In search of patterns of land-use in Mexico City using logistic regression at the plot level

6 Space Syntax Symposium, Istanbul Technical University, Istanbul, Turkey
12-15 June 2007

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Abstract

The study of big cities' tendency to decentralisation is in the current agenda to understand the structure of Latin American cities. In general, centres and subcentres are related to specific functions. According to the theories of the movement economy and centrality as a process, the urban grid shapes land use distribution through movement and therefore is the main determinant of the location of 'live centres', a key component of centres. Activities related to 'live centres' include retail, catering and other movement dependent uses. However, the distribution of this kind of activity in cities like Mexico is not as spatially clear as it is in organically grown cities. In this paper we show that, nonetheless complex, there is a relationship between the location of 'live centre' uses and spatial configuration. We use multiple logistic regression to evaluate exactly how much influence each variable has on the outcome 'shop' given the presence of all the others. The results also suggest different spatial influences for different types of retail on different scales of centres.

1. Introduction

Different authors in Latin American studies have highlighted current trends of population decentralization and dispersion, tertiarisation, and the consequent tendency towards polycentric cities with several clusters or subcentres of relatively independent activity. Batty's work on English town centres (1998) focuses on their definition and boundaries. They consider a selection of functions traditionally related to town centres that include retail, leisure and public administration.

According to the theories of the movement economy (Hillier, 1996, chapter 4; Hillier & Penn, 1996) and centrality as a process (Hillier, 1999), the urban grid is the main force shaping land use distribution as it accounts for the location of areas with high and others with low levels of activity. As a result, the city comprises concentrations of movement-dependent or 'live' uses, like retail, set against a background of housing. These 'live centres' are a key component of the location of centres in general. However, in the latter of those papers the shops and similar outlets investigated formed distinct localised clusters of the kind associated with London's urban villages.

It was therefore straightforward to correlate the size of clusters with the spatial variables associated with the location.

This is not the commonest arrangement. In some cities, like the present case study, the first ring of Mexico City, we find that in some parts of the urban grid shops are scattered in very small numbers, while in others they are densely aggregated across a whole area. Therefore, to show this relationship numerically, which is not in any case clear by visual inspection, becomes more complex than it may seem.

The morphology of Mexico City is also more complex than it seems at first sight. In spite of its grid-like basis, it has developed as a patchwork of offset grids. (Figure 1) The patches themselves can have very different morphologies, and especially, geometries from one another. This could be attributed to the city's process of unplanned, uncontrolled growth that started slowly with centralisation policies in the Porfirian era (1876-1910) and boomed with economic growth from the 40s to the 70s. (Luiselli, 2003). The patches correspond to areas that were 'added' in response to demographic and economic growth at different points in time to satisfy a variety of needs: the birth of a new middle class, a more exclusive area for high classes, industrial zones, housing for the labour force mainly consisting of migrants**,** irregular settlers, illegal 'developments' for the poor, etc. Even though many of them were not supplied by the government that does not mean that they 'developed'. Most of the patches would align a grid to the nearest main road. Even the irregular settlements of the overnight invasion type[1] would normally adopt the grid (Cymet, 1992). The inner geometry would vary in terms of size, compactness, density, etc. depending on other factors. Other patches with 'designed' morphologies that are further away from the regular grid or that combine it with other forms could reflect ideologies of the time. We also find the squatter irregular settlements that developed over a longer period of time thus showing a more organic inner pattern (Cymet, 1992). Finally, there are the adaptations and subdivisions that have occurred in the original Spanish grid of the Historic Centre of the city. The last two are the only processes that could be regarded as more 'naturally' developed rather than 'added'.

Figure 1. First ring of Mexico City: urban grid.

A third problem is size. The study area covers the rough 12 by 9 km encircled by the first ring road. At the level of plots in a city as dense as Mexico, this becomes a huge dataset (159,521 plots). Then again, it is at this level of resolution that we can better understand cities.

The chosen approach to deal with a problem this complex was multiple logistic regression, a statistical technique for binary (yes or no) cases that allows the simultaneous input of multiple factors. This technique evaluates quantitatively the influences of each variable in the presence of all others. The results suggest the location of 'live' and residential uses is influenced by configuration. Furthermore, the current study fosters the idea of a hierarchy of centres where different properties of space exert different influences in the location of specific uses related with 'live centres' of dissimilar size or nature. Main centres seem to be supported by global-to-local properties while small centres tend to develop in a spectrum that goes from more even global and local-to-local conditions.

