithm transformation was applied. A step-by-step method was used for fitting the MHL model, starting with a basic model in which all parameters were fixed, and then adding random coefficients as well as random-effects (Raudenbush and Bryk, 2002; Twisk, 2006). To assess the goodness of fit when additional variables are included, we assume that the difference in deviances has a Chi-square (χ^2) distribution in which the degrees of freedom are given by the difference in the number of estimated parameters. To estimate the model we use the software MLwiN©, version 2.24, developed by the Center for Multilevel Modeling, University of Bristol.

5. Commuting behavior

5.1 Descriptive analysis

On average, workers travel 3.6 kilometers between homes and workplaces. Table 4

summarizes the characteristics of commuters. In the survey dataset, 56.4% of commuters

indicated that at least one car was available in their house. Not surprisingly, the private

motorized mode (i.e., car, carpool and shuttle) was the most common choice, accounting

for 48.6% of overall commuting. The 34.1% of workers used bus, whereas 17.3% of

workers chose non-motorized modes such as cycling and walking. Following Van der

Laan's categorization (1998), the common commuting pattern in our dataset is

decentralized, in that 68.1% of residents commute between non-central areas and only

25.4% of trips were centralized (i.e., oriented to the core city). Other types, such as safe-

contained (employees live and work in the same area) and exchange commuting (workers

commute outside the city), accounted for about 6.5% of total commuting trips.

The demographic characteristics of commuters are also detailed in Table 4. About

62% of the commuters are men and 38% women. The 16.4% of workers were younger

than 24 and 5.7% were above 50, 33.1% of workers were single and 66.9% were married.

On average, each household had about 4 members. Around 90% of workers lived in their

own home, including those who were paying a mortgage or lived in an irregular

settlement. As for the education variables, about half of workers (51.5%) were highly

educated (high school degree or higher), 45.9% had basic education (elementary and

middle school), and about 2.6% did not finish elementary school. Based on their occupation, 20.4% of workers were employed in high-skilled jobs (professionals, professors, technician, workers of arts, and directors), 19.2% were moderately skilled jobs (supervisors, managers, machine operators, workers in protective services), and 54.1% were low-skilled jobs (farmers, machine drivers & machine assistants, blue-collar workers, craftsperson, clerk, sale workers & services workers). Meanwhile, 6.3% of workers were employees with jobs that did not require any skills (assistants & laborer, domestic workers and street vendors).[8]

By economic sectors, 64.9% of employees were in retailing and services activities, 30.9% were in manufacturing, and 4.2% engaged in agriculture activities. As for labor conditions, 77.6% of workers worked during the daytime. While 78.8% of commuters worked in private business, 21.2% worked in a public office at municipal and state level government. 87.3% were regular employees and 89.1% were paid by salary; 34.7% of commuters worked in a big firm and 65.3% worked in small workplaces.[9] Based on the dummy variables listed above, our reference categories are married workers (male) who used car as mode of transportation, those who lived in their own house with car ownership, those with basic education and low-skilled occupation, and those who worked in a small private business and received salary for working during the daytime in services sector (including retailing).

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[8] The classification of occupations was coded following the Mexican Classification of Occupations (*Clasificación Mexicana de Ocupaciones* [CMO by its acronym in Spanish]) developed by INEGI.

[9] The size of workplaces follows the classification suggested by Mexican Economic Bureau (*Secretaría de Economía, Diario oficial del 30 de junio de 2009*) based on the economic sector and the number of workers.

Since we were also interested in evaluating how workers' income level affects commuting distances, we included the number of appliances in a house (the average was 8 appliances), and house size (the average was 4 rooms per house) as a proxy of commuters' income level, we used years of schooling as an urban level proxy, which is 9 years on average corresponding to basic education. Some other characteristics of residential environment are also important in the analysis, including population density and employment density as well as urban size. On average, one AGEB in Ciudad Obregon has 85 residents and around 6 employees per hectare. These areas gained an average of one employee per hectare, from 2004 to 2009 (table 4). The job-housing ratio (JHR) was 0.24 on average. Note that a JHR value below 1 indicates a housing-rich area; otherwise a job-rich area is indicated (Cervero, 1989).

5.2 Does space matters?

A fundamental task in multilevel analysis as well as one of our objectives is to measure the dependency of commuters belonging to the same urban area or AGEB. If sites or individuals are nested within geographical regions, the intra-class correlation coefficient (ρ) measures the spatial autocorrelation.[10] Our analysis indicated that around 15% of total variation can be explained by distribution of urban areas [0.112 / 0.112+0.651] (see Table 4). Our results are consistent and even higher than those reported in literature, in which

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[10] The coefficient ρ is easily calculated through an intercept-only model to uncover the variance between the highest level of aggregation and the total variance. If commuting distances do not differ from one household or AGEB to another, ρ should be 0. Usually in cross sectional studies ρ will not be higher than 0.20 (Twisk, 2006).

an important percentage of differences in commuting have been explained by

geographical levels of variation. For instance, in Miranda and Domingues (2010) 6.8% of

variations were explained by differences between metropolitan areas of Belo Horizonte,

Brazil. Similarly, 6% of variations were explained by municipal differences across areas

in Pisa Italy (Bottai *et al.,* 2006). For the Hamilton CMA, Canada the zones explained a

low percent, ranging from 3% to 5% (Mercado and Páez, 2009). In the case of The

Netherlands, the municipal level differences explained 11.4% of commuting variations

(Schwanen *et al.,* 2004). Figure 2 illustrates how commuting distance varies across the 39

AGEBs in Ciudad Obregon, with the smallest residuals on the left to the largest residuals

on the right. We can observe that commuting distances in the central areas are

significantly below the city average, whereas those in the periphery are above the

average.

5.3 Commuting patterns and perception regarding commuting distance

Based on our previous discussion in 4.2, we fitted a two-level hierarchical model, in

which level 1 represents the variability between commuters at the same AGEB and level

2 captures the variability between different AGEBs. Following the step-by-step strategy,

the commuting distance was first modeled using random intercept and fixed-effects for

each individual attributes and AGEB's characteristics (random-intercept model). The

presence and extent of spatial autocorrelation or inter-AGEB variations can be further

captured through the random-effects in the variance-covariance matrix at the AGEB's

level (random intercept and slope model). Therefore, we included random slopes to fit the commuting data and Table 4 summarizes the model results. The rest of this section will focus on random-effect model, because it has a better fit according to the rule of thumb proposed by Snijers and Bosker (1999).[11] In other words, our model significantly improved overall fit, when the variances of slopes were considered in the random-effect model.

As shown in Table 4, commuters in the reference group drove approximately 4 kilometers to work (after logarithmic transformation). Focus on fixed-effects the results reported in table 4 for each coefficient indicates the amount of the relationship when the random-effects around the slopes are fixed. Our results show that gender has significant and important influence on commuting distance and as expected women have shorter commuting distances than men. Table 4 also suggests that a single worker tends to travel shorter distances than a married one. While existing studies have found that younger workers commute significant less than older ones, in Ciudad Obregon the age variable was not able to explain the commuting variation significantly. The results also indicate that workers who rented their homes tend to have shorter commute. Household characteristics are also important, given that we do not have enough information about income. In our study, we used the number of appliances and house size (numbers of rooms in particular) as a proxy of income. Results in Table 4 show that house size has a significant negative effect on commuting distance, which is opposite to what literature

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[11] The random-effect model fits better than the fixed-effect model when the difference in deviances by the number of degrees of freedom [(1,115.704 - 1,071.354) / 57 - 37] is greater than 2 (see table 4).

suggests. In our case, commute distance decreases with an increase in the number of rooms in a household.

The levels of education and occupation were not significant. Workers in the category of moderately skilled occupations, which correspond to supervisors, managers, machine operators and workers in protective services were found to have longer commutes than workers with low-skilled jobs. However, the economic sector in which employees work contributes to the differences in commuting distance. For instance, workers in manufacturing and agriculture sectors commute longer distances than those in retailing and services as a consequence of land use distribution, i.e., the industrial area is located in the periphery of the city and the agricultural land is located outside the city. As for work status, the results indicate that employers or self-employed travel shorter distances than employees. To the best of our knowledge, no studies have examined the effects of workplace characteristics, such as business nature (private business vs. public offices), workplace size (small vs. big) and working hours (during the daytime vs. nighttime), on commuting distance. In this research, we provided the first study on effects of these variables. In particular, the business nature was found significant: workers in government offices commute longer distance compared with those who work in a private business. This is as expected given that private businesses are more dispersed across the urban areas in Ciudad Obregon.

As for the mode of transportation used for commuting, the results suggest that walking or biking distances were considerably shorter than those of motorized vehicles (i.e., car and bus). Individuals who walk or bike to work usually live relatively close to

the workplace, whereas those who use motorized means of transportation tend to commute longer distances. In fact, the use of public transportation increases the commuting distance when compared with driving a car. The commuting pattern also has an impact on commuting distance: when the commuting pattern is non-centralized (i.e., decentralized, self-contained or exchange commuting pattern), commuters travel shorter distances between non-central areas and workers who travel to CBD and its surrounding area tend to have longer commutes.

Moreover, commuting distance increases for people who drive when they live in a large AGEB. If workers live in a house-rich area (lower number of jobs to residents), the commuting distances tend to be short. It is not consistent with the employment density effect on commuting distance: if a worker lives in a higher employment density area, he/she commute less due to the high job availability in that area. The literature suggests that higher income levels are associated with longer commuting distance. However, this positive relationship was not found in Ciudad Obregon. Instead, we found that commuting distance decreased with an increase in the regional income (i.e., year of schooling as a proxy).

Our random part shows a significant random-intercept (see the bottom of Table 4), which indicates that the commuting distance varies across AGEBs. The random part of our intercept as well as the random part of the slopes has two components: the inter-AGEB's variance (diagonal elements in variance-covariance matrix) and the covariance between variables and intercept. The covariance term tells us whether there is a positive or negative relationship or interaction between the random-slope and the random-

intercept in the model. Our model assumes that the effect of some characteristics such as the mode choice might differ in various groups. Actually the inter-AGEB's variances for bus, walking and biking are significant. Moreover when the intercept goes up, the slope decreases for bus and walking and increases for biking. The random part of the slope for bus increases with an increase in the slope for walking or a decrease in the slope for biking. We also found random-effects on workers in manufacturing as well as in university education (undergraduate level and higher) even when the fixed-effect for the latter one was not significant. None of the slopes of the two variables shows a significant interaction with the slopes of mode choice variables, except for biking and for the random part of the intercept.

6. Final remarks

This paper aims to offer a theoretical revision and an empirical application to commuting studies, based on the most comprehensive information available for examining the commuting in Ciudad Obregon, Mexico. Given that the data have a hierarchical structure, we chose the multilevel approach in order to capture the correlation within and across different levels of variables. Our results suggest that, in general, the effects of demographic and socioeconomic variables are consistent with the literature. When random-effects were introduced, the geographical variation characterized by AGEBs provided a better explanation in the overall commute variation, and therefore the commuting patterns in Ciudad Obregon.

With our reference group, the highest effect on commuting distance is produced by the mode choice of walking (-), other commuting type such as safe-contained and exchange commuting (-), workers in agriculture (+), biking mode choice (-), workers who gain some type of profits (-), occupation (moderately skilled jobs +), followed by public offices (+), employers (-), commuters who rent a house (-), bus mode choice (+), workers in manufacturing (+), female (-), decentralized commuting trip (-), single workers (-), AGEB's size (+), JHR (-), schooling (-), house size measure through the number of rooms (-) and employment density in 2009 (-). The commuting variation at the individual level was much stronger than that introduced by the structure of the city (level 2). This is partly because commuting patterns such as centralized, decentralized, self-contained and exchange commuting were captured at individual worker level, while in other studies (see Schwanen *et al.,* 2004) they were reported at a higher level of aggregation (e.g., the urban area).

Our findings enrich the empirical evidence in the field, and more importantly, the introduction of new variables related to workplace attributes contributes to the literature in providing additional explanation for commuting distances, at least for a medium-size city in developing countries. For example, the business nature (private business vs. public offices) was found to have a great effect on the length of commuting distance. Moreover, it is interesting to note that our findings indicate that age (younger and older commuters), education (with the exception of elementary education) and categories of occupation, such as highly skilled, are not statistically significant for explaining commuting behavior in the city, while these are often important factors that have been identified in the

commuting literature. The income proxy variables (i.e., house size and years of schooling) show an opposite effect on commuting comparing with what existing studies suggest. While it is possible that we have not been able to select the appropriate variable as a proxy of income, the high spatial segregation in the city with low income households located in remote areas where land prices are low makes our result non-surprising.

Although workers show economic rationality in many of their individual decisions, their overall commuting behavior depends also on the interaction of housing market and labor market, as well as the policymakers' decision on public transportation and land use development. The non-significant effects of age, education and occupation on commuting distance can be the consequence of the labor market conditions in Mexico. In a context of higher levels of unemployment and excess of workers, for Obregon's residents finding a job is most important no matter how far they need to commute even for highly educated workers. Based on our findings, quite different policy incentives may be needed in the city for workers of different education levels and for different economic sectors.

Knowledge about the patterns of commuting is essential to urban planning and transportation planning. The research helps uncover the complexity of daily commuting to work in Ciudad Obregon, Mexico and provides insights into transportation planning in the context of employment decentralization. However, the complexity of commuting requires continuing investigation in the area. One potential future direction is to investigate the effects of a set of interaction terms associated with demographic (e.g., gender and age) and socioeconomic factors, as well as apply our methodology and

expand the empirical evidence in more developing cities including, for instance, the city of *Heroica* Nogales, Mexico, where the Colson also collected commuting data. This new study could be helpful to elucidate the peculiarities of each urban center, regarding the characteristics of its intra-urban structure.

