ID 1676 | ANALYSING RETAIL LOCATION AND URBAN DYNAMICS IN LISBOA

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1 INTRODUCTION

What drives people into a city? Some cities seem able to attract workers and residents, sometimes tourists, eventually all of these. Some are commuter towns. And some are, to some extent, in between those. Christaller (1933) considered the city to be the centre of a market area, and Lösch (1954) further elaborated on that theory. Location theories date back to von Thünen (1826), but close to the 21st century, Krugman (1991) posed a relevant question: why is it that in such a large, fertile country like the U.S.A. "the bulk of the population resides in a few clusters of metropolitan areas?". The question was later emphasized, with Clarke (2003) and Jayne (2006) assuming postmodern cities as places of consumption.

Jacobs (1961) had long hinted at why people live in cities: "Not only do public characters spread the news and learn the news at retail, so to speak. They connect with each other and thus spread word wholesale, in effect.". The city was presented as more than just a market centre – it was an organic system, whose complexity couldn't be modelled at the time.

But modelling complex systems has evolved significantly, with the focus, in some cases, having shifted from "how to" to "how well", as more data becomes available and models become more sophisticated. "What scientists really need to know is exactly how well (or how poorly) their models perform over a broad range of conditions and criteria" (Costanza, 1989). Even though results still can't provide absolute certainties, they can prove to be relevant for research.

Therefore, this paper aims at contributing to research on modelling a complex system, by identifying factors that might explain retail spatial distribution, and analysing its effects on a city, with Lisboa being used as a case study.

Relevant insight on the subject has been provided by a number of authors, but the works of Mullins (Mullins et al., 1999) in relating households' location and consumption spaces, Borck (2007) in linking city size and measures of consumption and social interaction, Porta (Porta et al., 2009) in modelling the relationship between street centrality and commercial density, and Sevtsuk (2014) in identifying location patterns in retail and food establishments, were essential to this paper in the way they approached data and presented results. Using density surfaces to represent data relied heavily on the work of Thurstain-Goodwin and Unwin (2000) and Batty (Batty et al., 2004), as will be seen.

The paper starts with an overview of retail spatial distribution in Lisboa, but eventually focus on neighbourhood-scale retail: amongst retail, neighbourhood-scale promotes a relevant role in aiming for more sustainable communities – it encourages interaction between neighbours, walking instead of driving, and can help generating local employment (Sevtsuk, 2014). It's a key element of neighbourhood liveability and thus fundamental in the context of the contemporary – postmodern – city. Its resilience helps maintain a neighbourhood's vitality (Barata-Salgueiro and Erkip, 2014).

The location of retail establishments in the city of Lisboa, in two different periods (1995-2002 and 2002-2010) is analysed, and quantitative relationships with demographic factors are therefore established. Spatial analysis is used to uncover spatial patterns, and spatial regression analysis for correlating data.

1.1 CASE STUDY

An opportunity to analyse the evolution of the retail structure in Lisboa was presented when a geo-referenced database pertaining commercial establishments, and referring to several years between 1995 and 2010, was made available by the City Council. Considering that, around that period, the National Institute of Statistics ("INE") had conducted 3 national population and housing censuses ("Censos"), trying

to establish a relationship between commercial activity and demographic data also became feasible. Therefore, the demographic data used on the analyses refers to the censuses of 1991, 2001 and 2011 (INE, 2014, 2014a and 2014b), while for commercial data, 1995, 2002 and 2010 were used (CML, 2016).

1.2 SPATIAL ANALYSIS

A geo-referenced database of establishments containing 14.673 locations in 1995, 16.092 locations in 2002 and 17.035 location in 2010 was used to analyse spatial distribution of establishments. Establishments were compared both globally, disaggregated into "sectors" ("retail" and "restaurant") and into 10 types of activities: Foods (non-prepared: includes groceries and similar establishments, excludes restaurants, cafes, bars and similar establishments); Personal Use Items (mainly clothing and clothing accessories); Household Articles;

Health and Hygiene items; Leisure items (sporting goods, bookshops, music stores, etc.); Repairs (all sorts of repairs); Other items (all other items non-included in the remaining types); Restaurants and similar establishments; Cafes and similar establishments; Bars and similar establishments". The first seven types were considered the "retail sector", while the remaining three were considered, globally, the "restaurant sector".