2. Mexico City: current trends

Ecological conceptions of Latin American cities suggest a centralised, concentric urban structure with one CBD and inner city which constitutes the focus of employment, commercial and entertainment activities and cheap goods supply, and where socio-economic status of residential zones and population density, other than in the elite zones surrounding a commercial spine containing the city's most important amenities, decrease with distance from the centre (Griffin &

Ford, 1990, later modified by Ford, 1996). Nonetheless, a number of studies, outlined in this section, point towards a decentralised pattern of multiple centres.

Density studies suggest that Latin American cities have been experiencing decentralisation of population and, to a lesser extent, decentralisation of employment in the last decades. Ingram and Carroll (1979) highlighted this pattern in a study where they compared the densities in a number of Latin American cities, including Mexico City, with similar North American cities. They showed how in Mexico City central densities, although high, started to stabilise, while peripheral densities kept rising like in the other nine Latin American cities studied. They estimated the rate at which population density falls with distance from the centre, known as *density gradient*, using a population density function to account for the different definitions of the metropolitan areas studied. Their findings denote the tendency of larger cities, like Mexico, to have less steep gradients than smaller cities. Mexico City also appears to have a declining (central) intercept density over time despite its rapid population growth.

The Federal District Urban Development General Program (PGDUDF) (Gobierno del Distrito Federal, 2003) suggests decentralisation of population from the centre to the periphery as a consequence of the process of land-use changes and tertiarisation (p. 22), another concept that can be related to the polycentric city. *Tertiarisation* refers to the concentration on services and trade of an urban economy; hence it can be said to be focused on *tertiary sector* economic activity as opposed to primary (agriculture) or secondary (manufacturing) sectors. Ward (1990) points this trend as a result of the decline of industry in the central city together with growth and commercial redevelopment pressures to change land-uses in certain areas, generally from single-family residences to shops, offices or multifamily housing. Luiselli (2003) considers that tertiarisation, together with digitalisation, in the Mexican metropolis are possible only because of economies of agglomeration given the city's large population. Thus, the existence of a large enough consumer market allows for the recovery of investment in sectors of large aggregated value like in the case of professional services. (p. 181) In line with these ideas, Aguilar suggests *polarisation reversal* in large urbanised Mexican and Latin American regions (1999): in recent years, industrial activity has grown more rapidly outside than within metropolitan areas. His evidence also indicates a high rate of growth in the commercial and service sectors in urban settlements.

Anas et al (1997) use the concept of agglomeration economies (and diseconomies) to explain polycentricity. They present them as centripetal and centrifugal forces. The first, push people to cluster to take advantage of economic and social benefits; the second, limit the extent of clustering by congestion or other disamenities (p. 4-10). The balance between these forces then determines a certain *pattern selection* (Krugman 1996) in the spatial structure so that proximity facilitates specific transactions. However, centres are heterogeneous and scale dependent, and since they involve dynamic processes their definition is sensitive to arbitrary limits so in order to understand the order of any patterns it becomes necessary to understand the spatial structure they are embedded in.

3. Cities as movement economies

Space syntax provides the right framework to understand urban spatial structure in this context. According to the theories of the movement economy and centrality as a process, the urban grid should account for the formation of the clusters of activity associated with 'live centrality'.

The theory of the '*movement economy'* (Hillier, 1996) suggests that the 'living city' –the city, comprising areas with more and areas with less urban 'buzz'-- is determined by a space-to-function process which influences land-use distribution, allowing certain functions like retail in the areas with the most natural movement, and others like housing where the natural movement is low. 'Natural movement' is defined as *'the proportion of urban pedestrian movement determined by the configuration of the grid itself'* (Hillier et al, 1993, p.32). Therefore it is common to find areas in cities where activity of the more 'lively' kind –mix of land uses with prevalence of retail-- seems to concentrate. They are known as 'centres' or 'subcentres' and it is usually fairly clear, if not explicitly, at least as an idea, where and what they are. *'Live centrality'* refers to these concentrations (Hillier, 1999). It explains how their spatial location in a settlement is strongly influenced by natural movement as specific uses look for the most accessible locations to benefit from high levels of movement which in turn attract more movement and further changes in the land-use pattern. The key factor in this process is the influence of spatial configuration on movement, creating *'complexes of interdependent facilities'* with maximised interaccessibility[2].