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Figure 1. Location of Obregon, Mexico and its urban division

Division by agebs in Obregon
☆ Civic CBD
▲ Destination points
• Origin points
▨ Sampling of agebs
▨ Residential areas
■ Central Business Distict (CBD)
▨ Industrial area
□ Towns

1:85,000

Source: Elaborated by Liz Ileana Rodríguez-Gámez, based on INEGI's cartography for 2005.
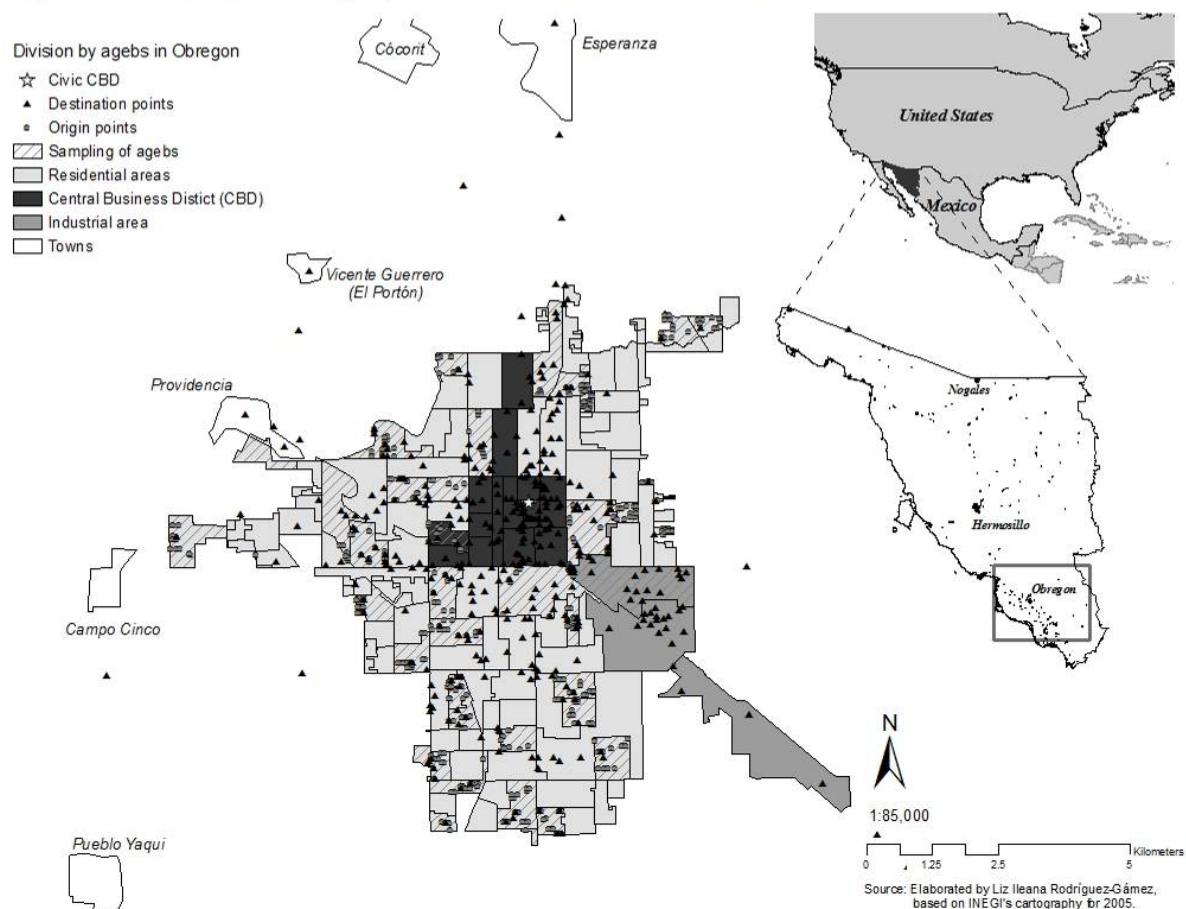
Figure 2. Estimated residuals for 39 AGEBs in the intercept only model

Note: The bars indicate the 95% confidence interval for the estimates.
Source: Calculations was performance d in MLwiN ©.
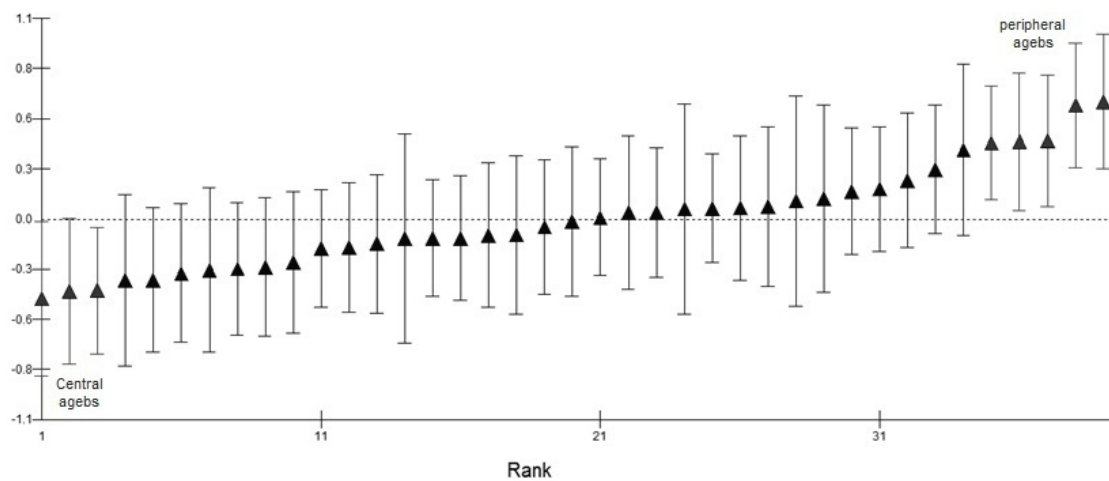
Table 1. Physical, social and economic characteristics in Obregon				
Variable	2000	2005	2010	Annual Growth [1]
Urban sprawl and Demography [1]				
Areas (number of agebs)	103	154	193	6.5%
City size (hectares)	4,556.8	5,290.9	5,610.1	2.1%
Population	250,042	270,992	296,336	1.7%
Population Density (inhabitants per hectare)	55	51	53	-0.4%
Households	60,533	69,292	82,509	3.1%
Inhabitants per household	4.1	3.9	3.6	-1.4%
% of households with 1 worker	46.5%	----	44.6%	0.2%
% of households with 2 workers	41.4%	----	31.5%	-2.6%
% of households with more than 3 workers	12.2%	----	22.0%	6.2%
Characteristics of Transportation				
Households with car ownership	29,717	----	52,073	5.8%
Number of vehicles registered [2]	84,263	----	132,861	4.7%
Auto (including motorcycle)	52.3%	----	60.0%	6.1%
Trucks, vans	46.8%	----	39.1%	2.8%
Bus	0.9%	----	0.9%	5.8%
Economic Characteristics [3]				
Total Employment	57,710	59,953	74,947	2.6%
Forestry, fishing, hunting, & agriculture support	393	2,799	100	-12.8%
Mining & oil extraction	11	103	312	39.7%
Water & electricity production	322	429	0	-----
Manufacturing [4]	14,662	15,656	20,625	3.5%
Retail & wholesale	17,605	21,170	24,439	3.3%
Services [5]	24,717	19,796	29,471	1.8%
Total employment density (jobs per hectare)	13	11	13	0.5%

[1] Urban sprawl, demographic data and characteristics of transportation are based on population census data from 2000, 2005 and 2010.

[2] The data refers to number of vehicles registered in the municipality of Cajeme.

[3] The data comes from Economic Census, 1999, 2004 and 2009. The information is disaggregated by sector (two digits) according with North America Industrial Classification System (NAICS).

[4] As consequence of confidentiality agreement the data exclude employment in construction.

[5] Include professional services, but exclude services related with construction, transportation & warehousing, finance, insurance & real estate, as well as government services.

Source: Elaborated based on INEGI.

Table 2. Locational Quotient of employment in Obregon by econocmic sector [1]											
	Civic CBD			CBD			Subcenter			Other areas		
	1999	2004	2009	1999	2004	2009	1999	2004	2009	1999	2004	2009
Agriculture, farming, hunting & fishing	----	0.60	----	1.49	0.47	2.31	----	----	1.33	1.29	1.84	0.12
Mining & oil extraction	----	----	----	----	----	0.28	5.04	3.68	3.72	----	0.38	0.00
Water & electricity production	16.27	----	----	----	4.10	----	----	----	----	----	----	----
Manufacturing [2]	0.29	0.21	0.19	0.48	0.36	0.28	3.08	2.93	2.74	0.51	0.52	0.50
Retail & wholesale	1.67	1.34	1.56	1.20	1.14	0.89	0.30	0.38	0.50	1.10	1.17	1.32
Services [3]	0.76	1.35	1.11	1.17	1.37	1.60	0.29	0.29	0.16	1.23	1.10	1.10
Diversification index [4]	1.73	2.14	2.20	3.62	2.59	2.09	0.94	0.98	1.02	3.84	3.76	3.51

[1] High locational quotient (above 1) indicate that a region is relatively specialized in a particular sector.

[2] As consequence of confidentiality agreement the data exclude employment in construction.

[3] Include professional services, but exclude services related with construction, transportation & warehousing, finance, insurance & real estate, as well as government services.

[4] Calculated in base on Duranton-Puga index. High index values represent a high degree of diversification in an area and inversely.

Note: Elaborated based on INEGI.

Table 3. Travelers' choice and commuting time by mode in Obregon						
	Workers (n = 880)	Commuting time [2] (minutes)				
		Average [3]	Morning (4am - 9pm)	Noon (9am - 3pm)	Afternoon (3pm - 8pm)	Night (8pm - 4am)
Car	38.40%	38.6	30.8	36.7	56.8	30.0
Carpool	6.70%	27.0	21.5	32.5	-----	-----
Motorcycle	0.70%	20.0	20.0	-----	-----	-----
Bus	31.60%	38.3	35.0	51.5	36.7	30.0
Cycling	11.60%	43.4	30.8	67.5	32.0	-----
Walking	7.80%	21.0	29.4	12.5	-----	-----
Others [1]	3.30%	30.8	32.5	30.0	30.0	-----
Average	100.0%	31.3	28.6	38.4	38.9	30.0

[1] Refers to company´s shuttle service to their workers.

[2] The distribution of the variable commuting time suggests analyze it in four departure schedules.

[3] Data based on 292 commuters.

Source: Based on E&QL (Colson, 2009).

Table 4. Multilevel regression model for the likelihood of commuting distance

Reference gategory: married workers (male) who used car as mode of transportation, those who lived in their own house with car ownership, those with basic education and low-skilled occupation, and those who worked in a small private business and received salary for working during the daytime in services sector (including retailing).

Fixed Part	Descriptive statistics	Intercept-only model	Random intercept Unstd. Coeff.	Std. Coeff.	Random intercept & slope Unstd. Coeff.	Std. Coeff.
Intercept	-----	7.862 ***	8.134 ***	----- ***	8.281 ***	----- ***
Woman	38.0%		-0.170 ***	-0.305 ***	-0.161 ***	-0.289 ***
Younger	16.4%		0.053	0.095	0.047	0.111
Older	5.7%		-0.028	-0.050	-0.036	-0.135
Single	33.1%		-0.116 *	-0.208 *	-0.122 *	-0.226 *
Family size	4.17		0.041	0.074	0.030	0.019
No car available	43.6%		0.065	0.117	0.074	0.130
Rented house	10.5%		-0.201 *	-0.361 *	-0.187 *	-0.532 *
Home size (number of rooms)	4.17		-0.034 ***	-0.061 ***	-0.050 ***	-0.026 ***
Appliances in home (max 10)	8.23		0.006	0.011	0.009	0.003
Bus	34.1%		0.198 ***	0.356 ***	0.207 ***	0.381 ***
Walking	4.8%		-0.988 ***	-1.775 ***	-1.123 ***	-4.603 ***
Bike	11.5%		-0.347 ***	-0.623 ***	-0.399 ***	-1.092 ***
Shuttle	6.5%		-0.045	-0.081	-0.030	-0.106
Decentralized commuting	68.1%		-0.128 **	-0.230 **	-0.142 **	-0.266 **
Other commuting type	6.5%		-0.742 ***	-1.333 ***	-0.762 ***	-2.693 ***
None education	2.6%		0.307	0.551	0.257	1.411
High education (high school)	27.5%		-0.032	-0.057	-0.030	-0.059
University education	24.0%		0.051	0.092	0.050	0.102
None qualification	6.3%		0.125	0.225	0.103	0.369
Moderately skilled jobs	19.2%		0.296 ***	0.532 ***	0.279 ***	0.618 ***
Highly skilled jobs	20.4%		0.039	0.070	0.068	0.147
Employer	12.7%		-0.234 *	-0.420 *	-0.208 *	-0.545 *
Public offices	21.2%		0.217 ***	0.390 ***	0.258 ***	0.551 ***
Big workplaces	34.7%		-0.051	-0.092	-0.035	-0.064
Nightly work time	22.4%		0.011	0.020	0.016	0.042
Profits	10.9%		-0.329 ***	-0.591 ***	-0.333 ***	-0.932 ***
Workers in manufacturing	30.9%		0.112 *	0.201 *	0.158 *	0.298 *
Workers in agriculture	4.2%		0.127 *	0.228 *	0.256 *	1.117 *
Ageb's size (Log of area size in m²)	38.78		0.123 ***	0.221 ***	0.153 ***	0.151 ***
Years of schooling	9.20		-0.066 ***	-0.119 ***	-0.074 ***	-0.027 ***
JHR (15-65 years)	0.24		-0.075 *	-0.135 *	-0.101 *	-0.092 *
Population density per ha in 2005	84.55		0.000	0.000	0.001	0.000
Employment density per ha in 2009	5.66		-0.031 ***	-0.056 ***	-0.035 ***	-0.006 ***
Gain/loss workers per ha (2009-2004)	1.32		0.018	0.032	0.022	0.010

Random Part

Level-1 Commuters Var. intercept (e_{ij})		0.651***	0.532***		0.474***	
Level-2 Agebs Var. intercept (u_{ij})		0.112***	0.068*		*var-cov matrix*	
-2LL		1,259.65	1,115.704		1,080.323	
Number of parameters		3	37		57	

Random intercept and slope (variance and covariance matrix)

Intercept (u_{0ij})	*0.107***					
Bus (u_{10ij})	*-0.066**	*0.012**				
Walking (u_{11ij})	*-0.188**	*0.128**	*0.657***			
Biking (u_{12ij})	*0.167****	*-0.166****	*-0.005*	*0.028**		
Manufacturing (u_{27ij})	*-0.004*	*-0.007*	*-0.059*	*0.053*	*0.067**	
University (u_{18ij})	*- 0.060*	*0.059*	*-0.078*	*0.160**	*0.000*	*0.112**

Note: *α=0.100; **α=0.050; ***α=0.001 for Wald statistics.
Source: Based on E&QL's Survey, Colson, 2009. Calculations performanced in MLwiN, version 2.24, Center for Multilevel Modeling, University of Bristol.

APPENDIX D.- EMPLOYMENT AND QUALITY OF LIFE (SURVEY)[*]

1. Home residents (HRs)

ENCUESTA
EMPLEO Y CALIDAD DE VIDA
OCTUBRE DE 2008

EL COLEGIO DE SONORA

CONACYT

MÓDULO DE RESIDENTES

SOLO PARA PERSONAS DE 14 AÑOS Y MÁS DE EDAD

Ciudad: O 1. Cd. Obregón   O 2. Nogales

Fecha de aplicación: [ ] [ ] de 2008
Dia   Mes

Folio: [ ] [ ] [ ] [ ]

	ENTREVISTADO			SEXO	INFORMANTE*
NÚMERO DE RENGLON	NOMBRE	EDAD			NÚMERO DE RENGLON

OBSERVACIONES

Notas para el encuestador(a):

1. Semana de referencia: semana anterior a la que se aplica la encuesta
2. Sólo se podra tener un informante sustituto en caso de que la persona no pueda proporcionar la información por los siguientes motivos: por tener alguna limitación física o mental o, se encuentre fuera de la ciudad u hospitalizada durante todo el período de la encuesta.

Sección II. Residentes de la vivienda, hogares y número de miembros

NÚMERO DE PERSONAS

1. ¿Cuántas personas viven normalmente en esta vivienda contando a los niños chiquitos y a los ancianos? _____

HOGARES EN LA VIVIENDA

2. ¿Todas las personas que viven en esta vivienda comparten un mismo gasto para comer?