A zoning system was defined considering the following:

1. Commercial locations were available as point features. Point density was used to create continuous surfaces, by calculating "a magnitude-per-unit area from point features that falls within a neighborhood around each cell" (ESRI, 2016);
2. Demographic data was available as polygon features. INE uses a zoning system of statistical subsections ("subsecção estatística"), with each polygon corresponding to a block in urban areas (INE, 2014c). Since their limits varied between 1991, 2001 and 2011, the polygon features were converted into points, and then into continuous surfaces, by using the process previously described for commercial locations;
3. Finally, a grid of 150m x 150m polygons was created (meaning an area of 22 500m2, similar to the average size area of INE's statistical subsections), to which all data was then related, allowing for an OLS-type regression to be modelled.

1.2.1 POINT DENSITY

Since data with this level of disaggregation has an "intrinsic granularity" with variables presenting "extremely high variances, with a pre-dominance of zero values and hence extremely non-normal frequency distributions" (Thurstain-Goodwin and Unwin, 2000), and considering the final purpose of modelling a regression, using continuous density surfaces presented itself as a way to both go around this problem and better identify patterns "by smoothing the data to iron out the inevitable discontinuities that take place from data that are originally represented by land parcels and/or the fine scale postal geography" (Batty et al., 2004).

Density surfaces were produced for establishments and a set of demographic indicators. In commercial establishments, density represents the number of point features found at a fixed distance (radius) around each cell, per unit area (km2). For demographic factors, the value of the variable being analysed served as the weight for each point feature.

1.2.2 COMMERCIAL DIVERSITY

To examine the diversity of commercial activity within each grid cell, an index based on Shannon's entropy was used (Song and Knaap, 2004).

$$\text{Entropy} = -\sum \frac{[Pj \times \ln (Pj)]}{\ln (J)}$$

with Pj being the proportion of establishments of type j, and J the total number of establishment types, for each grid cell. This index varies between 1 and 0, with 1 representing a perfect balance between all J types found at cell level.

Entropy was calculated using the disaggregated data for the 10 establishment types.

1.3 SPATIAL REGRESSION ANALYSIS

Regression analysis was used to test if the location of one type of establishment relies on the presence of other specific types. For this purpose, ordinary least squares regression was used.

The purpose of linear regression analysis is, as known, to find a (linear) relationship between a dependent variable and a set of explanatory variables:

$$y = X\beta + \varepsilon$$

with data consisting of n observations, and y being vector of n×1 scalar responses, X an n×p matrix of predictors (with p being the number of predictors), and ε a n×1 vector of unobserved scalar random variables (errors).

One establishment type was considered the dependent variable (Foods), with the remaining used as dependent variables (predictors). Variables accounting for demographic factors (population, ratio of younger residents (under 13yo) and older residents (over 65)) and economic activity (with primarily non-residential buildings posing as a possible source of information for job location) were also included in the model. An additional variable, “Activity within Malls”, was calculated by dividing the density of establishments located within malls by total establishment density. All variables represent densities (as explained in Point Density) or ratios of densities.

A classical OLS regression was performed, with a considerable number of variables being significant at the 99 percent level. But diagnostics for spatial dependence (Lagrange Multiplier) signalled for significant spatial autocorrelation, making the OLS results unreliable (Anselin, 2005; Sevtsuk, 2014).

To overturn the bias, a spatial lag model was used. Having set a weights matrix, the model runs an implementation of the previously mentioned function:

$$y = \rho W y + X\beta + \varepsilon$$

where y is an n×1 vector of observed dependent variables, W is a n×n spatial weights matrix that describes adjacency relationships, and ρ is the spatial autoregressive parameter (lag).