The urban grid's potential to attract movement is quantified through the accessibility of a representation of space where every line of potential movement is represented as a node of a network. In traditional space syntax analysis, accessibility has been determined by the configurational values of 'global' and 'local integration' in the axial map that describe the depth of each node in relation to the system (Hillier & Hanson, 1984). Local interaccessibility within centres is emphasized through grid intensification: blocks tend to be smaller in size as centres grow to allow greater ease of movement (Siksna, 1997); the greater the scale of the centre, the stronger this process seems to be (Hillier, 1999).

In the case of this analysis, two kinds of spatial representation have been adopted: the axial lines and the continuity lines. Continuity lines offer a compressed description of the urban grid based on flows and simplest routes between places. They emerge from a generalisation of the axial map where axial lines are aggregated to represent an urban path *'in its maximum extension, respecting a maximum sinuosity previously defined'*, hence reinforcing the global properties of the system (Figueiredo & Amorim, 2005). The argument is that continuity lines overcome some limitations of axial lines (Peponis et al, 1997; Turner, 2001; Asami et al, 2003; Dalton, 2001) by standardising long straight and curved or sinuous paths into equally important lines of movement in the hierarchy of streets.

4. Distribution of retail in the study area

Figures 2 and 3 show axial and continuity maps of the first ring of Mexico City as delimited by the first ring road, *Circuito Interior*. They both highlight the grid-like nature of the system showing the main axes as the most integrated lines. In addition, the continuity map also picks some routes that in reality form a continuum of movement but in the model are translated into several lines given their sinuous nature. Mainly, *Reforma* and *Viaducto* become very evident in this representation. The most integrated line in both cases is *Insurgentes Avenue*. However, areas equivalent to the London villages cannot be clearly distinguished.

Figure 2. Axial map of first ring of Mexico City: Integration R2.

Figure 3. Continuity map of first ring of Mexico City: Integration R2.

On the other hand, Figure 4 shows the spatial distribution of all shops and catering outlets (referred to as 'retail' or 'all retail' in the rest of the paper) in the study area. In spite of a couple of more concentrated clusters, the largest one around the Historic Centre and a smaller one located around *Colonia Obrera*, between *Rio de la Loza* and *Viaducto*, and slightly more consistent concentration along main roads, retail seems to be scattered across the whole area with diverse degrees of dispersion.

To search for grid intensification process in Mexico City, block size has been included in the analysis (Figure 5). Darker colour in the map indicates smaller blocks. Nevertheless, it does not seem to match visually the distribution of live uses.

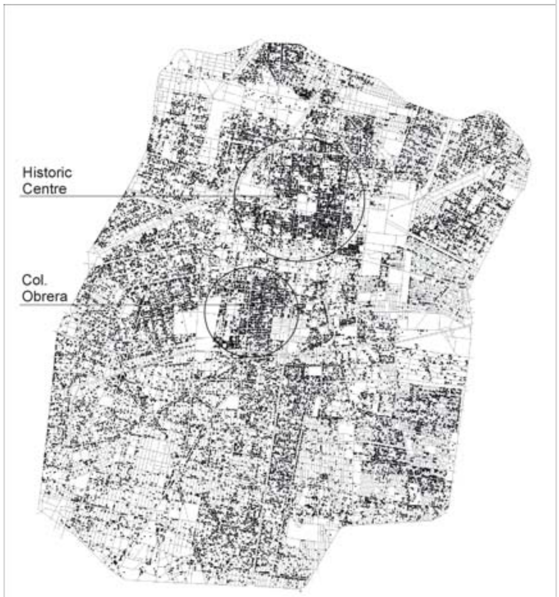

Figure 4. Shops and catering outlets in first ring of Mexico City.


Figure 5. Block size in first ring of Mexico City.

5. The rate problem and the concept of opportunity

What seems to be needed next is some measure of the *rate* of shop formation in different spatial situations. The notion of a rate however requires us to refer it to some measure of opportunity, such as the number of plots or shops or the length of a line or segment or some combination of the two.