○ 1. Sí ⟶ Pase a 3   ○ 2. No

2a. ¿Cuántos hogares o grupos de personas tienen gasto separado para comer contando el de usted? _____   *Levante cuestionarios en cada hogar*

HUESPEDES EN EL HOGAR

3. ¿Hay personas en este hogar que paguen por dormir aquí en su vivienda?   ○ 1. Sí ⟶ 3a. ¿Cuántos? _____

○ 2. No   Pase a 4 ⟵

3b. ¿De esa o esas... personas cuántas de ellas también le pagan por comer en este hogar? _____

TRABAJADORES DOMÉSTICOS EN EL HOGAR

4. ¿En este hogar tienen trabajadores domésticos que duermen en esta vivienda?   ○ 1. Sí ⟶ 4a. ¿Cuántos son incluyendo a los familiares de estos? _____

○ 2. No   Pase a 4c

4b. ¿De esa o esas... personas cuántas de ellas comen de los alimentos que se preparan en este hogar? _____

OBSERVACIONES _____

	PARA TODAS LAS PERSONAS EN LA LISTA					
	NOMBRE	PARENTESCO	SEXO	EDAD	SALUD	
N Ú M D E R E G I S T R O	4c. ¿Cuál es el nombre de los integrantes de este hogar empezando por el jefe (a)? Al final de la lista incluya a los huéspedes, trabajadores domésticos y a sus familiares	5. ¿Qué es del jefe del hogar? (Anote la respuesta)	6. ¿Es hombre o mujer? Anota H. Hombre M. Mujer	7. ¿Cuántos años cumplidos tiene?	8. ¿Tiene derecho a servicio médico (o cobertura médica)?: 1. Seguro Social (IMSS)? 2. En el ISSSTESON 3. En el ISSSTE? 4. En otra institución pública (PEMEX, ejercito, Marina, etc.)? 5. En instituciones privadas pagadas por la empresa en donde trabaja? 6. Con Seguro popular? 7. Con seguro privado (pagado por un miembro del hogar)? 8. No tiene derecho a servicio y acude al centro de salud? Pase a pregunta 10	9. ¿Por quién tiene derecho a ese servicio médico? 1. Por él/ella mismo(a) 2. Por su cónyuge/esposo(a) 3. Por su madre/padre 4. Por su hermano/hermana 5. Por su hijo 6. Por su hija 7. Por otro pariente 8. Otro, especifique
01	_____	▼	▼	_____	▼	▼
02	_____	▼	▼	_____	▼	▼
03	_____	▼	▼	_____	▼	▼
04	_____	▼	▼	_____	▼	▼
05	_____	▼	▼	_____	▼	▼
06	_____	▼	▼	_____	▼	▼
07	_____	▼	▼	_____	▼	▼
08	_____	▼	▼	_____	▼	▼
09	_____	▼	▼	_____	▼	▼
10	_____	▼	▼	_____	▼	▼

PARA RESIDENTES DE 5 O MÁS AÑOS

	ALFABETISMO	GRADO Y NIVEL DE ESC		ESTUDIOS SUPERIORES		ASIST	TPO DE ESCUELA	NOMBRE DE LA ESCUELA	BECA
NÚM DE REGISTRO	10. ¿Sabe leer y escribir un recado? 1. Sí 2.No	11. ¿Hasta que año aprobó (pasó) (nombre) en la escuela? NIVEL: 0. Menor de 5 años 1. Ninguno 2. Preescolar o kinder 3. Primaria 4. Secundaria 5. Preparatoria 6. Normal 7. Carrera Técnica 8. Profesional 9. Maestría o Doctorado		12. ¿En qué es (o fue) su último estudio superior y en qué universidad? NOTA: Únicamente para los que cursaron o se encuentran cursando estudios superiores		13. ¿Actualmente va (nombre) a la escuela? 0 Menor de 5 años 1 Sí 2 No ↓ Pase a pregunta 17	14. ¿La escuela a la que asiste es? 1. Pública 2. Privada 3. Otro tipo	15. ¿Cuál es el nombre de la escuela?	16. ¿Le otorgaron beca para este año escolar?, ¿quién se la otorga? 1 ¿Programa Oportunidades? 2. ¿Su escuela pública? 3. ¿Su escuela privada? 4. ¿Organismo de gobierno? 5. ¿Institución privada? 6. ¿Crédito educativo? 7. ¿No le otorgaron beca?
		Grado/ año	Nivel	Carrera	Universidad				
01	___	___	▼	___	___	___	▼	___	▼
02	___	___	▼	___	___	___	▼	___	▼
03	___	___	▼	___	___	___	▼	___	▼
04	___	___	▼	___	___	___	▼	___	▼
05	___	___	▼	___	___	___	▼	___	▼
06	___	___	▼	___	___	___	▼	___	▼
07	___	___	▼	___	___	___	▼	___	▼
08	___	___	▼	___	___	___	▼	___	▼
09	___	___	▼	___	___	___	▼	___	▼
10	___	___	▼	___	___	___	▼	___	▼

PARA RESIDENTES DE 12 AÑOS O MÁS / SOLO PARA MUJERES

	LUGAR DE NACIMIENTO		TIEMPO DE RESIDENCIA		SITUACIÓN CONYUGAL	HIJOS VIVOS	HIJOS FALLECIDOS	HIJOS SOBREVIVIENTES
NÚM DE REGISTRO	17. ¿Cuál es su lugar de nacimiento?		18. ¿Cuánto tiempo tiene viviendo en esta ciudad? (Anote 00 cuando tenga menos de 30 días residiendo en la ciudad)		19. Actualmente.. 0. Menor de 12 años 1. Vive con su pareja en unión libre? 2. Está separado(a)? 3. Está divorciado(a)? 4. Está viudo(a)? 5. Está casado(a)? 6. Está soltero(a)?	20. ¿En total cuántos hijos(as) que nacieron vivos ha tenido? (Ninguno, escriba "00" y pase a pase a siguiente módulo)	21. ¿De sus hijos(as) que nacieron vivos cuántos han fallecido? (Ninguno, entonces escriba "00"	22. ¿Cuántos de sus hijos(as) viven actualmente, aunque no residan en esta vivienda? (Ninguno, entonces escriba "00"
	Municipio	Estado	Meses	Años				
01	▼	▼	▼	___	▼	___	___	___
02	▼	▼	▼	___	▼	___	___	___
03	▼	▼	▼	___	▼	___	___	___
04	▼	▼	▼	___	▼	___	___	___
05	▼	▼	▼	___	▼	___	___	___
06	▼	▼	▼	___	▼	___	___	___
07	▼	▼	▼	___	▼	___	___	___
08	▼	▼	▼	___	▼	___	___	___
09	▼	▼	▼	___	▼	___	___	___
10	▼	▼	▼	___	▼	___	___	___

2. Home and household (H&H)

EL COLEGIO DE SONORA

**ENCUESTA
EMPLEO Y CALIDAD DE VIDA
OCTUBRE DE 2008**

CONACYT

MÓDULO DE VIVIENDA Y HOGAR

SOLO PARA PERSONAS DE 14 AÑOS Y MÁS DE EDAD

Fecha de aplicación: ☐☐ de 2008
Día   Mes

Folio: ☐☐☐☐

Identificación geográfica de la vivienda

Localidad	▼
AGEB	☐☐ - ☐
Colonia	_____
Manzana	☐☐
Número de viviendas en la manzana	☐☐
Número de viviendas deshabitadas en la manzana	☐☐
Número de viviendas habitadas en la manzana	☐☐
Vivienda seleccionada	☐☐

Buenos días, estamos realizando una encuesta en algunas colonias de la ciudad, para conocer las características socioeconómicas de sus habitantes y para identificar los servicios públicos que tienen y necesitan, así como su opinión sobre cuestiones que tienen que ver con la calidad de vida.

Su vivienda fue seleccionada en esta encuesta y sus respuestas son muy importantes. La información que nos proporcione servirá para elaborar estadísticas y se mantendrá el carácter confidencial; es decir, en ningún momento se publicaran los nombres de las personas entrevistadas o la dirección de esta casa. De antemano le agradezco su colaboración.

Clase de vivienda

ANOTE UN SÓLO CÓDIGO

○ 1 Casa independiente

○ 2 Departamento en edificio

○ 3 Vivienda en cuarto o en vecindad

○ 4 Vivienda en cuarto o en azotea

○ 5 Vivienda en Fraccionamiento cerrado

○ 6 Multifamiliar

○ 7 Local no construido para habitación

○ 8 Vivienda móvil

○ 9 Casa de cartón, etc

○ 10 Refugio

Tipo de colonia

○ 1 Colonia o barrio

○ 2 Fraccionamiento de interés social

○ 3 Fraccionamiento residencial

○ 4 Fraccionamiento residencial cerrado

○ 5 Asentamiento irregular

○ 6 Otro

ESTADO DE CLAVES PARA REGISTRAR EL RESULTADO DE LA ENTREVISTA

"00" Entrevista lograda

Entrevista no lograda

TIPO A (vivienda no habitada)

1. Nadie en el momento de las visitas
2. Ausente temporalmente
3. Se negó a dar información
4. Informante inadecuado
5. Otro motivo (especifica en observaciones)
6. Entrevista suspendida

Resultado de la visita

Visita 1

Día [▼] Mes [▼] Año [▼]

Resultado de la visita _____

Visita 2

Día [▼] Mes [▼] Año [▼]

Resultado de la visita _____

Visita 3

Día [▼] Mes [▼] Año [▼]

Resultado de la visita _____

NOMBRE DE LOS RESPONSABLES

ENTREVISTADOR

[▼]

RESPONSABLE DE ÁREA

[▼]

Sexo [▼]

Edad [▼]

OBSERVACIONES:

_____

Sección I. Características de la vivienda

PAREDES O MUROS

1. ¿De qué material es la mayor parte de las paredes o muros de esta vivienda?
(Escuche la respuesta y cruce un código)

O 1. Material de desecho

O 2. Lámina de cartón

O 3. Lámina metálica o de asbesto

O 4. Carrizo, bambú o palma

O 5. Embarro o bajareque

O 6. Madera o tejamanil

O 7. Adobe

O 8. Multipanel o panel

O 9. Tabique, ladrillo, tabicón, block

O 10. Piedra o cantera

O 11. Concreto

O 12. Otro material.   Especifique

TECHOS

2. ¿De que material es la mayor parte del techo de esta vivienda?
(Escuche la respuesta y cruce un código)

O 1. Material de deshecho

O 2. Lámina de cartón

O 3. Lámina metálica o de asbesto

O 4. Carrizo, bambú o palma

O 5. Madera o tejamanil

O 6. Terrado con viguería

O 7. Teja

O 8. Losa de concreto sólida o con tabique, tabicón o unice

O 9. Vigueta de acero con tabique, tabicón, unicel, cuña o bovedilla

O 10. Otro material.   Especifique

2a. ¿El techo de esta vivienda se gotea?

O 1. Si   O 2. No

PISOS

3. ¿De qué material es la mayor parte del piso de esta vivienda?
(Escuche la respuesta y cruce un código)

O 1. Tierra

O 2. Cemento o firme

O 3. Loseta vinílica, linóleum o congóleum

O 4. Mosaico o loseta de cemento

O 5. Vitropiso, mármol o terrazo

O 6. Madera, duela o parquet

O 7. Alfombra

O 8. Otro material. Especifique

NÚMERO DE CUARTOS

4. ¿Cuántos cuartos se usan para dormir? _____

4a. ¿Cuántos cuartos tienen en total esta vivienda contando la cocina (no cuente pasillos ni baños)?
_____

COCINA

5. ¿Esta vivienda tiene un cuarto para cocinar?

O 1. Sí   O 2. No
                    ↓
                Pase a 6

5a. ¿En el cuarto donde cocinan también duermen?

O 1. Sí   O 2. No

COMBUSTIBLE

6. ¿Qué combustibles usan para cocinar o calentar sus alimentos?
Marque los que mencione

1. ¿Gas?

2. ¿Leña?

3. ¿Carbón?

4. ¿Petróleo?

5. ¿Electricidad?

6. No utiliza combustible

7. Otro combustible. Especifique

6A. ¿Cuál utilizan con mayor frecuencia?

O 1. ¿Gas?

O 2. ¿Leña?

O 3. ¿Carbón?

O 4. ¿Petróleo?

O 6. ¿Electricidad?

O 7. Otro combustible

DRENAJE

7. ¿Esta vivienda tiene drenaje o desagüe conectado a...
(Lea y anote un solo código)

○ 1. la red pública?

○ 2. una fosa séptica?

○ 3. una tubería que va a dar a una barranca o grieta?

○ 4. una tubería que va a dar a un río, lago o mar?

○ 5. No tiene drenaje

NÚMERO DE BAÑOS

8. ¿Cuántos cuartos de baños tiene esta vivienda?

_____

SANITARIO

9. ¿Esta vivienda tiene:

(Lea las opciones hasta obtener una respuesta afirmativa y anote un solo código)

○ 1. excusado o sanitario?

○ 2. Retrete o fosa?

○ 3. letrina?

○ 4. hoyo negro o pozo ciego?

○ 5. ningún servicio sanitario?

USO DE SANITARIO

9a. ¿Este servicio lo usan solamente las personas de esta vivienda?

○ Sí   ○ No

CONEXIÓN DE AGUA

9b. Este servicio sanitario:

(Lea las opciones hasta obtener una respuesta afirmativa y anote un solo código)

○ 1. tiene conexión de agua

○ 2. le echan agua con cubeta

○ 3. no se le puede echar agua

ELECTRICIDAD

10. ¿Hay luz eléctrica en esta vivienda?

○ 1. Sí   ○ 2. No

Pase a 12

10 a. ¿De dónde obtienen la luz eléctrica ...
(Lea y anote un solo código)

○ 1. del servicio público?

○ 2. de una planta particular?

○ 3. de otra fuente?   Especifique:

_____

Nota para encuestador: Favor de verificar

NÚMERO DE FOCOS

11. ¿Cuántos focos tiene esta vivienda?   _____

ELIMINACIÓN DE LA BASURA

12. ¿Habitualmente qué hacen con la basura....
(Marque las que mencione)

1. la tiran al río, lago o mar?

2. la tiran en la barranca o grieta?

3. la tiran en un terreno baldío o calle?   *Pase a 14*

4. la tiran en el basurero público?

5. la entierran?

6. la queman?

7. la tiran en un contenedor?

8. la recoge un camión o carrito de basura

RECOLECCIÓN DE BASURA

13. ¿Cada cuándo recogen la basura?
(Escuche la respuesta y cruce un código)

○ 1. Un dia a la semana

○ 2. Dos días a la semana

○ 3. Tres días a la semana

○ 4. Cuatro días a la semana

○ 5. Cinco días a la semana

○ 6. Seis días a la semana

○ 7. Diario

○ 8. No sabe

○ 9. Otro periodo.   Especifique

_____

RECICLAJE DE DESECHOS

14. ¿Separan o reciclan los desechos?

○ 1. Sí   ○ 2. No ——▶ *Pase a 15*

14a. ¿Qué hacen con los desechos reciclados?

○ 1. Los reutilizan

○ 2. Los venden

○ 3. Los entregan al servicio de recolección?

DISPONIBILIDAD DE AGUA

15. ¿En esta vivienda tienen:

(Lea las opciones y anote un sólo código)

○ 1. agua entubada dentro de la vivienda

○ 2. agua entubada fuera de la vivienda pero dentro del terreno

○ 3. agua entubada de llave pública (o hidrante)?

○ 4. agua entubada que acarrean de otra vivienda?

○ 5. agua de pipa

○ 6. agua de un pozo, río, lago, arroyo?

Pase a 17

DOTACIÓN DE AGUA: FRECUENCIA

16. ¿Cuántos días a la semana les llega el agua? (Lea y cruce un código)

○ 1. Diario

○ 2. Cada tercer día

○ 3. Dos veces por semana

○ 4. Una vez por semana

○ 5. De vez en cuando

16a. ¿El agua les llega:

○ 1. todo el día?

○ 2. una parte del día?

16b. ¿Beben y usan para cocinar el agua entubada?

○ 1. Sí

○ 2. No

OTRAS PROBLEMÁTICAS DE LA VIVIENDA

17. ¿Tiene su vivienda alguno de los problemas e inconvenientes siguientes?

(Escuche y marque las que mencione)

1. Falta de espacio
2. Ruidos producidos por los vecinos
3. Luz natural insuficiente en alguna o todas las habitaciones
4. Goteras
5. Humedades o salitre
6. Cuarteaduras

PROPIEDAD DE LA VIVIENDA

18. ¿Esta vivienda es propiedad de alguna persona que vive aquí?