The general model fit was improved when compared to classical OLS, as was indicated by a higher value of R-squared, and analyses was made possible.

2 RESULTS

2.1 SPATIAL ANALYSYS

2.1.1 POINT DENSITY

“Eventually, a range of resolutions is necessary to adequately describe the fit of models with reality” (Costanza, 1989). Transforming points to surfaces by using point density required the choice of a radius. Smaller radii added to the resolution (but increased the difficulty in discerning patterns), and larger radii implied significant data loss (though revealing patterns that could be relevant at regional scale), as shown on Figure 1. Finally, a radius of 300m was considered appropriate, and density surfaces for commercial activity were created. Figure 2 present total establishments variation between analysed periods.

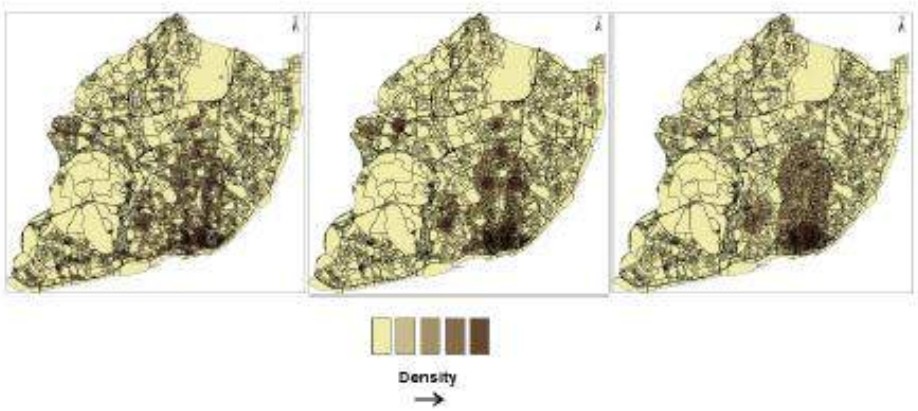

Figure 1 – Total Establishment Density (2010) using 100m, 300m and 600m radii (left to right)

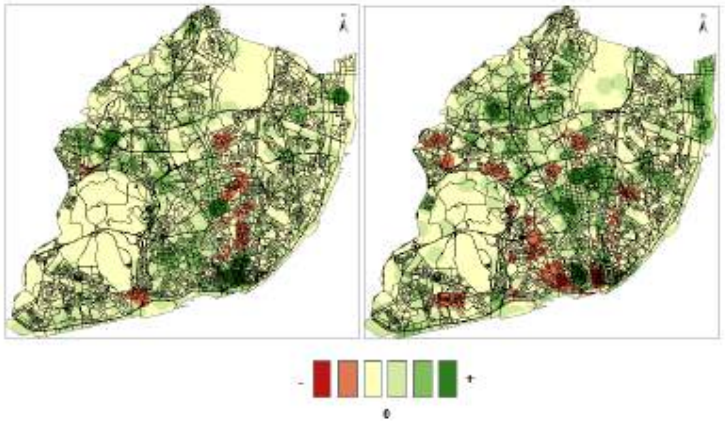

Figure 2 – Total Establishments Variation: 1995 to 2002, and 2002 to 2010 (left to right)

The period between 1995 and 2002 can be directly related to a stage in the evolution of shopping malls (Cachinho, 2002) characterized by the opening of few but (much) larger units when compared with previous decades (before 1990). Apart from Baixa-Martim Moniz (the dark green irregular area, south in the left image), they amount for all other significant, positive variation in establishment density: Colombo (opened 1997) is the dark green circle northwest, Vasco da Gama (opened 1999) the one northeast, and closer to the centre, in the Saldanha neighborhood, Atrium Saldanha (1998) Saldanha Residence (1998), and Picoas Plaza (2001), with slightly different characteristics, amount for a significant commercial area when considered as a whole (especially when including the renovated Monumental cinema, inaugurated just before, turned from a cinema into a multiplex cinema with a commercial area).