Unfortunately, such normalisations are fraught with pitfalls. In the case of shops, the longer the line or the higher the total number of plots on a street segment, the higher the prospects of the random event 'shop' to occur just because more plots means more opportunity. If we try to normalize, say by dividing the number of shops by the line length, the problem will only be inverted so for example, a random shop falling on a short line with few dwellings will be assigned a higher rate than one falling on a long line, though both may be equally chance events. In long lines, each event 'shop' will contribute less to the rate giving a false picture of its opportunity to happen. Figure 6 is a scattergram that shows the relation between the number of retail outlets per segment and the rate of retail divided by segment length. The segments with the highest numbers of retail have the lowest rates and vice versa. Additionally, strong clusters of shops on a high street will also generate shops on short lines attached to the high street, and this will again fall foul of our attempts to normalise. The problem is very similar to that of trying to establish a rate for crime in a location (Hillier & Sahbaz 2005).

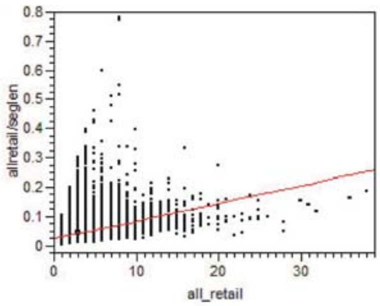

Figure 6. Number of retail outlets per segment and untrue rate of retail.

In order to overcome both, the problem of retail dispersion and that of false rates, accounting for the drive exerted by different spatial variables simultaneously, we use logistic regression. It is a multivariate technique for cases when the outcome is binary, say alive or dead, and the technique evaluates exactly how much influence each variable has on the outcome given the presence of all the others. It is much used in medical research where situations are multivariate and outcomes are often binary in this sense. In this case the binary variable is 'retail or not', but it could equally well be used for any other land use category. The syntactic variables used were local and global integration and choice. The geometric variables were length, connectivity and block area, the latter to examine the influence of local grid conditions.

First, using Mindwalk (Figueiredo, 2004), a piece of software specifically designed for spatial analysis, all 159,521 plots were connected to axial or continuity lines representing the street network. This method is part of a parallel underway study that aims to show the non-linear relationship between accessibility and land-use in Mexico City using a scaling 'pattern matching' technique[3]. Hitherto, there seems to be a trend of the kind described by the process of centrality. That is, roughly speaking, that retail uses increase and residential use decreases with increased accessibility (Figure 7). In that approach, the connected plots become additional nodes in the spatial network. For the purpose of the current study, once plots were 'assigned', they merely inherited the spatial and geometric properties of the lines. Unfortunately, the segment model could not be compared because of computer capability limitations.

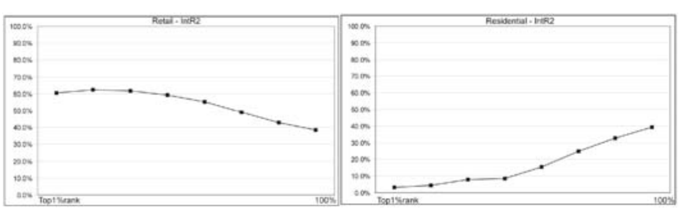

Figure 7. Proportion of retail (left) and residential (right) plots in integration R2 rank.

6. Mexico City… a movement economy?

If we compare the averages of some spatial measures of residential and non-residential uses on both models (Tables 1 and 2), we find that non-residential ones tend to be in longer, and therefore more connected lines, especially with the compressed continuity map. They also have higher values of integration and choice. These values are even higher when it comes to retail plots.

Table 1: Mean spatial measures of different uses for axial map

	N	%	Length	Conn	IntR2	IntRR4	IntRN	Choice
Residential	106710	66.8	1002.52	12.61	4.4	2.81	1.76	35651.45
Non-residential	49017	30.7	1613.08	21.28	5.18	3.09	1.95	115801.32
of which retail	29678	18.6	1653.12	22.46	5.28	3.11	1.97	123735.15

Table 2: Mean spatial measures of different uses for continuity map

	N	%	Length	Conn	IntR2	IntRR4	IntRN	Choice
Residential	106710	66.8	1581.21	17.82	4.99	3.83	2.7	33448.13
Non-residential	49017	30.7	2948.46	34	5.99	4.35	3	89256.95
of which retail	29678	18.6	2991.89	35.21	6.07	4.37	3.03	90973.91

With a closer look it can be noticed that the highest increases from residential to non-residential are in mean choice, with an increase of 224.8% for the axial map and 166.8% for the continuity map, mean connectivity, with +68.7% for axial and +90.8% for continuity, and mean length, with +60.9% for axial and +86.4% for continuity. Yet we cannot tell much as to how configuration is playing a role in the location of live uses related to centrality.