○ 1. Sí   ○ 2. No

PREGUNTE   PREGUNTE

LEA LAS OPCIONES HASTA OBTENER UNA RESPUESTA AFIRMATIVA Y CIRCULE UN SOLO CÓDIGO

○ 1. ¿Está pagándose?
○ 2. ¿Está totalmente pagada?
○ 3. ¿Está hipotecada?
○ 4. ¿Está en juicio?
○ 5. Tenencia irregular

○ 6. ¿Está rentada?
○ 7. ¿Esta prestada, la cuidan o en otra situación?

ANTIGÜEDAD DE LA VIVIENDA

19. ¿Esta vivienda fue construida hace .... (Lea y cruce un código)

○ 1. menos de un año?
○ 2. de 1 a 5 años?
○ 3. de 6 a 10 años?
○ 4. de 11 a 20 años?
○ 5. de 21 a 30 años?
○ 6. de 31 a 50 años?
○ 7. más de 50 años?
○ 8. No sabe

EQUIPAMIENTO

20. ¿Esta vivienda tiene...
(Marque las que mencione)

1. lavadero?
2. fregadero o tarja?
3. lavabo?
4. regadera?
5. tinaco en la azotea?
6. cisterna o aljibe?
7. pileta, tanque o depósito de agua?
8. calentador o boiler de gas?
9. calentador o boiler de otro combustible?
10. bomba de agua?
11. tanque de gas estacionario?
12. sistema de aire acondicionado?
13. sistema de calefacción?

BIENES DE LA VIVIENDA

21. ¿Cuáles de los siguientes bienes tienen en esta vivienda:
(Marque únicamente las afirmativas)

1. radio o grabadora?
2. estereo, minicomponente, etc.?
3. televisión?
4. DVD?
5. videocasetera?
6. videojuegos?
7. licuadora?
8. exprimidor de jugos?
9. refrigerador?
10. plancha eléctrica?
11. lavadora?
12. aspiradora?
13. microondas?
14. automóvil o camioneta propios?

22. ¿Tienen computadora?

O 1 Sí   O 2 No ⟶ *Pase a 23*

22a. ¿Esa computadora tiene acceso a internet?

O 1 Sí   O 2 No

23. ¿Este hogar cuenta con...
(Marque unicamente las afirmativas)

1. línea telefónica fija?
2. teléfono móvil o celular?
3. televisión por cable, SKY o Multivisión?

SERVICIOS FINANCIEROS

24. ¿Alguno de los miembros de este hogar cuenta con algún tipo de cuenta bancaria (ahorro, nómina, tarjeta de crédito, chequera, cuenta maestra, etc.)?

O 1. Sí   O 2. No

25. ¿Usted o alguno de los miembros de su hogar tienen algún seguro de vida?

O 1. Sí   O 2. No

26. En los últimos cinco años (de 2003 a la fecha), ¿algún miembro del hogar ha solicitado un crédito o método de financiamiento (hipotecario, compras a plazos, compra de autos, etc.)?

O 1. Sí   O 2. No

27. ¿Usted o alguno de los miembros de su hogar tienen algún seguro de gastos médicos?

O 1. Sí   O 2. No

28. ¿En su hogar tienen aseguradas algunas de sus posesiones (auto, vivienda, enseres, etc.)?

O 1. Sí   O 2. No

RELACIÓN CON FAMILIARES EN ESTADOS UNIDOS

29. ¿Usted o algún miembro de este hogar tiene parientes que vivan o trabajen en Estados Unidos

O 1 Sí   O 2 No ➤ *Pase a 30*

29a. ¿Aproximadamente cuántos? _____

29b. ¿En cuántos estados viven? _____

29c. ¿En cuáles estados?

_____

29d. ¿Les envían cosas desde Estados Unidos (muebles, ropa, aparatos electrónicos, etc.)?

O 1 Sí   O 2 No

29e. ¿Les envían dinero desde Estados Unidos?

O 1 Sí   O 2 No ➤ *Pase a 30*

29f. ¿Qué parentesco con el jefe del hogar tiene(n) el(los) pariente(s) que les envían dinero?

O 1. Es el jefe(a)
O 2. Esposo(a)
O 3. Hijo(a)
O 4. Hermano(a)
O 5. Otro pariente
O 6. Amigo(a)
O 7. Otro no pariente

GASTO EN SERVICIOS

30. ¿Cuánto pagó el hogar por concepto de... Si no cuenta con el servicio anote "00" *Tomar como referencia los últimos tres meses y anotar el promedio mensual*	31. ¿Qué tan frecuentemente se retrasa en los pagos de los servicios señalados? 01 Nunca ➤ *Pase a 33* 02 Casi nunca 03 De vez en cuando 04 Muy seguido 05 Seguido	32. ¿Cuál es el motivo del retraso en el pago de los siguientes servicios públicos? 01 Falta de dinero 02 Falta de tiempo 03 Olvido 04 Otra	33. ¿Con qué frecuencia ha dejado de comprar su despensa habitual de alimentos por hacer frente a los pagos de los siguientes servicios? (Mencione de 1-12) 01 Nunca 02 Casi nunca 03 De vez en cuando 04 Muy seguido 05 Seguido
1) ¿agua? (mensualmente) _____	▼	▼	▼
2) ¿energía eléctrica? (mensualmente) _____	▼	▼	▼
3) ¿recolección de basura? (mensualmente) _____	▼	▼	▼
4) ¿cuotas de vigilancia? (mensualmente) _____	▼	▼	▼
5) ¿teléfono fijo en casa? (mensualmente) _____	▼	▼	▼
6) ¿televisión por cable, satelital u otro servicio relacionado? (mensualmente)	▼	▼	▼
7) ¿transporte público? (mensualmente) _____	▼	▼	▼
8) ¿pago por la vivienda en renta, abono o hipoteca? (mensualmente) _____	▼	▼	▼
9) ¿gasto en mantenimiento para su vivienda? Por ejemplo: trabajos de plomería, albañilería, electricidad, pintura, etc. (mensualmente) _____	▼	▼	▼
10) ¿conexiones a servicios públicos? Por ejemplo: contratos de agua, drenaje o luz (anualmente)	▼	▼	▼
11) ¿impuesto predial? (anualmente) _____	▼	▼	▼
12) ¿contribución para obras de servicios público local? (anualmente) Por ejemplo, para pavimentación de calles, banquetas, ampliación de la red de agua potable y/o drenaje, etc. _____	▼	▼	▼

GASTO EN SERVICIOS

	34. ¿Quién aporta en el hogar el mayor porcentaje de dinero para el pago de los servicios públicos (Considere el parentesco con el Jefe del Hogar) 01 Es el jefe(a) 02 Esposo(a) 03 Hijo(a) 04 Hermano(a) 05 Otro pariente 06 Amigo(a) 07 Otro no pariente	35. ¿Quién es el responsable de hacer el pago de los servicios públicos en la oficina correspondiente? (Considere el parentesco con el Jefe del Hogar) 01 Es el jefe(a) 02 Esposo(a) 03 Hijo(a) 04 Hermano(a) 05 Otro pariente 06 Amigo(a) 07 Otro no pariente
1) ¿agua? (mensualmente)	▼	▼
2) ¿energía eléctrica? (mensualmente)	▼	▼
3) ¿recolección de basura? (mensualmente)	▼	▼
4) ¿cuotas de vigilancia? (mensualmente)	▼	▼
5) ¿teléfono fijo en casa? (mensualmente)	▼	▼
6) ¿televisión por cable, satelital u otro servicio relacionado? (mensualmente)	▼	▼
7) ¿transporte público? (mensualmente)	▼	▼
8) ¿pago por la vivienda en renta, abono o hipoteca? (mensualmente)	▼	▼
9) gasto en mantenimiento para su vivienda? Por ejemplo: trabajos de plomería, albañilería, electricidad, pintura, etc.	▼	▼
10) ¿conexiones a servicios públicos? Por ejemplo: contratos de agua, drenaje o luz (anualmente)	▼	▼
11) ¿impuesto predial? (anualmente)	▼	▼
12) ¿contribución para obras de servicios público local? (anualmente) Por ejemplo: pavimentación de calles, banquetas, ampliación de la red de agua potable y/o drenaje, etc.	▼	▼

ACCESO DEL HOGAR A ESPARCIMIENTO Y CULTURA

	36. En su colonia o cerca de ella hay... 1 Sí 2 No	37. Las instalaciones de... (mencione cada una) ¿son públicas o privadas? 01 Pública 02 Privada	38. ¿Cuánto tiempo le tomaría llegar caminando a... (nombre cada uno) más cercano? (Anote la cantidad en minutos)	39. ¿Usted acude a las instalaciones de... (mencione cada una)? 01 Sí → Pase a 41 02 No	40. ¿Por cuáles de las siguientes razones no acude? 01 Falta de tiempo 02 No me interesa 03 No tengo acceso 04 Problemas de salud 05 No hay dinero 06 Otra
1) ¿unidad deportiva o o canchas para jugar?	▾	▾	_____	_____	▾
2) ¿área de juegos infantiles?	▾	▾	_____	_____	▾
3) ¿parques y jardines?	▾	▾	_____	_____	▾
4) ¿museo, centro de exposiciones o casa de cultura?	▾	▾	_____	_____	▾
5) ¿teatro o sala de conciertos?	▾	▾	_____	_____	▾
6) ¿centro comunitario?	▾	▾	_____	_____	▾

ACCESO DEL HOGAR A ESPARCIMIENTO Y CULTURA

	41. ¿Con qué frecuencia asiste a ... (nombre cada uno)? (Anote el número de veces por periodo) Periodo 01 Semana 02 Mes		42. ¿Cuál es su opinión sobre la calidad de las instalaciones de ... (mencione cada una)? 01 Muy buena 02 Buena 03 Satisfactoria 04 Pobre 05 Muy Pobre Nota: Preguntar de las que contestaron afirmativamente en la p 36	43. ¿Cuántos integrantes del hogar menor de 18 años asisten a ... (mencione cada uno)?	44. ¿Cuántos integrantes del hogar mayores de 18 años asisten a ... (mencione cada uno)?
	Cantidad	Periodo			
1) ¿unidad deportiva o canchas para jugar?	_____	_____	▾	_____	_____
2) ¿área de juegos infantiles?	_____	_____	▾	_____	_____
3) ¿parques y jardines?	_____	_____	▾	_____	_____
4) ¿museo, centro de exposiciones o casa de cultura?	_____	_____	▾	_____	_____
5) ¿teatro o sala de conciertos?	_____	_____	▾	_____	_____
6) ¿centro comunitario?	_____	_____	▾	_____	_____

MOBILIARIO, EQUIPAMIENTO Y SERVICIOS URBANOS

45. En su calle ... 01 Sí 02 No	46. En su colonia, ¿cuántas calles cuentan con el servicio de ... (mencione cada uno) 01 Todas 02 La mayoría 03 Pocas 04 Ninguna	47. ¿Cuál es su opinión sobre la calidad del equipamiento y/o servicios de ... (mencione cada uno)? 01 Muy buena 02 Buena 03 Satisfactoria 04 Pobre 05 Muy pobre
a) ¿su calle tiene SEÑALES DE TRÁNSITO y letrero para AUTOMOVILISTAS? ____	▼	▼
b) ¿su calle tiene SEÑALES DE TRÁNSITO y letrero para PEATONES? ____	▼	▼
c) ¿su calle tiene ALUMBRADO PÚBLICO? ____	▼	▼
d) ¿su calle esta PAVIMENTADA? ____	▼	▼
e) ¿su calle tiene BANQUETAS? ____	▼	▼
f) ¿por su calle tiene o se observa que opera habitualmente el servicio de RECOLECCIÓN DE BASURA ____	▼	▼
g) ¿por su calle tiene o se observa que opera habitualmente el servicio de LIMPIA CALLES? ____	▼	▼

48. En su colonia... se comparten los gastos para: 01 Sí 02 No	
a) Vigilancia	_____
b) Limpieza de calles	_____
c) Mantenimiento de jardines	_____
d) Mantenimiento de alberca	_____
e) Otro:	_____

49. En su colonia o cerca de ella hay... (Marque únicamente las afirmativas)	50. ¿Cuánto tiempo le tomaría llegar caminando a ... (nombre cada uno más cercano) (Anote la cantidad en minutos)	51. ¿Cuál es su opinión sobre la calidad de las instalaciones y/o servicio (mencione cada una)? 01 Muy buena 02 Buena 03 Satisfactoria 04 Pobre 05 Muy pobre
a) ¿un mercado o supermercado?	_____	[▼]
b) ¿un centro de salud u hospital?	_____	[▼]
c) ¿una estación de policia?	_____	[▼]
d) ¿una estación de bomberos?	_____	[▼]
e) ¿una biblioteca?	_____	[▼]
f) ¿una escuela preescolar (kinder)?	_____	[▼]
g) ¿una escuela primaria?	_____	[▼]
h) ¿una escuela secundaría?	_____	[▼]
i) ¿una escuela preparatoria?	_____	[▼]

En caso afirmativo pregunte

52. ¿En su colonia?			52a. ¿En su calle?	
1. Existe graffiti en las paredes?	O 01 Si	O 02 No	O 01 Si	O 02 No
2. Hay signos de vandalismo?	O 01 Si	O 02 No	O 01 Si	O 02 No
3. Se observa presencia de basura?	O 01 Si	O 02 No	O 01 Si	O 02 No
4. Hay rutas peatonales o lugares que se consideren peligrosos?	O 01 Si	O 02 No	O 01 Si	O 02 No

TRANSPORTE

53. ¿Hay servicio de transporte público en esta colonia?

○ 1 Sí   ○ 2 No   ⟶   Pase a 54

53a. ¿En esta colonia existen paraderos o lugares marcados y equipados para que los pasajeros suban y bajen del transporte público?

○ 1 Sí   ○ 2 No

53b. Las veces que ha utilizado el transporte público ¿qué tan bueno le ha parecido?
(Lea las respuestas y anote un sólo código)

○ 1 Muy bueno   ○ 2 Bueno   ○ 3 Satisfactorio   ○ 4 Pobre   ○ 5 Muy pobre

PROBLEMAS DE LA COLONIA

54. En esta colonia, ¿cuál diría que es la frecuencia con la que se presentan las siguientes problemáticas?	01 Muy frecuente	02 Frecuente	03 Poco frecuente	04 No se presenta
1. La cantidad de tráfico?	❏	❏	❏	❏
2. La pobreza?	❏	❏	❏	❏
3. El estacionamiento en doble fila en la vía pública?	❏	❏	❏	❏
4. La inseguridad?	❏	❏	❏	❏
5. Los vendedores ambulantes que se apropian de las calles?	❏	❏	❏	❏
6. Corrupción?	❏	❏	❏	❏
7. La falta de alumbrado público?	❏	❏	❏	❏
8. Excremento de animales en las banquetas y calles?	❏	❏	❏	❏
9. La falta de civilidad de los conductores de autobuses?	❏	❏	❏	❏
10. La falta de civilidad de los conductores particulares?	❏	❏	❏	❏
11. La falta de civilidad de los taxistas?	❏	❏	❏	❏
12. El ruido que ocasiona el transporte?	❏	❏	❏	❏
13. La contaminanción que ocasiona los autobuses urbanos?	❏	❏	❏	❏
14. La falta de luz en las calles?	❏	❏	❏	❏
15. La falta de pavimentación en calles y avenidas?	❏	❏	❏	❏
16. El cruce de peatones en zonas prohibidas?	❏	❏	❏	❏
17. La basura en las calles	❏	❏	❏	❏
18. Los indigentes que viven en las calles	❏	❏	❏	❏
19. La falta de cumplimiento de las instrucciones de tránsito por parte de los conductores?	❏	❏	❏	❏

APROPIACIÓN DE LA COLONIA

55 ¿Qué tanto acostumbra a caminar por su colonia?
(Lea las opciones y anote un sólo código)

○ 1 Siempre   ○ 2 Muchas veces   ○ 3 Algunas veces   ○ 4 Pocas veces   ○ 5 Nunca

56. De las siguientes situaciones, ¿cuál cree que es el principal problema que tiene la colonia para la gente que camina por sus calles?