The impact of the shopping malls is evident on Avenida Almirante Reis, Avenida de Roma and Alvalade, traditionally associated with commercial activity at street level (these areas form the axis shown in orange, east of Saldanha). This period thus represents (roughly) a decade where commercial activity was still growing, even though malls were already capturing a significant part of what had previously existed at street level. In the following period, the effects were extended to the remaining traditional commercial areas, including Baixa, but also Madragoa-Estrela-Campo de Ourique (the axis shown in orange, west of Baixa) and Estrada de Benfica (the orange patches southeast and southwest of Colombo). Two additional shopping malls opened (and are visible) in more central areas: Campo Pequeno, less than 1 mile north of Saldanha, and Acqua Roma, east of it, in the heart of yet another traditional commercial area, Avenida de Roma.

In this second period, Vasco da Gama became central in a new neighborhood: Parque das Nações (the former Expo98 grounds, which transitioned into a new neighborhood of Lisboa). Up north, the residential areas of Telheiras and Lumiar /Alta de Lisboa also revealed some growth dynamics.

Figures 3 and 4 present the variation for the restaurant and retail sectors, as previously defined.

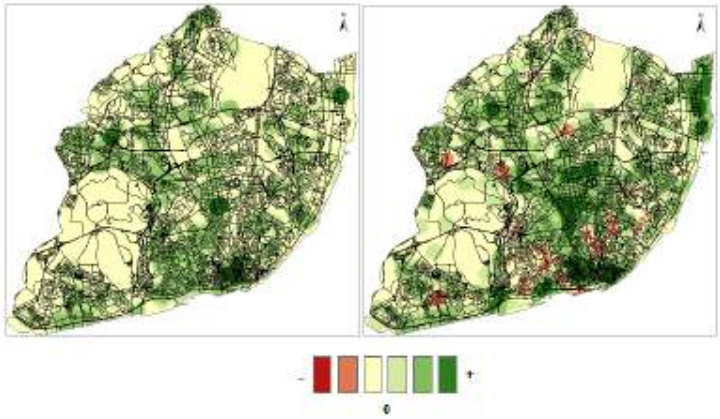

Figure 3 – Restaurant Sector – Density Variation: 1995 to 2002, and 2002 to 2010 (left to right)

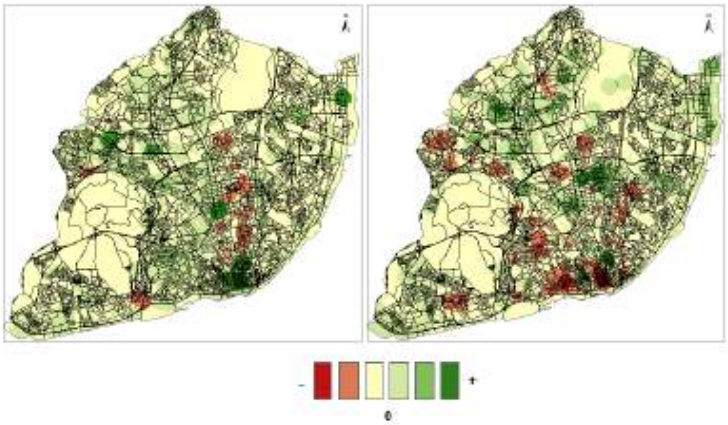

Figure 4 – Retail Sector – Density Variation: 1995 to 2002, and 2002 to 2010 (left to right)

Analysed separately, the two sectors show different trajectories: while on the period between 1995 and 2002, the impact of the shopping malls is noticeable in both sectors, the restaurant sector is, in general, growing steadily, while retail, outside shopping malls, shows significant growth only in Baixa-Martim Moniz, and therefore contributes for most of the losses in total commercial activity observed in Figure 2 in this period.