Next step was to apply multiple logistic regression to try to find out if the different spatial and geometric variables were influencing the presence of retail use, or residential on the opposite case, and if they did how much was each one 'contributing' to the process. The models were first explored for retail[4] and residential use, then for different sizes of retail, and finally subdivided into two sub areas.

Retail plots in axial mapping show a strong influence of **global integration** with an odds ratio of **2.69**. This implies that if the rest of the independent variables are held still, the odds or likelihood of a retail outlet increase by **169%** per increase unit of global integration.[5] Other variables supporting retail are connectivity with a less marked 1.524 odds (+52%) and a low, but still **positive**, effect of block area. The effect of choice is minimal. The continuity map suggests similar results except that the most influential factor seems to be connectivity and then global integration, although the difference between both increments is small (odds ratios: 1.45 and 1.39). The values are smaller than those for the same variables of the axial map too. Overall, the continuity map seems to show lower figures that are also less differentiated from one another.

Residential locations in both models show the opposite tendency being less likely with incremental spatial values. The highest negative influence is **global integration** with **-66%** for axial and **-38%** for continuity, followed by block area (35 and 32% respectively) having an, again unexpected, negative effect on housing that is stronger than that of connectivity. In other words, this would mean that the probability of housing use decreases by 35% when block size increases. (Table 3)

Table 3: Logistic regression for retail and residential best fit (p value<0.0001 for all variables)

	Retail	odds ratio	influence	Residential	odds ratio	influence
Axial	Int RN	**2.698**	+169%	Int RN	0.338	-66%
	Connectivity	1.524	+52%	Block area	0.651	-35%
	Block area	1.133	+13%	Connectivity	0.685	-31%
	Choice	1.051	+5%	Choice	0.938	-6%
Continuity	Connectivity	1.456	+45%	Int RR3	0.612	-38%
	Int RN	1.390	+39%	Block area	0.676	-32%
	Block area	1.123	+12%	Connectivity	0.814	-18%
	Choice	1.047	+4%	Choice	0.946	-5%

The second approach was to look at different types, or ‘scales’ of retail to see if there were any substantial differences in their patterns. ‘Big retail’ includes all main shops and service outlets, markets, catering and entertainment. ‘Small retail’, on the other hand, refers to housing plots, often planned as exclusively for housing, where retail activity has developed in the lower floors. These are normally associated to a smaller-scale, more local and bottom-up pattern. It is clear, at least empirically, that these two kinds of retail tend to have different locations.

Table 4 shows the summary of logistic regression analysis of these two types of retail. **Global integration** seems to have a remarkable influence of **424%** in the location of **big retail** uses in the axial model and **200%** in the continuity one, while **block size** affects them with **+41% and 34%.** This result denotes the positive contribution of larger blocks to the presence of big shops. Local factors seem to have a mild positive effect according to axiality but a negative one in the continuity model.

The results for both models differ when it comes to **small retail** even though they both go in line with the pattern of all retail explained earlier. Axial lines indicate a higher global than local influence whereas continuity lines highlight local over global properties of the system but with less variation between them. As expected, global influence is higher for big than for small retail and the opposite is true for local measures.