(Lea las opciones y anote un sólo código)

○ 1 Las banquetas no estan en buenas condiciones   ○ 2 Las banquetas estan obstruidas   ○ 3 No hay banquetas   ○ 4 Hay demasiada inseguridad   ○ 5 Otros problemas

3. Employment (E&QL)

EL COLEGIO DE SONORA

ENCUESTA
EMPLEO Y CALIDAD DE VIDA
OCTUBRE DE 2008

CONACYT

MÓDULO DE EMPLEO

SOLO PARA PERSONAS DE 14 AÑOS Y MÁS DE EDAD

Ciudad: ○ 1. Cd. Obregón   ○ 2. Nogales

Fecha de aplicación: [Día | Mes] de 2008

Folio: [| | |]

ENTREVISTADO			SEXO	INFORMANTE*
NÚMERO DE RENGLON	NOMBRE	EDAD		NÚMERO DE RENGLON

O B S E R V A C I O N E S

Notas para el encuestador(a):

1. Semana de referencia: semana anterior a la que se aplica la encuesta
2. Sólo se podra tener un informante sustituto en caso de que la persona no pueda proporcionar la información por los siguientes motivos: por tener alguna limitación física o mental o, se encuentre fuera de la ciudad u hospitalizada durante todo el periodo de la encuesta.

I.- CONDICIONES DE OCUPACIÓN

1. ¿La semana pasada trabajó por lo menos una hora?

○ Si ⟶ *Pasa a 3*   ○ No

1a. Independientemente de lo que me acaba de decir, ¿le dedicó la semana pasada al menos una hora a :
(Lee las opciones y marca las indicadas por el informante)

1 realizar una actividad que le proporcionó ingresos?
2 ayudar en las tierras o en el negocio de un familiar o de otra persona?

} .Pasa a 3

3 No trabajó la semana pasada

1b.- Aunque ya me dijo que no trabajó la semana pasada, ¿tiene algún empleo, negocio o realiza alguna actividad por su cuenta?

○ 1. Si   ○ 2. No ⟶ *Pasa a 2*

1c- ¿Cuál es la razón principal por la que no trabajó la semana pasada?
(Escucha y marca la opción indicada por el informante)

○ 01 Huelga o paro laboral
○ 02 Paro técnico
○ 03 Suspensión temporal de las funciones (asalariado)
○ 04 Asistencia a cursos de capacitación

} *Pasa a 3*

○ 05 Vacaciones
○ 06 Permiso, enfermedad o arreglo de asuntos personales
○ 07 Falta de vehículo o descompostura de maquinaria
○ 08 Falta de materias primas, financiamiento o clientes
○ 09 Mal tiempo o fenómeno natural
○ 10 Termino de temporada de trabajo o cultivo
○ 11 Comenzará un trabajo o negocio nuevo ⟶ *Pasa a 2*
Especifica
○ 12 Otra razón _____
○ 9 NS

1d. Durante este periodo de ausencia ¿recibió sueldo o ganancias?

○ 1 Si ⟶ *Pase a 3*
○ 2 No
○ 9 NS

1e. ¿En cuánto tiempo regresará a este mismo trabajo?
(Lee las opiniones y marca la indicada)

○ 1 ¿Ya se reincorporó o regresará a trabajar esta semana? ⟶ *Pasa a 3*
○ 2 ¿En cuatro semanas o menos?
○ 3 ¿ En más de cuatro semanas?
○ 4 ¿No hay seguridad de que regrese a trabajar o cuándo reiniciara?
○ 5 No regresará
○ 9 NS

II.- NO OCUPADOS

2 ¿Ha tratado de

    1 Buscar trabajo en otro país o hacer preparativos para cruzar la frontera?

    2 Buscar trabajo aquí en el país?

    3 Poner un negocio o realizar una actividad por su cuenta sin poder todavía comenzar?

    4 Entonces, ¿no ha tratado de buscar trabajo? ⟶ *Pasa a 2e*

2a ¿En qué fecha comenzó a buscar trabajo (o comenzó con los preparativos para poner el negocio)?

día	o	Semana	Mes	año

2b ¿En qué fecha fue la última vez que buscó trabajo?

día	o	Semana	Mes	año

(Clasifica en relación con el último día de la semana de referencia)

○ 1 Hasta 1 mes ⟶ *Pasa a 2d*   ○ 3 Más de 2 hasta 3 meses   ○ 4 Más de 3 meses ⎫
○ 2 Más de 1 hasta 2 meses   ○ 9 NS ⎬ *Pasa a 2e*
⎭

ATENCIÓN: Vérifica que el tiempo de búsqueda sea continuo. Si la búsqueda se interrumpió por dos semanas o más anota en 2a la fecha en que reinició ésta.

2c. ¿Estaba dispuesto a trabajar la semana pasada?   ○ 2 No ⎫
                                                ⎬ *Pasa a 2e*
                            ○ 1 Si   ○ 9 NS ⎭

2d. ¿A dónde acudió o qué hizo para buscar empleo (o iniciar un negocio o actividad por su cuenta)?

(Escucha, anota y marca abajo las opciones indicadas por el informante)

  01 Acudió directamente al lugar de trabajo (fábrica, tienda, taller)

  02 Hizo trámites en una agencia o bolsa de trabajo

  03 Hizo trámites en un servicio público de colocación

  04 Hizo trámites en algún programa de empleo temporal del gobierno (federal, estatal y/o municipal)

  05 Hizo trámites o realizó alguna actividad para iniciar un negocio por su cuenta

  06 Puso o contestó un anuncio en internet

  07 Puso o contestó un anuncio en algún lugar público o en medios de comunicación (periódico, radio)

  08 Acudió a un sindicato o gremio

  09 Pidió a conocidos o familiares que lo recomendaran o le avisaran de algún trabajo

  10 Sólo consultó el anuncio clasificado

  11 Otra actividad

  99 NS

Pasa a 2h

2 e. ¿Usted es

(Lee las opciones y marca la indicada por el informante)

○ 1 una persona temporalmente ausente de su actividad u oficio? ➤ *Pase a 9*

○ 2 pensionado o jubiliado de su trabajo?

○ 3 estudiante?

○ 4 una persona que se dedica a los queahaceres de su hogar?

○ 5 una persona con alguna limitación fisica o mental que le impide trabajar por el resto de su vida? → *Pase a 2h*

○ 6 Otra condición _____ *Especifica*

○ 9 NS

2 f. Actualmente ¿tiene necesidades de trabajar?

(Lee las opciones y marca la indicada por el informante)

○ 1 Sí tiene necesidades de trabajar

○ 2 Sólo tiene deseos de trabajar

○ 3 No tiene necesidad ni deseos de trabajar ↓ *Pase a 2h*

○ 9NS

2g. ¿Hay alguna otra razón además de ser (menciona la que contestaron en 2e) por la que no esté buscando trabajo?

(Escucha, anota y marca la opción indicada por el informante)

_____

1. Sí

○ 01 Está esperando la respuesta a una solicitud, lo llamará un patrón en fecha próxima o está esperando la siguiente temporada de trabajo

○ 02 No hay trabajo en su especialidad, oficio o profesión

○ 03 No cuenta con la escolaridad o experiencia necesaria para realizar un trabajo

○ 04 Considera que no hay trabajo actualmente o piensa que no se lo darían

○ 05 Tiene problemas de financiamiento para iniciar un negocio propio

○ 06 Tiene que realizar demasiados trámites para iniciar un negocio propio

○ 07 Espera recurperarse de una enfermedad o accidente

○ 08 Está embarazada

○ 09 No tiene quien le cuide a sus hijos pequeños

○ 10 No lo(a) deja un familiar

○ 11 Otras razones de mercado

○ 12 Otras razones personales

○ 13 No

○ 99 NS

2h. ¿Ha trabajado alguna vez en su vida

(Lee las opciones y marca la indicada por el informante)

○ 1 por un pago o salario?

○ 2 por su cuenta?

○ 3 ayudado en el negocio o actividad económica de alguna persona

○ 4 Nunca ha trabajado

○ 9 NS } *Pase a 9*

25

III. CONTEXTO LABORAL

3. Si tiene más de un trabajo, hablemos del principal. ¿cuáles son las tareas o funciones principales que desempeña en su trabajo?

_____

3.1. ¿Cuál es el nombre del oficio, puesto o cargo?   **3.2 Ocupación:**

_____   _____

ATENCION: Si la respuesta en la pregunta 3 se refiere a:
Quehaceres domésticos de su hogar
Pedir ayuda o dinero   } Corrige la secuencia en batería 1 y haz la pregunta 2
Vender o empeñar bienes

3a. ¿En su trabajo tiene un jefe (a) o superior?

O 1 Si ➔ _Pasa a 3h_   O 2 No

3b. ¿Se dedica a un negocio o actividad por su cuenta´

O 1 Si   O 2 No ➔ _Pasa a 3h_

3c. ¿Ofrece sus productos o servicios
(Lee las opciones y marca las indicadas por el informante)

1. a una sola empresa, negocio o intermediario?

2 a varios negocios, empresas o intermediarios?

3 directamente al públco?

4 Es autoconsumo agropecuario

9 NS

3d. ¿Tiene empleados o le ayudan personas en su negocio o actividad?

O 1 Si

O 2 No

O 9 NS   } _Pasa a 3l_

3e. ¿Tiene (Lee las opciones y marca la indicada por el informante)

O 1 un solo tipo de negocio o actividad?

O 2 varios tipos de nogocios? ➔ | De aquí en adelante hablemos del negocio principal |
(con ubicaciones y actividades diferentes)

3 f. ¿Cuántos puestos o establecimientos (o en su caso vehículos) forman este negocio o empresa?

O 1 ¿Uno solo?   O 3 No tiene puesto o establecimiento (o vehículo)

O 2 ¿Más de uno? ¿cuántos? _____   O 9 NS

3g. De las personas que ocupa o le ayudan ¿cuántas son

1. trabajadores asalariados?   _____

2. socios?   _____   } _Pasa a 3r_

3. trabajadores sin pago?   _____

4. trabajadores por honorarios, comisión o porcentaje   _____

9. NS   _____

3h. ¿En este trabajo...   (Lee las opciones y marca la indicada por el informante)

O 1 recibe un pago?   O 9 NS

O 2 es un trabajador no familiar sin pago?   } _Pasa a 3q_

O 3 es un trabajador familiar sin pago?

3i. ¿En este empleo pertenece a algún sindicato?

○ 1 Sí   ○ 2 No   ○ 9 NS

3j. ¿En su empleo cuenta con un contrato por escrito?

○ 1 Sí   ○ 2 No → *Pasa a 3l* ← ○ 9NS

3k. ¿El contrato es
(Lee las opciones y marca la indicada por el informante)

○ 1. Temporal o por obra determinada

○ 2. de base, planta o por tiempo indefinido

○ 99. NS

} *Pase a 3l*

○ 1 menos de dos meses   ○ 3 más de seis meses hasta un año
○ 2 de dos a seis meses   ○ 4 hasta el término de la obra

3l. Por su trabajo, le dan
(Lee las opciones y marca las indicadas por el informante)

1. aguinaldo?

2. vacaciones con goce de sueldo?

3. reparto de utilidades?

4. ninguna de las anteriores

5. No le dan nada → *Pasa a 3n*

3m. En este trabajo, ¿tiene derecho, aunque no utilice,
(Lee las opciones y marca las indicadas por el informante)

1 crédito para vivienda (Infonavit, Fovissste)?

2 guardería o apoyo para guardería?

3 tiempo para cuidados maternos o paternos?

4 fondo de retiro (SAR o Afore)?

5 Seguro de vida?

6 seguro privado para gastos médicos?

7 préstamos personales y/o caja de ahorro?

8 ninguna de las anteriores

9 NS

3n. ¿cómo se enteró de este empleo?
(Escucha, anota y marca la opción indicada por el informante)

○ 01 Acudió directamente al lugar de trabajo (fábrica, tienda, taller)
○ 02 Acudió a una agencia o bolsa de trabajo privada
○ 03 Acudió a un servicio público de colocación
○ 04 Por medio de un programa de empleo temporal del gobierno (federal, estatal y/o municipal)
○ 05 Acudió a un sindicato o gremio

○ 06 Por Internet
○ 07 Por medio de un anuncio en un lugar público o en medios de comunicación (periódico, radio)
○ 08 Por medio de un familiar, amigo o conocido
○ 09 Le ofrecieron el empleo
○ 10 Otro medio
○ 99 NS

3o. Para conseguir o conservar este trabajo, ¿se vio obligado a cambiar de ciudad o de localidad?

○ 1 Sí   ○ 2 No → *Pasa a 3q*

3p. Antes de este cambio, ¿en qué estado de la República o país vivía?

○ 1 En el mismo estado   ○ 2 En otro estado   ○ 3 En otro país   ○ 9 NS

3q. ¿Aproximadamente cuántas personas, incluyendo al dueño, laboran donde trabaja..? _____
(Anota, numera y clasifica)

O 01 1 persona
O 02 2 a 5 personas
O 03 6 a 10 personas
O 04 11 a 15 personas
O 05 16 a 20 personas
O 06 21 a 30 perssonas

O 07 31 a 50 personas
O 08 51 a 100 personas
O 09 101 a 250 personas
O 10 251 a 500 personas
O 11 501 y más personas
O 99 NS

3s. ¿Desde entonces...
(Pregunta según el tipo de trabajador y marca la opción indicada)

ha trabajado todos los años para su actual empresa, institución o patrón? → Subordinados

ha trabajado todos estos años en su actual negocio (o actividad)? → Independientes

O 1 Sí ⟶ *Pasa a 4*
O 2 No ⟶ *Pase a 3t*
O 9 Ns ⟶ *Pasa a 4*

3r. ¿En qué año... (Pregunta según el tipo de trabajador, anota el año y marca la opción)

entró trabajar por primera vez para su actual empresa, institución o patrón? O 1 Subordinados

comenzó o se hizo cargo de su actual negocio (o actividad)? O 2 Independientes

_____ Año

_____ Mes

ATENCIÓN: Si se trata del año en curso o del año pasado, pregunta en que mes, anótalo y clasifica en todos lo casos

O 1 El año en curso ⎫ *Pasa a 4*
O 2 El año pasado ⎭
O 3 Antes del año pasado
O 9 NS ⟶ *Pasa a 4*

3t. ¿En qué año... (Pregunta por el tipo de trabajador y anota el año)

regresó a trabajar Independiente

reinició su actual negocio (o actividad) Subordinados

Año: _____

ATENCIÓN: Si se trata del año en curso o del año pasado, pregunta en que mes y anótalo

Mes: _____

IV. CARACTERISTICAS DE LA UNIDAD ECÓNOMICA

4. ¿Cuál es el nombre de la empresa, negocio o institución para la que trabaja o ayuda?
(Escucha y marca la opción indicada por el informante, en caso de que se verifique una opción ahí señalada)

1 _____
(Anota el nombre completo de la empresa, negocio o institución)

O 2 El negocio no tiene nombre o razón social
O 3 Es una unidad doméstica o trabajador(a) de otro(a) trabajador(a) ⟶ *Pasa a 5*
O 4 Es una) trabajador(a) en el extrajero → *Pasa a 8*
O 9 NS

4a. ¿a qué se dedica esta empresa, negocio o institución?
(Detalla el tipo y material de los productos que se elaboran o de lo servicios que se prestan)

_____

Nota: En caso de actividades por cuenta propia se refiere a lo que el entrevistado hace

4b. SÓLO PARA EL ENTREVISTADOR (Clasifica según las respuestas obtenidas en las preguntas 4 y 4a)

O 1 Es una actividad agropecuaria ⟶ *Pasa a 4e*
O 2 Es una institución educativa u hospital ⎫ *Pasa a 4d*
O 3 Es una institución pública o una sin fines de lucro ⎭
O 4 Se trata de una actividad o negocio del sector privado
O 5 Aún no se puede determinar

4c. Entonces, ¿estamos hablando de que este negocio es

O 1 de tipo independiente, personal o familiar?