As for the following period, the restaurant sector shows significant growth mostly all over the city, while in retail, the traditional street-level commercial areas that hadn't been affected between 1995 and 2002 suffered losses in this period. Alvalade showed persistent loss throughout both periods. As for Baixa, it gained almost 60 personal use items stores between 1995 and 2002; and lost roughly the same number in the following period, along with several other types of retail. They also explain for the losses in Figure 2, only for this period.

Personal use items was indeed the most affected commercial type at street level: from 6.2% of total stores located at malls in 1995 it went to 27.8% in 2010 – 712 stores, amounting to 45% of retail located in malls in 2010, and explaining in part of what happened in Baixa and Alvalade.

Tables 1 and 2 contains a summary of the 10 types of commercial activity, both total and located in shopping malls, thus presenting a general overview of the studied period.

Year/Variation		1995	2002	Variation 2002-1995	2010	Variation 2010-2002
Type	Description	Total Number	Total Number		Total Number	
1	Foods	2259	2166	-4.12%	1868	-13.76%
2	Personal Use Items	2387	2678	12.19%	2566	-4.18%
3	Household Articles	1356	1503	10.84%	1265	-15.83%
4	Health and Hygiene	586	642	9.56%	740	15.26%
5	Leisure	1519	1657	9.08%	1616	-2.47%
6	Repairs	598	683	14.21%	944	38.21%
7	Other Items	2129	2306	8.31%	2386	3.47%
Total (Retail Sector)		10834	11635	--	11385	--
8	Restaurants (and similar)	2139	2515	17.58%	3202	27.32%
9	Cafes (and similar)	1597	1833	14.78%	2212	20.68%
10	Bars (and similar)	103	109	5.83%	236	116.51%
Total (Restaurant Sector)		3839	4457	--	5650	--
Total		14673	16092	--	17035	--

Table 1 – Total Number of Establishments and Variation 1995-2002 and 2002-2010

Year/Variation		1995		2002		Var. 2002-1995	2010		Var. 2010-2002
Type	Description	Number	% of Total	Number	% of Total		Number	% of Total	
1	Foods	19	0.84%	69	3.19%	263.16%	98	5.25%	42.03%
2	Pers. Use It.	148	6.20%	465	17.36%	214.19%	712	27.75%	53.12%
3	House. Art.	42	3.10%	141	9.38%	235.71%	119	9.41%	-15.60%
4	Health &Hyg.	23	3.92%	73	11.37%	217.39%	119	16.08%	63.01%
5	Leisure It.	78	5.13%	205	12.37%	162.82%	215	13.30%	4.88%
6	Repairs	5	0.84%	18	2.64%	260.00%	81	8.58%	350.00%
7	Other Items	45	2.11%	169	7.33%	275.56%	234	9.81%	38.46%
Total (Retail Sec.)		360	3.32%	1140	9.80%	--	1578	13.86%	--
8	Restaurants	38	1.78%	167	6.64%	339.47%	316	9.87%	89.22%
9	Cafes	34	2.13%	105	5.73%	208.82%	147	6.65%	40.00%
10	Bars	0	0.00%	0	0.00%	--	0	0.00%	--
Total (Rest.Sector)		72	1.88%	272	6.10%	--	463	8.19%	--

Table 2 – Establishments located in Malls - Total Number and Percentage, 1995, 2002 and 2010

Foods present both a persistent decrease (Table 1), and a very low percentage of activity inside malls (Table 2). This may indicate not only the direct competition from malls, but also a lack of characteristics that would allow these establishments to locate inside malls, which is consistent with the activities within this type (groceries, butchers and bakeries, amongst others), that are important at neighbourhood level but don't have the scale to compete directly with the supermarkets that serve as anchors in Colombo and Vasco da Gama. Visually, the effect is as displayed on Figure 5.