Table 4: Logistic regression for retail types best fit (p value<0.0001 for all variables)

	Big retail	odds ratio	influence	Small retail	odds ratio	influence
Axial	Int RN	**5.249**	+424%	Int RN	1.948	+94%
	Block area	1.410	+41%	Connectivity	1.528	+52%

	Connectivity	1.241	+24%	Block area	1.064	+6%
	Choice	1.102	+1%	Choice	1.038	+3%
Continuity	Int RR3	3.008	+200%	Connectivity	1.454	+45%
	Block area	1.344	+34%	Int RN	1.135	+13%
	Length	0.793	-20%	Block area	1.058	+5%
	Choice	1.111	+11%	Choice	1.040	+4%

7. Different kinds of centres

Another important aspect to consider is the fact that the old Historical Centre, the original core of Mexico City and still one of its main retail centres, is within the study area. In terms of this analysis there might be implications as to whether this large compact concentration of live centre activity affects the results for the rest of the mostly more dispersed location of outlets (See Figure 4). In order to further investigate this and the different tendency towards global or local of both modelling representations, the study area, the first ring of the city, was subdivided into two smaller areas that were analysed separately using the same technique. The split was done north and south of the *Viaducto* road that cuts the system roughly by half. The resulting northern sub area (HC) comprises 74,940 plots which include the whole of the Historical Centre plus surrounding neighbourhoods. The southern half (SC) has a total of 79,734 plots. SC and most of the areas surrounding the HC have a more homogeneous residential background. The reasons for splitting the system in two, as opposed to cutting out the Historical Centre and analysing it in isolation, or using neighbourhood or other kind of political demarcation, are several. Foremost, political boundaries seem arbitrary, cutting through areas that in reality are known and feel like one area and even seem geometrically alike visually. They are also inconsistent: neighbourhoods sitting on the limits between *delegaciones*, the broadest administrative units, sometimes belong partly to one and partly to another *delegacion*. In addition, as it often happens with urban centres, the Historical Centre's boundaries are not well defined and in some places its more like certain kinds of activity seem to 'fade' into each other.

The results suggest a more detailed picture of the location of retail in the city (Table 5). For **HC**, **global** integration maintains its predominant influence on **big retail** on both models with 397 and 222%. The effect of connectivity becomes negative (24%) in the axial model, approximating the previous and current results for continuity. **Small retail**, where there was the most discrepancy between models in the previous analysis, stresses **global** over local in HC: in the continuity map the highest influence is now that of global integration (49%) while in the axial map the already existing gap between global and local is stretched (143 and 13%).

The influence of global integration on **big retail** in **SC** is **much lower** than on the overall model and on HC. In the axial map it continues to be the highest one with +103%, but it appears significantly reduced compared to HC and the whole first ring. It is followed by connectivity that now contributes twice as much with 41%. In the continuity equivalent the **focus shifts marginally** (only one percentile point difference from global integration) to connectivity with 56%. The results for **small retail** in **SC** seem to experience even higher tendency towards the impact of local factors. For the axial map, where the stress is on global properties, such stress decreases so the gap between global and local decreases (+30 to +20%); for continuity, with focus on local properties, the gap increases (+68 to -17%).

Table 5: Logistic regression for retail types by area best fit (p value<0.0001 for all variables)

Historical Centre and surroundings (HC)						
	Big retail	odds ratio	influence	Small retail	odds ratio	influence
Axial	Int RR4	4.972	+397%	Int RN	2.438	**+143%**
	Block area	1.587	+58%	Length	1.303	**+13%**
	Connectivity	**0.760**	**-24%**	Block area	1.203	+12%
	Choice	1.140	+14%	Choice	1.052	+5%
Continuity	Int RR3	3.220	+222%	Connectivity	**1.149**	**+14%**
	Block area	1.520	+52%	Int RR3	**1.493**	**+49%**
	Connectivity	0.648	-36%	Block area	**1.230**	**+23%**
	Choice	1.144	+14%	Choice	1.045	+4%
South of Centre (SC)						
	Big retail	odds ratio	influence	Small retail	odds ratio	influence
Axial	Int RR4	2.037	**+103%**	Int RN	1.305	**+30%**
	Block area	1.216	+21%	Length	1.199	**+20%**
	Connectivity	**1.410**	**+41%**	Block area	**0.895**	**-11%**
	Choice	1.169	+17%	Choice	1.117	+11%
Continuity	Int RR3	**1.558**	**+55%**	Connectivity	1.679	+68%
	Block area	1.161	+16%	Int RR3	**0.834**	**-17%**
	Connectivity	**1.565**	**+56%**	Block area	**0.931**	**-7%**
	Choice	1.077	+7%	Choice	1.046	+4%

Global effect remains higher for big than for small retail location in all cases. Nevertheless, the values are considerably smaller in SC. Local measures are not only higher for small retail in HC but they also have a negative influence on big retail. In SC, their area of influence is not as differentiated but it is still slightly higher for small than for big retail in the continuity model. This is not the case for the axial model but the difference is also narrow. **Compared to the whole study area, block size's contribution rises in all four cases of HC, reaching over 50% for big retail.** The opposite happens in SC where the influence of block size drops in all four cases becoming negative for small retail. The role of choice, although keeping a limited influence across all cases, appears a little clearer when we disaggregate the model, with twice as much effect in big than on small retail in SC, and three times in HC.