O 2 una compañia o empresa del sector privado? (sociedad mercantil: anónima o bajo
otra modalidad, transnacional, cadena comercial, bancaria o de servicios)? } *Pasa a 4e*

O 3 Ninguno de los anteriores

4d. Entonces, ¿usted trabaja para

O 1. una institución de gobierno?   O 2. una institución que no administra el gobierno?

(Con base a la información obtenida en las
preguntas 4 y 4b, circula la opción que corresponda
y verifica con el informante)

O 1 Poder judicial o poder legislativo

O 2 Empresa pública o paraestatal

O 3 Escuelas, hospitales, clinicas y servicios
asistenciales, administrados por el gobierno

O 4 Gobierno o dependencias federales

O 5 Gobierno del estado (incluyendo DF)

O 6 Gobierno del municipio

O 7 Ninguna de las anteriores

O 9 NS

(Con base a la información obtenida en las preguntas 4
y 4b, circula la opción que corresponda y verifica con el
informante)

O 1 Institución educativa u hospital particular

O 2 Una institución autónoma y pública de estudios
de nivel medio superior o superior

O 3 Organismo autónomo (IFE, Institutos Estatales
Electorales, Comisiones Nacionales o Estatales de
Derechos Humanos)

O 4 Iglesia, asociación profesional, cámara o sindicato

O 5 Asociación civi no clasificada en las opciones
anteriores

O 6 Organismo internacional

O 7 Partido político

O 8 Ninguna de las anteriores

O 9 NS

4e. ¿El negocio o actividad
   (Lee las opciones y marca la indicada por el informante)

O 1 cuenta con establecimiento y oficina?
   (no importa si están integradas o por separado)   O 4 no tiene local, oficina o establecimiento?

O 2 sólo tiene oficina o despacho?   *Pasa a 4g*

O 3 sólo tiene local?   O 9 NS

4f. Entonces, ¿en dónde se realizan las actividades de este negocio?
   (Escucha, anota y marca la opción indicada por el informante)

O 01 En el campo, a cielo abierto, bordo, poza, mar

O 02 Ambulante de casa casa o en la calle

O 03 Puesto improvisado

O 04 En vehículo sin motor (bicicleta, triciclo, carretón, lancha)

O 05 En vehículo motorizado (automovil, motocicleta, camioneta)

O 06 En su propio domicilio sin instalación especial

O 07 En su propio domicilio con instalación especial

O 08 En el domiclio o propiedad del patrón o en
el lugar donde lo requieren los clientes

O 09 Puesto semífijo

O 10 Puesto fijo

O 11 Otro lugar

O 99 NS

4g. En este negocio o actividad

(Lee las opciones y marca la indicada por el informante)

O 1 ¿Se llevan libros de contabilidad o se acude acude a los servicios de un contador?

O 2 ¿Solo se utiliza un cuaderno de apuntes personales para llevar las cuentas?

O 3 Se lleva el cuadernillo de ingresos o tiene caja registradora de Secretaría de Hacienda para pequeños contribuyentes

O 4 No lleva ningún registro contable

O 9 Ns

4g1. ¿En qué dirección se ubica la empresa, negocio o patrón para el que trabajó o ayudó?

_____   _____   _____
                Calle   No. exterior   No. interior

_____   _____
              entre calles   Colonia

4h. ¿Normalmente en qué lugar trabaja?   (Lee las opciones y marca la indicada por el informante)

O 1 ¿En las instalaciones (o vehículos) de (menciona el nombre que te indicaron en la pregunta 4)?

O 4 ¿En el lugar de la obra?

O 2 ¿En las instalaciones de otra empresa o institución a donde se le envía?

O 5 Ninguna de las anteriores

O 3 ¿Visitando a distintos clientes?

O 9 NS

4i. La empresa a la que pertenece ¿tiene oficinas o establecimientos?

(Lee las opciones y marca la indicada por el informante)

O 1 en otros países?

O 2 únicamente en México, pero en varias ciudades del país?

O 3 sólo en esta ciudad?

O 4 Se trata de un negocio que opera bajo la modalidad de franquicia?

O 9 NS

4j. Sector de actividad _____

V. JORNADA Y REGULARIDAD LABORAL

5. ¿Su jornada de trabajo es   (Lee las opciones y marca la indicada por el informante)

O 1 de día? (entre 6 am y las 8 pm)

O 4 rola turnos?

O 2 de noche? (entre las 8 pm y las 6am)

O 9 NS

O 3 mixto?

5a. La semana pasada, ¿tuvo poco trabajo qué hacer?   (Hubo tiempos muertos, largos periodos de espera)

(Escucha y marca la opción indicada por el informante)

O 1 Si

O 3 No se encontró en esta situación

O 2 No trabajó la semana pasada → Pasa a 5e

O 9 NS

} Pasa a 5c

5b. ¿Le preocupa esta situación?   (Escucha y marca la opción indicada por el informante)

○ 1 Sí

○ 2 Sólo un poco

○ 3 No, porque así es su trabajo

○ 4 No, porque así es en esta época del año

○ 5 No, porque le considera una situación pasajera

○ 6 No, por otras razones

○ 9 NS

5c. ¿Qué días y cuántas horas le dedicó a su trabajo la semana pasada?
(Anota por día, según corresponda)

	Horas		Minutos
Lunes	_____	y/o	_____
Martes	_____	y/o	_____
Miércoles	_____	y/o	_____
Jueves	_____	y/o	_____
Viernes	_____	y/o	_____
Sabado	_____	y/o	_____
Domingo	_____	y/o	_____

Anota:
De 00 a 24 horas
De 00 a 59 minutos
00 en horas y 00 en minutos: No trabajó ese día
98 en horas y 00 en minuto: Trabajó ese día, pero no
                                                sabe cuánto tiempo
                                                                                    99
en horas y 00 en minutos: No sabe si trabajo ese día.

5d. ¿Ese es el número de horas que habitualemente trabaja?

○ 1 Sí ⟶ *Pasa a 5g*   ○ 2 No   ○ 9 NS

5e. ¿Qué dias y cuántas horas le dedica habitualmente a su trabajo?
(Anota por día, según corresponda)

	Horas		Minutos	
○ 1	_____	y/o	_____	Lunes
	_____	y/o	_____	Martes
	_____	y/o	_____	Miércoles
	_____	y/o	_____	Jueves
	_____	y/o	_____	Viernes
	_____	y/o	_____	Sabado
	_____	y/o	_____	Domingo

ATENCIÓN: Si no trabajó la semana pasada (5a=2)

↓

Pasa   a   5g

○ 2 No tiene un horario de trabajo ⟶ *Pasa a 5g*

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5f. ¿Cuál es el motivo principal por el que la semana pasada no trabajó las horas habituales?
(Escucha y marca según la respuesta del informante)

○ 01 Exceso de trabajo

○ 02 Obtener más ingresos

○ 03 Horas extras

○ 04 Temporada alta (clientes, ventas, siembra o cosecha)

○ 05 Reducción o suspensión del trabajo (falta de ventas o clientes)

○ 06 Término del contrato o temporada de trabajo

○ 07 Causas climatológicas

○ 08 Vacaciones o días festivos

○ 09 Enfermedad o accidente

○ 10 Cuidar o atender a niños, enfermos o ancianos

○ 11 Otros motivos personales o familiares

○ 12 Ninguno de los anteriores

○ 99 NS

5g. ¿En qué meses del año realiza este trabajo?
(Escucha y marca según la respuesta del informante)

01 Enero   02 Febrero   03 Marzo

04 Abril   05 Mayo   06 Junio

07 Julio   08 Agosto   09 Septiembre

10 Octubre   11 Noviembre   12 Diciembre

13 Trabaja todos los meses del año ⟶ *Pasa a 6*

14 Varían los meses en que trabaja

15 Tiene poco tiempo que empezó a trabajar ⟶ *Pasa a 6*

5h. ¿Cuál es el motivo principal por el que no trabaja todos los meses del año?
(Escucha, anota y marca la opción indicada por el informante)

○ 1 Trabaja sólo cuando lo llaman o solicitan sus servicios

○ 2 Sólo hay trabajo durante algunas épocas o temporadas del año

○ 3 Trabaja sólo en periodos de vacaciones escolares

○ 4 No necesita trabajar todo el año

○ 5 Motivos personales o familiares

○ 6 Otro motivo

○ 9 NS

VI. INGRESOS Y ATENCIÓN MÉDICA

6. ¿En su trabajo recibe o le pagan

(Lee las opciones y marca las indicadas por el informante)

01 por comisión?

02 a destajo (por pieza, servicio u obra determinada?

03 por honorarios?

04 con propinas?

05 con bonos de compensación o de productividad?

06 con vales o productos comercializables?

07 Sólo recibe sueldo, salario o jornal   } Pasa a 6b

08 Sólo lo que le deja su negocio

09 No le pagan ni recibe ingresos (incluye autoconsumo agropecuario) → Pasa a 6d

10 Ninguna de las anteriores

99 NS

6a. Aparte de lo que me acaba de mencionar, ¿obtiene o le pagan sus ingresos?

(Lee las opciones y marca la indicada por el informante)

O 1 a sueldo, salario o jornal?

O 2 por ganancias o de lo que deja su negocio?

O 3 No le pagan ni recibe ingresos (incluye autoconsumo agropecuario) → Pasa a 6d

O 4 Ninguna de las anteriores

O 9 NS

6b. ¿Cada cuándo obtiene sus ingresos o le pagan?

(Escucha, clasifica el período, pregunta por los ingresos y anótalos)

6b1. ¿Cuánto ganó o en cuánto calcula sus ingresos?

O 1. Cada mes

O 2. Cada 15 días

O 3. Cada semana

O 4. Diario

O 5. Otro periodo de pago. Especifique _____

O 6. Le pagan por pieza producida o vendida, servicio u obra realizada _____ Unidad

Total de unidades por semana _____ Total _____

Cantidad en el periodo:

$ _____

→ Pasa a 6d

$ _____ Precio por unidad

O 7. No supo estimar

O 8. Se negó a contestar esta pregunta

6c. Actualmente el salario mínimo mensual es de $1,528.80, ¿la cantidad que obtiene al mes por su trabajo es

(Lee las opciones y marca la indicada por el informante)

O 1 menor?

O 2 igual a esta cantidad?

O 3 más de 1 salario mínimo hasta 2?

O 4 más de 3 salarios mínimos hasta 3

O 5 más de 3 salarios mínimos hasta 5?

O 6 más de 5 salarios mínimos hasta 10?

O 7 más de 10 salarios mínimos?

O 8 No quiso dar información

O 9 NS

6d. Por parte de este trabajo ¿tiene acceso a atención médica en

(Lee las opciones y marca la indicada por el informante)

O 1 el Seguro Social (IMSS)?

O 2 el hospital o clínica naval, militar o de Pemex?

O 3 el ISSSTE?

O 4 el ISSSTE estatal (ISSTESON)?

O 5 otra institución médica o seguro de salud particular? _____ Especifica

O 6 No recibe atención médica

O 9 NS

VIa.

6e. De las siguientes afirmaciones que le voy a hacer sobre su trabajo, dígame por favor si está totalmente de acuerdo, de acuerdo, en desacuerdo o totalmente en desacuerdo

Encuestador(a):   Si el(la) encuestado(a) dejó de trabajar hace tiempo no olvide utilizar el pasado para cada afirmación. Por ejemplo: necesita, necesitaba; existe, existía; etc.

	1. Totalmente de acuerdo	2. De acuerdo	3. En desacuerdo	4. Totalmente en desacuerdo	9. No sabe/ No aplica
01 En su trabajo necesita estar aprendiendo cosas nuevas	❏	❏	❏	❏	❏
02 Su trabajo implica muchas acciones repetitivas	❏	❏	❏	❏	❏
03 Para su trabajo necesita ser creativo	❏	❏	❏	❏	❏
04 En su trabajo puede tomar muchas decisiones por sí mismo	❏	❏	❏	❏	❏
05 Su trabajo requiere de un alto nivel de habilidad	❏	❏	❏	❏	❏
06 Usted tiene muy poca libertad para decidir cómo hacer su trabajo	❏	❏	❏	❏	❏
07 Existe variedad en las actividades que realiza en su trabajo	❏	❏	❏	❏	❏
08 Sus opiniones cuentan mucho en su trabajo	❏	❏	❏	❏	❏
09 En su trabajo tiene oportunidad de desarrollar sus propias habilidades	❏	❏	❏	❏	❏
10 En su trabajo tiene que trabajar muy rápido	❏	❏	❏	❏	❏
11 En su trabajo tiene que trabajar muy duro	❏	❏	❏	❏	❏
12 Se le pide que realice una cantidad excesiva de trabajo	❏	❏	❏	❏	❏
13 Tiene tiempo suficiente para terminar su trabajo	❏	❏	❏	❏	❏
14 En su trabajo tiene que responder a órdenes contradictorias	❏	❏	❏	❏	❏
15 La estabilidad de su trabajo es buena	❏	❏	❏	❏	❏
16 Usted tiene las herramientas y equipos necesarios para hacer bien su trabajo	❏	❏	❏	❏	❏
17 Su trabajo le da un sentimiento de autorrealización	❏	❏	❏	❏	❏
18 Las condiciones de trabajo (instalaciones, luz, ventilación, seguridad) son adecuadas	❏	❏	❏	❏	❏
19 Su jefe lo trata bien en su trabajo	❏	❏	❏	❏	❏
20 Su supervisor(a) toma en cuenta sus ideas y sugerencias	❏	❏	❏	❏	❏
21 Usted no recibe el reconocimiento adecuado cuando hace bien su trabajo	❏	❏	❏	❏	❏
22 Lo que le pagan es justo por el trabajo que hace	❏	❏	❏	❏	❏
23 Usted no esta satisfecho(a) con sus oportunidades de ascenso	❏	❏	❏	❏	❏
24 Esta satisfecho(a) con la forma en que lo trata su supervisor(a)	❏	❏	❏	❏	❏
25 El trabajo que usted hace es importante	❏	❏	❏	❏	❏
26 Donde trabaja al que hace un buen trabajo le pagan más	❏	❏	❏	❏	❏
27 Existe buen ambiente de trabajo entre sus compañeros de trabajo	❏	❏	❏	❏	❏
28 Usted recibe información necesaria para hacer su trabajo	❏	❏	❏	❏	❏
29 En su trabajo, las políticas y los procedimientos son justos con sus empleados	❏	❏	❏	❏	❏
30 En general, usted está satisfecho(a) con las prestaciones que tiene	❏	❏	❏	❏	❏

VII. TRABAJO SECUNDARIO

7. Además del trabajo principal del que ya hablamos, ¿tiene o realiza otra actividad como
(Lee las opciones y marca la indicada por el informante)

O 1 vender o hacer productos para la venta (alimentos, productos de belleza, ropa)?

O 2 prestar servicios (dar clases, cortar el pelo, lavar ropa?

O 3 trabajar su tierra o parcela y/o crianza de animales?

O 4 trabajar por propinas, comisión o destajo?