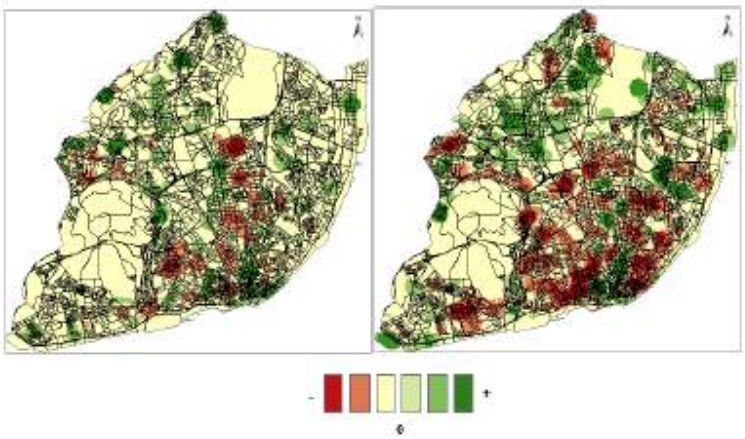

Figure 5 – Foods – Density Variation: 1995 to 2002, and 2002 to 2010 (left to right)

Vasco da Gama and Colombo are visible on the first period (the malls in Saldanha don't rely on supermarkets as anchors). Another phenomenon, though, becomes noticeable in the second period: "old Lisboa" losing this type of activity while "new Lisboa" gains it. Marked in tones of red and orange are the older neighbourhoods in town, with Bairro Alto-Baixa-Martim Moniz appearing as the exceptions (south in green). Upper north, Lumiar /Alta de Lisboa and northeast, Parque das Nações, show positive variation. A preliminary conclusion about Foods can be made: they are needed, to some extent, in residential areas that are still developing, since they provide for daily necessities. Figure 6 compares variation in Foods and Population in this period, with the correlation being obvious.

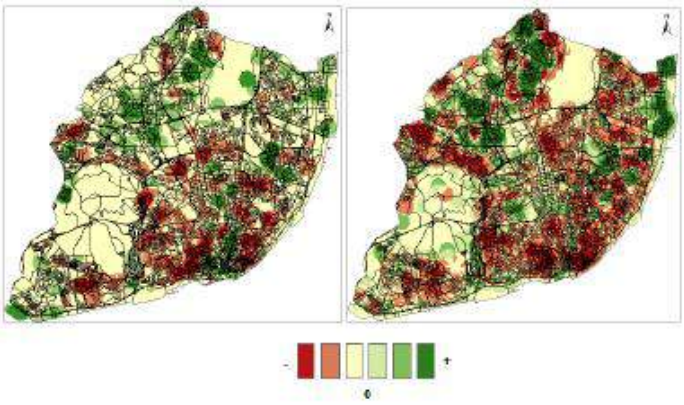

Figure 6 – Foods (left) and Population (right) – Density Variation: 2002 to 2010 (Foods) and 2001 to 2011 (Population)

2.1.2 COMMERCIAL DIVERSITY

Commercial diversity, here measured by entropy, is high at cell-size level, with some small variations between 1995, 2002 and 2010. This doesn't necessarily indicate a good balance of commercial types in Lisboa, but an overall good mix of establishment types at cell-size, for the types taken into consideration. Since cell-size was based on the average area of a statistical subsection, which corresponds to a city block, one preliminary conclusion would be that at block size, activities tend to mix. The analyses on diversity produced the results shown of Figure 7.