8. Discussion

The aim of this paper has been to investigate the relationship between movement-seeking land uses and spatial accessibility. Although it might not be as evident (or perhaps it is better to say that it is not evident at all!) as for more organically grown cities, like western cities, there seems to be a spatial hierarchy shaping the pattern of land use distribution in Mexico City. A reason for the apparent mismatch at first glance could be its patchy grid nature. The spatial pattern in cities like the much studied London consists in the ‘deformed wheel’: an integration core and a number of integrated spikes that radiate from it to the limit of the settlement. These spikes normally correspond to lines of growth. Mexico City, like many other Latin American cities, has grown very rapidly over the last few decades, faster than its planning process, and over an imposed orthogonal grid. In most of the cases, new neighbourhoods ‘follow’ the grid by aligning to main roads. However, the inner structure could differ greatly depending on its origins. The city ended up as a patchwork of areas with different geometries and morphologies. Also, there are no lines of growth as such since the structure (main grid, new main roads, block structure of different areas) has been imposed so it is somehow ‘artificial’.

Despite all that, the results of the present analysis suggest that land use distribution in the first ring of the city follows the theories of movement economy and centrality as a process. The first part of the analysis indicated the positive influence of high syntactic values on the ‘live’ uses that are traditionally found in centres and also benefit from movement. These forces also appeared to have a negative influence in the location of residences. The analysis at this point seemed to highlight a mostly globally driven process.

Subsequently, the more we disaggregated the analysis into different categories and later into different areas that are qualitatively different, the more we could understand the processes it entails by looking at it quantitatively. We can agree with previous studies pointing to decentralisation and a polycentric city as there is obviously a hierarchy of centres in the current study. Even though this paper did not look specifically at the issue of size, it presents evidence that supports the idea of different ‘kinds’ or ‘scales’ of live centres that, rather than being associated with specific types of retail as they often are (global ‘big name’ shops versus small-scale local ones), relate directly to the street hierarchy as defined by configuration. There seems to be a wide and gradual global-to-local spatial ‘range’ for live centre activity to locate itself depending on the importance of the centre or subcentre. Different positioning in the ‘global-to-local scale’ was found for the four spatio-functional binomials studied.

- Main centres, which come out as denser clustered concentrations, are strongly determined by the global structure regardless of the kind of retail. In the case of big retail, not only is global configuration extremely predominant compared to other values, but local factors have a negative influence on the location of big shops. Main centres-big retail appears to lie on the global end of the scale.

- Yet, when it comes to small retail in the same kind of centre, albeit still being globally predominant, the effect of local factors is low but positive. Main centres-small retail moves slightly away from the global end and towards the local end.
- In smaller centres, where retail is more dispersed, the presence of big retail seems to be influenced considerably by both, global and local forces. In fact, when the network was described as a continuity map, an aggregated representation that reinforces the local properties of the grid as it is explained later, the global and local influences seem to be more or less even. Small centres-big retail then, are found around the middle of the scale.
- The most local case is small centres-small retail. The absolute result again varies depending on the representation but the interpretation is the same: these are located further towards the high local influence end of the scale.

However, the latter of the theories mentioned above refers to two spatial strategies to maintain interaccessibility to 'live centres': highly integrated lines that lead to them and grid intensification conditions for easier movement. We attempted to look at the second of these points by examining block size, measured as block area, in the Mexico City case study. The results indicate that the study area might lack or, at the least, have a weak grid intensification effect of the Siksna kind (1997). For residential uses, the influence of block size is negative, that is, residences seem to be more influenced by smaller blocks. Some of this effect can be attributed to the presence of a few *unidades habitacionales*, housing-estate-like housing units, but besides these there are also some residential areas with very compact allotment. Unexpectedly, small retail (big retail can be expected to have a certain degree of correspondence with big blocks) in main centres seems to relate, though slightly, to big blocks. Small retail in small centres was the only case associated with small blocks but with a very marginal influence.