O 5 trabajar como asalariado (sueldo, salario o jornal)?

O 6 ayudar en algun negocio o en las tierras de un familiar o de otra persona?

O 7 No tiene otro trabajo

O 9 NS } *Pase a 8*

7a. ¿Cuáles son las tareas o funciones principales que desempeña en su segundo trabajo?
(Detalla el tipo de tareas y funciones)

_____

7a1. ¿Cuál es el nombre de este oficio, puesto o cargo?

_____

7b. ¿Cuál es el nombre de la empresa, negocio o institución para la que realiza este otro trabajo?
(Escucha y marca la opción indicada por el informante)

1 _____
(Anota el nombre completo de la empresa, negocio o institución)

O 2 El negocio no tiene nombre o razón social

O 3 Es una unidad doméstica o trabajador(a) de otro(a) trabajador(a)

O 4 Es un(a) trabajador(a) en el extranjero } *Pase a 8*

O 9 NS

7c. ¿A qué se dedica esta empresa, negocio o institución donde trabaja o ayuda en su segundo trabajo?
(Detalla el tipo y material de los productos que se elaboran o de los servicios que se prestan)

_____

7d. Por parte de este segundo trabajo, ¿tiene acceso a atención médica en
(Lee las opciones y marca la indicada por el informante)

O 1 el Seguro Social (IMSS)?

O 2 el ISSSTE?

O 3 otra institución médica?

O 4 No recibe atención médica

O 9 NS

VIII. BÚSQUEDA DE OTRO TRABAJO

8.- Durante los últimos tres meses, ¿ha tratado de

(Lee las opciones y marca las indicadas por el informante)

1 buscar trabajo en otro país o hacer preparativos para cruzar la frontera?

2 buscar trabajo aquí en el país?

3 poner un negocio o realizar una actividad por su cuenta sin poder todavía comenzar?

4 Entonces, ¿no ha tratado de buscar otro trabajo?

9 NS   } *Pasa a 9*

8a. Lo que intenta ¿es

(Lee las opciones y marca la indicada por el informante)

O 1 tener más de un trabajo?

O 2 tener un trabajo de tiempo completo?   } *Pase a 9*

O 3 conseguir una actividad en la que pueda trabajar más horas para ganar más?

O 4 Ninguna de las anteriores

O 9 NS

8b. ¿Cuál es el motivo principal por el que está buscando otro trabajo?

(Escucha, anota y marca la opción indicada por el informante)

_____

O 01 Teme quedarse sin su actual trabajo, que haya recorte de personal o está por terminar su contrato

O 02 Mejorar sus ingresos trabajando la misma jornada

O 03 Mejorar sus condicones de trabajo /(horario, prestaciones laborales, ambiente de trabajo)

O 04 Contar con seguridad social (IMSS o ISSSTE)

O 05 Tener un trabajo acorde a sus escolaridad, experiencia o capacitación

O 06 Tener un trabajo independiente

O 07 Tener tiempo para atender o convivir con su familia

O 08 Tener tiempo para estudiar o realizar otras actividades

O 09 Ninguna de los anteriores

O 99 NS

IX. TRANSPORTE

9. En día hábil, ¿cómo se traslada usted de su casa a su actividad principal?	9.1. ¿Normalmente cuántos viajes realiza por día? (Solo para respuestas positivas en pregunta 9)
1. En automóvil particular como conductor	_____
2. En automóvil particular como pasajero	_____
3. En motocicleta	_____
4. En bicicleta	_____
5. En transporte público	_____
6. En taxi	_____
7. Se va a pie	_____

IX A. SALUD

Ahora tengo algunas preguntas sobre su salud

9a. En general, diría que su salud es:
(Lee las opciones y marca la indicada)

O 1. Excelente   O 2. Muy buena   O 3. Buena

O 4. Regular   O 5. Mala   O 6. Muy mala

9b. De las siguientes sensaciones que le voy a decir, dígame por favor si en las últimas dos semanas las experimentó con mucha frecuencia, varias veces, una vez o nunca: (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Nunca	2. Una vez	3. Varias veces	4. Con mucha frecuencia
1. Se sintió deprimido/a	❑	❑	❑	❑
2. Sintió que todo le costaba trabajo	❑	❑	❑	❑
3. Su sueño no fue reparador	❑	❑	❑	❑
4. Se sintió alegre	❑	❑	❑	❑
5. Se sintió sola/o	❑	❑	❑	❑
6. La gente fue hostil	❑	❑	❑	❑
7. Disfrutó de la vida	❑	❑	❑	❑
8. Se sintió triste	❑	❑	❑	❑
9. Sintió que le caía mal a la gente	❑	❑	❑	❑
10. Sintió que no podía seguir adelante	❑	❑	❑	❑
11. Su apetito no era bueno	❑	❑	❑	❑
12. Se sintió esperanzada/o sobre el futuro	❑	❑	❑	❑
13. Se sintió nerviosa/o o ansiosa/o	❑	❑	❑	❑
14. Sintió miedo o temor	❑	❑	❑	❑
15. Se sintió muy cansada/o por las mañanas	❑	❑	❑	❑
16. Al terminar el día se sentía completamente exhausta/o física y mentalmente	❑	❑	❑	❑
17. Se sentía fácilmente molesta/o o irritada/o	❑	❑	❑	❑
18. Se enojaba con facilidad por cosas de poca importancia	❑	❑	❑	❑

9c. ¿En el último mes ha presentado algunos de los siguientes síntomas y/o enfermedades? (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Nunca	2. Una vez	3. Varias veces	4. Con mucha frecuencia
1. Catarro o gripe	❏	❏	❏	❏
2. Tos	❏	❏	❏	❏
3. Asma	❏	❏	❏	❏
4. Dolores de cabeza	❏	❏	❏	❏
5. Dolor en el cuello	❏	❏	❏	❏
6. Dolor en la espalda alta (a la altura de los hombros)	❏	❏	❏	❏
7. Dolor en la espalda baja (a la altura de la cintura)	❏	❏	❏	❏
8. Dolor en los brazos	❏	❏	❏	❏
9. Dolor de hombros	❏	❏	❏	❏
10. Migraña (dolores laterales de cabeza que se presentan periódicamente, a veces asociados con malestares estomacales)	❏	❏	❏	❏
11. Palpitaciones	❏	❏	❏	❏
12. Dolor u opresión en el pecho	❏	❏	❏	❏
13. Dificultad para respirar	❏	❏	❏	❏
14. Dolor de pies durante el movimiento	❏	❏	❏	❏
15. Ardor en el pecho o en el corazón	❏	❏	❏	❏
16. Malestar estomacal	❏	❏	❏	❏
17. Acidez, gastritis o úlcera	❏	❏	❏	❏
18. Dolor de estómago	❏	❏	❏	❏
19. Aire en el vientre	❏	❏	❏	❏
20. Diarrea	❏	❏	❏	❏
21. Estreñimiento	❏	❏	❏	❏
22. Inflamación y enrojecimiento de la piel que produce comezón y genera un líquido transparente	❏	❏	❏	❏
23. Problemas alérgicos en piel	❏	❏	❏	❏
24. Problemas alérgicos en ojos, nariz y/o garganta	❏	❏	❏	❏
25. Bochornos	❏	❏	❏	❏
26. Problemas del sueño como insomnio, sueño ligero o despertar varias veces	❏	❏	❏	❏
27. Cansancio o agotamiento	❏	❏	❏	❏
28. Mareos	❏	❏	❏	❏
29. Ansiedad	❏	❏	❏	❏
30. Tristeza o depresión	❏	❏	❏	❏
31. Dolor de cadera	❏	❏	❏	❏
32. Náuseas	❏	❏	❏	❏
Sólo mujeres:	❏	❏	❏	❏
33. Malestares pre-menstruales	❏	❏	❏	❏
34. Cólicos menstruales	❏	❏	❏	❏

9d. ¿Alguna vez le ha dicho un doctor o personal médico que tenía o tiene usted: (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Sí	2. No
1. Presión baja?	❑	❑
2. Hipertensión o presión alta?	❑	❑
3. Diabetes, azúcar o nivel alto de azúcar en la sangre?	❑	❑
4. Asma?	❑	❑
5. Enfisema pulmonar?	❑	❑
6. Alguna enfermedad del corazón?	❑	❑
7. Artritis o reumatismo?	❑	❑
8. Tuberculosis?	❑	❑
9. Problemas de audición?	❑	❑
10. Problemas de la vista?	❑	❑
11. Problemas en los huesos?	❑	❑

9e. ¿Hay alguna cosa que le preocupe especialmente de su salud?

○ 1. Sí ⟶ ¿Qué es? _____

○ 2. No

X. APOYOS ECONÓMICOS

10. En los últimos tres meses ¿ha recibido del gobierno

(Lee las opciones y marca las indicadas por el informante)

1 beca de capacitación o ayuda económica para encontrar trabajo? ¿Cuánto? $ _____

2 apoyo para realizar una actividad por su cuenta (Procampo, microcréditos)? ¿Cuánto? $ _____

3 ayuda de otro programa de gobierno (beca de estudio, despensa)? ¿Cuánto? $ _____

4 No ha recibido nada del gobierno

10a. ¿En los últimos tres meses ha recibido (le enviaron) apoyo económico de alguien que vive y/o trabaja

(Lee las opciones y marca las indicadas por el informante)

1 en el extranjero? ¿Cuánto? $ _____

2 en otro estado del país? ¿Cuánto? $ _____

3 en este mismo estado? ¿Cuánto? $ _____

4 no ha recibido nada?

9 NS

XI. OTRAS ACTIVIDADES

Ahora le voy a pedir que me diga, por favor, qué fue lo que hizo el día de ayer desde que se levantó hasta que se acostó.

11. ¿A qué hora se levantó el día de ayer? _____

11a. ¿Cuáles fueron las actividades que realizó y cuánto tiempo le dedicó a cada una de ellas? _____

ACTIVIDADES	Hora de inicio	Hora final	Tiempo total en minutos
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____
7. _____	_____	_____	_____
8. _____	_____	_____	_____
9. _____	_____	_____	_____
10. _____	_____	_____	_____
11. _____	_____	_____	_____
12. _____	_____	_____	_____
13. _____	_____	_____	_____
14. _____	_____	_____	_____
15. _____	_____	_____	_____
16. _____	_____	_____	_____
17. _____	_____	_____	_____
18. _____	_____	_____	_____
19. _____	_____	_____	_____
20. _____	_____	_____	_____

XII. OPCIONES PRODUCTIVAS

12. En términos generales ¿qué tantas oportunidades de trabajo usted cree que le ofrece esta ciudad?

(Lea todas las opciones y anote un solo código)

○ 1. Muchas oportunidades

○ 2. Bastantes oportunidades

○ 3. Pocas oportunidades

○ 4. Ninguna oportunidad

12b. ¿Qué tan seguro se siente usted de mantener su trabajo actual?

(Lea todas las opciones y anote un solo código)

○ 1. Muy seguro

○ 2. Seguro

○ 3. Inseguro

○ 4. Muy inseguro

○ 5. No tiene trabajo actualmente

12a. Con respecto a otras ciudades y según lo que usted sabe o ha oído, en esta ciudad las opciones de trabajo son:

(Lea todas las opciones y anote un solo código)

○ 1. Mucho mejores

○ 2. Mejores

○ 3. Peores

○ 4. Mucho peores

○ 9. No sabe

12c. ¿Cuál cree que sería la mejor forma para tener un trabajo estable en esta ciudad?

(Lea todas las opciones y anote un solo código)

○ 1. Poner un negocio

○ 2. Trabajar en una fábrica o maquila

○ 3. Ser empleado de alguna empresa

○ 4. Trabajar para alguna oficina de gobierno

○ 5. Otra   ¿Cuál? _____

12d. En su opinión, ¿en esta ciudad cuál sería el grado de dificultad para:	1. Muy difícil	2. Difícil	3. Poco difícil	4. Nada difícil	9. No sabe/ No aplica
1. Conseguir una renta barata de casa o departamento	❏	❏	❏	❏	❏
2. Tener un trabajo bien pagado	❏	❏	❏	❏	❏
3. Recibir buena atención en un hospital público	❏	❏	❏	❏	❏
4. Contar con calles seguras	❏	❏	❏	❏	❏
5. Tener escuelas de calidad	❏	❏	❏	❏	❏
6. Contar con transporte público de calidad	❏	❏	❏	❏	❏
7. Disponer de un medio ambiente limpio	❏	❏	❏	❏	❏
8. Contar con áreas verdes suficientes	❏	❏	❏	❏	❏

Ahora le voy a hacer algunas preguntas relacionadas con la calidad de vida en su ciudad o colonia

XIII. BIENESTAR Y ATRIBUTOS DE LA CIUDAD

13. De los siguientes atributos, mencione usted si considera que hace falta en esta ciudad
(Lea cada una de las opciones y señala las afirmativas)

1. Tranquilidad para usted y sus hijos	8. Lugares para distracción y entretenimiento
2. Seguridad pública	9. Infraestructura vial adecuada
3. Buen clima	10. Mercados públicos de calidad
4. Que no haya contaminación	11. Instalaciones deportivas adecuadas
5. Empleo	12. Transporte público de calidad
6. Limpieza	13. Centros comerciales
7. Buenas escuelas	14. Áreas verdes

13a. De las anteriores, ¿cuál es su nivel de importancia? (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Muy importante	2. Importante	3. Poco importante	4. Nada importante
1. Tranquilidad para usted y sus hijos	❑	❑	❑	❑
2. Seguridad pública	❑	❑	❑	❑
3. Buen clima	❑	❑	❑	❑
4. Que no haya contaminación	❑	❑	❑	❑
5. Empleo	❑	❑	❑	❑
6. Limpieza	❑	❑	❑	❑
7. Buenas escuelas	❑	❑	❑	❑
8. Lugares para distracción y entretenimiento	❑	❑	❑	❑
9. Infraestructura vial adecuada	❑	❑	❑	❑
10. Mercados públicos de calidad	❑	❑	❑	❑
11. Instalaciones deportivas adecuadas	❑	❑	❑	❑
12. Transporte público de calidad	❑	❑	❑	❑
13. Centros comerciales	❑	❑	❑	❑
14. Áreas verdes	❑	❑	❑	❑

XIV. RELACIONES CON AUTORIDADES Y PARTICIPACIÓN COMUNITARIA

14. ¿Durante el último año usted hizo alguno de los siguientes trámites? (Lea cada una de las opciones y anote la respuesta en cada caso)	1 Sí	2 No	14a. ¿Cómo calificaría la eficiencia de la autoridad ante la que hizo el trámite en esa ocasión? (Señale únicamente en las afirmativas)	1. Muy eficiente	2. Eficiente	3. Regular	4. Poco eficiente	5. No sabe/ No aplica
1. Trámite para la introducción o regularización de servicios: agua, drenaje, alumbrado, pavimento, etc	❏	❏	1. Trámite para la introducción o regularización de servicios: agua, drenaje, alumbrado, pavimento, etc	❏	❏	❏	❏	❏
2. Trámite para obtener licencia o permiso de uso de suelo, de demolición, construcción o alineamiento y número oficial	❏	❏	2. Trámite para obtener licencia o permiso de uso de suelo, de demolición, construcción o alineamiento y número oficial	❏	❏	❏	❏	❏
3. Trámite predial	❏	❏	3. Trámite predial	❏	❏	❏	❏	❏
4. Trámite de licencia de manejo	❏	❏	4. Trámite de licencia de manejo	❏	❏	❏	❏	❏
5. Trámite de placas o regularización o tenencia de vehículos	❏	❏	5. Trámite de placas o regularización o tenencia de vehículos	❏	❏	❏	❏	❏
6. Trámite para el pago de alguna multa o infracción	❏	❏	6. Trámite para el pago de alguna multa o infracción	❏	❏	❏	❏	❏
7. Trámite de permiso para habilitación de un negocio?	❏	❏	7. Trámite de permiso para habilitación de un negocio?	❏	❏	❏	❏	❏

EN CASO AFIRMATIVO EN ALGUNA DE LAS OPCIONES DE LA PREGUNTA 14, CUESTIONE; 14b. En esa ocasión, ¿fue necesario el pago de "mordida" o algún otro tipo de soborno para resolver el trámite?	1 Sí	2 No
1. Trámite para la introducción o regularización de servicios: agua, drenaje, alumbrado, pavimento, etc	❏	❏
2. Trámite para obtener licencia o permiso de uso de suelo, de demolición, construcción o alineamiento y númer oficial	❏	❏
3. Trámite predial	❏	❏
4. Trámite de licencia de manejo	❏	❏
5. Trámite de placas o regularización o tenencia vehicular	❏	❏
6. Trámite para el pago de alguna multa o infracción	❏	❏
7. Trámite de permiso para habilitación de un negocio	❏	❏

14c. ¿Considera que las autoridades de su ciudad actúan de manera discriminatoria contra ciertos grupos de la población?