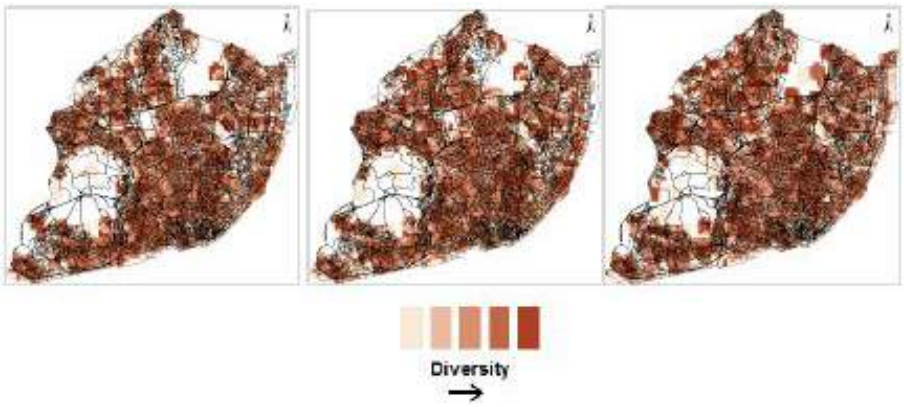

Figure 7 – Commercial Diversity: 1995, 2002 and 2010 (left to right)

Figure 8 presents Commercial Diversity in 2010 and Establishment Density for that same year.

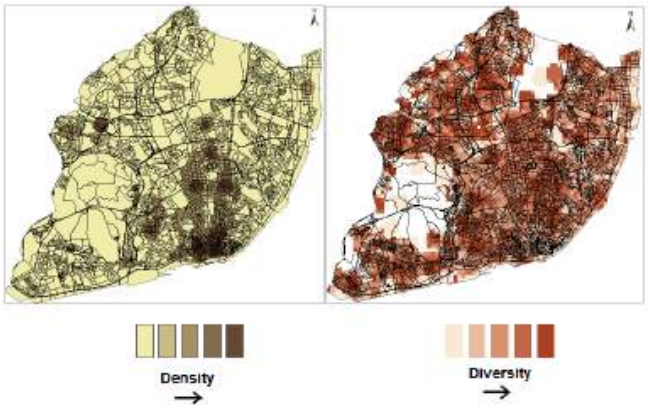

Figure 8 – Establishment Density and Commercial Diversity, 2010 (left to right)

Adding to the previous conclusion, Colombo presents high density but lower diversity. To a lesser degree, the same happens with Vasco da Gama and the smaller malls at Saldanha. Malls offer high density at block size; street level commercial activity, a more balanced distribution.

2.2 SPATIAL REGRESSION ANALYSIS

Regression was focused on Foods, considering the analyses that had been made to this point. The results are presented in Table 3.

Variable	OLS			Spatial Lag		
	coefficient	t-statistic	p-value	coefficient	z- statistic	p-value
ρ (lag)	--	--	--	0.876	142.93	0.000
Constant	-1.521	-1.27	0.203	-2.728	-4.91	0.000
Personal Use Items	0.013	1.87	0.062	0.011	3.23	0.001
Household Articles	0.051	3.89	0.000	-0.004	-0.59	0.553
Health and Hygiene	-0.340	-9.85	0.000	-0.075	-4.67	0.000
Leisure	-0.037	-1.90	0.058	0.004	0.40	0.686
Repairs	0.204	10.69	0.000	0.039	4.39	0.000
Other Items	0.233	20.57	0.000	0.026	4.74	0.000
Restaurants (and similar)	0.067	7.09	0.000	0.024	5.41	0.000
Cafes (and similar)	0.280	14.85	0.000	0.075	8.24	0.000
Bars (and similar)	0.169	5.75	0.000	0.010	0.74	0.457
% Activity within Malls	-13.773	-9.64	0.000	-3.23	-4.83	0.000
Population	0.002	27.38	0.000	0.0003	10.52	0.000
% older than age 65	10.41	4.21	0.003	1.987	1.73	0.084
% younger than age 14	-25.64	-4.61	0.000	1.065	0.41	0.680
Primarily Non-Residential Building	-0.13	-12.19	0.000	-0.062	-11.79	0.000
R-squared	0.852*			0.968*		
LM (lag)	2580.965*		0.000	--	--	--
Robust LM (lag)	3.877*		0.049	--	--	--
LM (error)	3996.75*		0.000	--	--	--
Robust LM (error)	1419.66*		0.000	--	--	--
Likelihood Ratio Test	--		--	4340.779*		0.000

Note: OLS: Ordinary Least Squares. LM (Lagrange Multiplier).
*Entries presented are Values.