An interesting point is the discrepancy between the outcomes of analysing axial and continuity maps. Continuity maps are a compressed description of an urban system. This means that since lines are aggregated, the total number of lines or nodes is less than in its equivalent axial representation. However, lines are also longer so each line will 'reach' more other lines (node count) at every step. This is true for global and local measures, but global node count is fixed while local is not, so it is the local that will tend to reach more towards global the more compressed the system becomes. As a result, their effects seem more 'blended' and the particular influence of each one appears less evident than in the axial map. Figures 8a and 8b illustrate the 2-step grid from the highest local integrator for axial (part of *Insurgentes Avenue*) and continuity maps (all *Insurgentes Avenue*) respectively. The former, covers 573 out of 4773 lines and the latter, 951 of 3836: 12 against 25%.

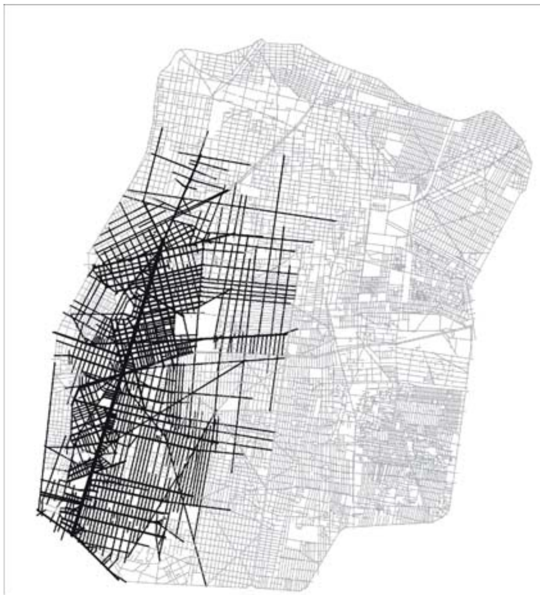

Figure 8a. Axial map: 2-step grid from highest local integrator.

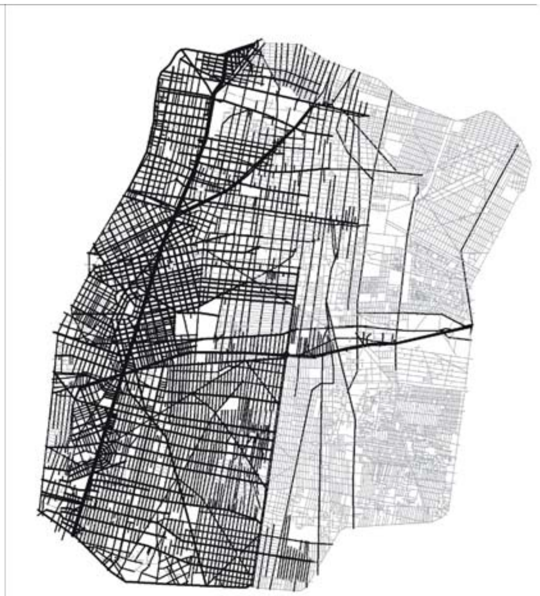

Figure 8b. Continuity map: 2-step grid from highest local integrator.

The global and local influences in most of Mexico City, certainly in the first ring, are highly diffused because of the grid nature of the system. The continuity map emphasizes this effect by shortening the differences between them. This does not necessarily give a less true spatial picture of the city: aggregated lines correspond better to real roads that are understood as 'spatial units' within the city's context. Even so, it is clear that disaggregating gives more details on the complex relationships between space and land use.

9. References

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[1] Invasion settlements that occur through massive overnight surprise operations where streets or plots are mapped in advance by the leaders of the movement.

[2] Ease of movement from one place to another within the town centre and to the town centre from the settlement as a whole.

[3] Work in progress being developed in The Bartlett School of Graduate Studies, UCL, by Figueiredo and Ortiz-Chao.

[4] The study does not include 'informal' commercial activity.

[5] Note that an odds ratio above 1.0 refers to the odds of the dependent variable happening. The closer the odds ratio is to 1.0, the more the independent variable's categories are independent of the dependent variable, with 1.0 representing full statistical independence.