O 1 Sí   O 2 No ⟶ *Pase a 14e*

(Lea cada una de las opciones y anote la respuesta en cada caso)

14d. Ese trato discriminatorio es por:	Sí	No
1. sexo?	❑	❑
2. posición económica?	❑	❑
3. edad?	❑	❑
4. preferencia sexual?	❑	❑
5. religión?	❑	❑
6. raza o grupo étnico?	❑	❑
7. Otra. ¿Cuál? _____	❑	❑

Pase a 14e

14e. Aproximadamente, ¿cada cuando usted y la gente que vive en su colonia se hacen favores?
(Lea las opciones y anote un solo código)

O 1. Siempre

O 2. Muchas veces

O 3. Pocas veces

O 4. Nunca

(Lea cada una de las opciones y anote la respuesta en cada caso)

14f. En el último año, ¿usted asistió a una o más de las reuniones de las siguientes organizaciones o grupos?	Sí	No
1. Sociedad de padres de familia de una escuela?	❑	❑
2. Iglesia o grupos religiosos?	❑	❑
3. Clubes u organizaciones sociales?	❑	❑
4. Organizaciones de vecinos o comunitarias?	❑	❑
5. Sindicatos?	❑	❑
6. Partidos políticos?	❑	❑

XV. CULTURA EN PROTECCIÓN CIVIL

15. En su opinión, en esta ciudad ¿la población está preparada en caso de presentarse una amenaza natural?

O 1 Sí   O 2 No

15a. ¿Considera usted que vive en una zona de riesgo en caso de desastre natural?

O 1 Sí   O 2 No

15b. ¿Con qué frecuencia se registran en su colonia los siguientes siniestros?	1. Casi nunca	2. De vez en cuando	3. Seguido	4. Muy seguido
1) Inundaciones	❑	❑	❑	❑
2) Incendios	❑	❑	❑	❑
3) Derrumbes	❑	❑	❑	❑
4) Temblores	❑	❑	❑	❑
5) Otro: Especifique	❑	❑	❑	❑

_____

XVI. PERCEPCIÓN SOBRE EL MEDIO AMBIENTE

16. Considera que el aire en su ciudad se encuentra:

(Lea todas las opciones y anote un solo código)

O 1 Muy contaminado
O 2 Contaminado
O 3 Más o menos limpio
O 4 Muy limpio

16b. Considera que el ruido en su colonia se encuentra en niveles:

(Lea todas las opciones y anote un

O 1 Excesivos
O 2 Altos
O 3 Normales

16d. Considera que las áreas verdes, parques o canchas comunes de su colonia son:

(Lea todas las opciones y anote un solo código)

O 1. Suficientes
O 2. Insuficientes

16e. Considera que las áreas verdes, parques o canchas comunes de su colonia están:

(Lea todas las opciones y anote un solo código)

O 1. Muy limpias
O 2. Limpias
O 3. Sucias
O 4. Muy sucias

16a. Considera que el agua en su ciudad se encuentra:

(Lea todas las opciones y anote un solo código)

O 1 Muy sucia
O 2 Sucia
O 3 Más o menos limpia
O 4 Muy limpia

16c. Considera que las calles de su colonia se encuentran:

(Lea todas las opciones y anote un solo código)

O 1 Muy limpias
O 2 Limpias
O 3 Sucias
O 4 Muy sucias

16f. Usted conoce alguna acción del gobierno de la ciudad que se esté llevando a cabo para combatir el problema de la contaminación?

O 1 Sí   O 2 No

XVII. CIUDADES PREFERIDAS

17. En general. ¿a usted qué tanto le agrada su ciudad?
(Lea todas las opciones y anote un solo código)

O 1 Me agrada mucho
O 2 Me agrada
O 3 Me desagrada
O 4 Me desagrada mucho
O 5 Ni me agrada ni me desagrada
O 9 NS/NC

17a. Si usted tuviera oportunidad de vivir en otra ciudad, ¿se cambiaría?
(Lea todas las opciones y anote un solo código)

O 1 Sí
O 2 No
O 3 Depende
O 9 NS/NC

XVIII. DERECHOS

18. Todas las personas tenemos ciertos derechos por el solo hecho de ser personas, más allá de nuestra raza, religión, ideas, políticas, preferencia sexual, edad, nacionalidad o sexo. A esos derechos se les llama derechos humanos. En su opinión, ¿quién es responsable de vigilar que se respeten los derechos humanos?:
(Lea todas las opciones y anote un solo código)

O 1 El gobierno   O 2 La sociedad   O 3 Ambos   O 4 Cada quien   O 5 Otra

18a. ¿Alguna vez usted ha sentido que no se le han respetado sus derechos?
O 1 Sí   O 2 No

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18b. Con respecto a los siguientes derechos, indique qué tanto le han sido respetados (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Siempre	2. No siempre	3. Nunca
1 Derechos a la libertad de tránsito	❏	❏	❏
2 Derechos a la libertad de palabra o expresión	❏	❏	❏
3 Derechos a la libertad de pensamiento	❏	❏	❏
4 Derechos a la libertad de creencias religiosas	❏	❏	❏
5 Derechos a un trato igual ante la ley	❏	❏	❏
6 Derechos a la libertad de creencias políticas	❏	❏	❏
7 Derecho a votar	❏	❏	❏
8 Derecho a ser votado	❏	❏	❏
9 Derecho a asociarse	❏	❏	❏
10 Derecho a una educación adecuada	❏	❏	❏
11 Derecho a la protección de la salud	❏	❏	❏
12 Derecho a decidir cuántos y cuando tener hijos	❏	❏	❏
13 Derecho a la seguridad social	❏	❏	❏
14 Derecho a tener un trabajo digno y socialmente útil	❏	❏	❏
15 Derecho a un medio ambiente adecuado	❏	❏	❏
16 Derecho a una vivienda digna y decorosa	❏	❏	❏
17 Derecho al libre ejercicio de un oficio o profesión	❏	❏	❏
18 Derecho a no ser molestado en su domicilio	❏	❏	❏

18c. ¿Considera que alguna vez sus derechos han sido limitados o no han sido respetados por:

(Lea cada una de las opciones y marque únicamente las señaladas afirmativamente)

1 Su apariencia física?
2 Ser hombre/mujer?
3 Su religión?
4 Su forma de vestir?
5 El color de su piel?
6 No tener dinero?
7 Su edad?
8 Provenir de una región del país?
9 Su preferencia sexual?
10 Su origen étnico?
11 Alguna condición de discapacidad?

→ EN CASO AFIRMATIVO PREGUNTE

18d. Principalmente dónde fue que no le respetaron sus derechos por...?	Trabajo	Escuela	Oficina pública	Otra
1. Su apariencia física?	❏	❏	❏	❏
2. Ser hombre/mujer?	❏	❏	❏	❏
3. Su religión?	❏	❏	❏	❏
4. Su forma de vestir?	❏	❏	❏	❏
5. El color de su piel?	❏	❏	❏	❏
6. No tener dinero?	❏	❏	❏	❏
7. Su edad?	❏	❏	❏	❏
8. Provenir de una región del país?	❏	❏	❏	❏
9. Su preferencia sexual?	❏	❏	❏	❏
10. Su origen étnico?	❏	❏	❏	❏
11. Su condición de discapacidad?	❏	❏	❏	❏

18e. De los grupos de personas, ¿quiénes diría usted que están desprotegidos en México?

(Lea cada una de las opciones y marque las señaladas afirmativamente)

01 Los ancianos	07 Los niños
02 Los desempleados	08 Los jovenes
03 Los extranjeros que viven en México	09 Los enfermos de SIDA
04 Las personas con discapacidad	10 Los no católicos
05 Los indígenas	11 Las mujeres en general
06 Madres solteras	12 Otro

18f. De lo que usted ha visto, en esta ciudad ¿los hombres y las mujeres reciben trato similar en?	1. Sí	2. Sí, en parte	3. No
1 En el trabajo	❏	❏	❏
2 En la escuela	❏	❏	❏
3 En la familia	❏	❏	❏
4 En las oficinas públicas	❏	❏	❏

XIX. VICTIMIZACIÓN

19. ¿Considera usted que vivir en su ciudad es:

(Anote un solo código)

O 1. muy seguro?   O 2. algo seguro?   O 3. algo inseguro?   O 4. muy inseguro?

19a. Con base en su experiencia personal, ¿qué tan seguro o inseguro se siente en los siguientes lugares? (Lea cada una de las opciones y anote la respuesta en cada caso)	1 Muy seguro	2 Algo seguro	3 Algo inseguro	4 Muy inseguro
1 En su hogar	❏	❏	❏	❏
2 En la calle	❏	❏	❏	❏
3 Centro de trabajo	❏	❏	❏	❏
4 Escuela	❏	❏	❏	❏
5 Transporte público	❏	❏	❏	❏
6 Auto particular	❏	❏	❏	❏
7 Mercado o centro comercial	❏	❏	❏	❏

19b. A continuación le voy a leer una serie de delitos y me gustaría que me dijera si usted considera que en su ciudad, estos han aumentado, siguen igual o han disminuido con respecto de los últimos 12 meses (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Han aumentado	2. Siguen igual	3. Han disminuido
01 Robo de autos	❏	❏	❏
02 Asaltos en la vía pública	❏	❏	❏
03 Venta de drogas	❏	❏	❏
04 Secuestro	❏	❏	❏
05 Robo/asalto a casas	❏	❏	❏
06 Robo a comercios	❏	❏	❏
07 Narcotráfico	❏	❏	❏
08 Homicidio	❏	❏	❏
09 Delito sexual	❏	❏	❏
10 Robo a bancos	❏	❏	❏
11 Robo a usuarios de taxis	❏	❏	❏
12 Robo a pasajeros de transporte público	❏	❏	❏
13 Secuestro express	❏	❏	❏
14 Extorsión	❏	❏	❏

XX. CAMBIOS EN LA VIDA DIARIA POR LA INSEGURIDAD

20. Por temor a ser victima de algún delito, ¿usted ha dejado de realizar actividades que antes hacia?

O 1 Si   O 2 No ⟶ *Pase a 20b*

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20a. ¿Qué ha dejado de hacer? (Lea cada una de las opciones y anote la respuesta en cada caso)	1 Sí	2 No
1. Salir de noche	❑	❑
2. Caminar por calles oscuras	❑	❑
3. Visitar parientes que viven lejos	❑	❑
4. Salir muy temprano	❑	❑
5. Tomar un taxi en la calle	❑	❑
6. Usar joyas	❑	❑
7. Llevar dinero en efectivo	❑	❑
8. Llevar tarjetas de crédito	❑	❑
9. Portar más dinero que el necesario	❑	❑
10. Otro	❑	❑

20b. ¿En el último año, ha tomado algún tipo de medida de protección, tal como: (Lea cada una de las opciones y anote la respuesta en cada caso)	1 Sí	2 No
01 poner cerraduras adicionales en su casa?	❑	❑
02 levantar bardas?	❑	❑
03 reforzar ventanas?	❑	❑
04 colocar cercas?	❑	❑
05 instalación de alarma(s)?	❑	❑
06 colocar reflectores?	❑	❑
07 adquirir un perro?	❑	❑
08 cerrar la calle donde vive?	❑	❑
09 colocar una caseta de vigilancia?	❑	❑
10 contratar seguridad privada?	❑	❑
11. comprar un arma de fuego?	❑	❑
12 portar arma de fuego?	❑	❑
13 asegurar el auto?	❑	❑
14 usar bastón de seguridad?	❑	❑
15 proteger accesorios del auto?	❑	❑
16 otro?	❑	❑

20c. Durante los últimos doce meses, ¿usted considera que la seguridad pública en su ciudad ha:

O 1. mejorado?   O 2. permanecido igual?   O 3. empeorado?

20d. En comparación con el año pasado, ¿usted considera que los delitos en su ciudad han sido:

O 1. más violentos?   O 2. igual de violentos?   O 3. menos violentos?

XXI. VIOLENCIA INTRAFAMILIAR Y ROLES DE GÉNERO

21. En la calle, manzana o barrio o colonia donde usted vive ¿conoce usted a:

(Lea cada una de las opciones y anote la respuesta en cada caso)

	Calle o manzana 1. Sí 2. No	Barrio o colonia 1. Sí 2. No
1. Una mujer que golpee a su pareja		
2. Una mujer que insulte a su pareja		
3. Un hombre que golpee a su pareja		
4. Un hombre que insulte a su pareja		
5. Un niño que sufre golpes de sus padres		
6. Un niño al que sus padres le gritan o insultan		

XXII. SATISFACCIÓN GLOBAL Y EXPECTATIVAS

22. ¿Cuál es su grado de satisfacción con.... (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Muy satisfecho	2. Satisfecho	3. Poco satisfecho	4. Insatisfecho
1. la situación económica del país?	❑	❑	❑	❑
2. la situación económica de la ciudad?	❑	❑	❑	❑
3. la situación económica de usted?	❑	❑	❑	❑
4. la situación laboral del país?	❑	❑	❑	❑
5. La situación laboral de la ciudad?	❑	❑	❑	❑
6. la situación laboral de usted?	❑	❑	❑	❑

22a. ¿Cómo considera que serán los próximos doce meses? (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Mejorará	2. Igual	3. Empeorará
1. la situación económica del país?	❑	❑	❑
2. la situación económica de la ciudad?	❑	❑	❑
3. la situación económica de usted?	❑	❑	❑
4. la situación laboral del país?	❑	❑	❑
5. La situación laboral de la ciudad?	❑	❑	❑
6. la situación laboral de usted?	❑	❑	❑

22b. En lo general, ¿Cuál es el grado de satisfacción con.... (Lea cada una de las opciones y anote la respuesta en cada caso)	1. Muy satisfecho	2. Satisfecho	3. Poco satisfecho	4. Insatisfecho
1. las relaciones entre usted y su familia?	❑	❑	❑	❑
2. sus relaciones con sus vecinos?	❑	❑	❑	❑
3. su vivienda?	❑	❑	❑	❑
4. la colonia en la que vive?	❑	❑	❑	❑
5. la ciudad en la que vive?	❑	❑	❑	❑
6. la vida que lleva?	❑	❑	❑	❑

22c. ¿Considera que ha podido tener la educación que quería?

(Anote un solo código)

O 1. Sí

O 2. No

O 3. Regular, más o menos

23. Para usted ¿cuáles son las tres cosas más importantes con las que mejoraría su calidad de vida?

23.1 _____

23.2 _____

23.3 _____

¡MUCHAS GRACIAS POR TU COLABORACIÓN!