Table 3 – OLS Model – Classic OLS Regression and Spatial Autocorrelation (lag) for Foods, 2010-11

The lag model presents a variable for the spatial lag term of Foods, ρ (lag). Its coefficient parameter (Rho) reflects the spatial dependence inherent in sample data, measuring the average influence on observations by their neighbouring observations. It has a positive effect and it is highly significant, which must be taken into consideration when examining the results. Still, controlling for spatial dependence allows for an analysis, focused on the lag model results.

Personal Use items, Repairs, Other items, Restaurants (and similar) and Cafes (and similar) present a positive and significant relation ($p<0.001$). A negative and significant relation is found with Health and Hygiene.

With the % Activity within Malls also being significant and negative, and considering both the values on Table 2 and the preliminary conclusions about Foods, and commercial diversity, one might establish a relation between these types: except for Personal Use items, these are the types of activity one might find at street level, and block size. This relation, though, requires a similar analysis to be done on the other types. It's a finding pending further investigation and opened for discussion.

As for the relation with Personal Use items, the part of that activity still occurring outside malls is so relevant at neighbourhoods like Alvalade, Campo de Ourique, and the areas surrounding Avenida de Roma and Avenida Almirante Reis, that it might be sufficient to establish a significant relationship with Foods.

Foods is significantly related with Population, but with a very small coefficient. This might be explained by a bigger density of establishments being found in older, less dense areas. The relation with % older than age 65 (and the lack of it with % younger than age 14) also point to that conclusion.

Relation with Primarily Non-Residential Building is significant and negative, which is consistent with Foods being necessity type goods and thus, more related with residential type occupation.

Regression analysis, as said, was used to test if the location of one type of establishment relies on the presence of other specific types. Having made that point, to some extent, the spatial lag model was run using the same variables, but with data from 1991 (demographic) and 1995 (commercial). Table 4 displays the results (along with those displayed on the previous table, for spatial lag in 2010-11).

Variable	1991-1995			2010-2011		
	coefficient	t-statistic	p-value	coefficient	t-statistic	p-value
ρ (lag)	0.868	133.46	0.000	0.876	142.93	0.000
Constant	-0.929	-1.23	0.215	-2.728	-4.91	0.000
Personal Use Items	0.004	0.76	0.446	0.011	3.23	0.001
Household Articles	-0.002	-0.28	0.776	-0.004	-0.59	0.553
Health and Hygiene	0.058	2.52	0.012	-0.075	-4.67	0.000
Leisure	-0.035	-3.24	0.012	0.004	0.40	0.686
Repairs	0.045	3.16	0.002	0.039	4.39	0.000
Other Items	-0.008	-1.04	0.297	0.026	4.74	0.000
Restaurants (and similar)	0.046	7.17	0.000	0.024	5.41	0.000
Cafes (and similar)	0.151	11.60	0.000	0.075	8.24	0.000
Bars (and similar)	-0.015	-0.45	0.651	0.010	0.74	0.457
% Activity within Malls	-1.024	-0.44	0.663	-3.23	-4.83	0.000
Population	0.0003	10.84	0.000	0.0003	10.52	0.000
% older than age 65	-6.517	-3.17	0.001	1.987	1.73	0.084
% younger than age 14	-1.437	-0.50	0.618	1.065	0.41	0.680
Primarily Non-Residential Building	-0.049	-8.92	0.000	-0.062	-11.79	0.000
R-squared	0.970*			0.968*		
Likelihood Ratio Test	3721.152*		0.000	4340.779*		0.000

Note: OLS: Ordinary Least Squares. LM (Lagrange Multiplier).
*Entries presented are Values.

Table 4 – Regression results with Spatial Autocorrelation for Foods, 1991-95 and 2010-11

Table 4 allows for yet another approach to change in Foods in a period of 15 years (before and after the shopping malls from the late 90's). Foods maintains a positive and significant relation ($p<0.001$) with Restaurants (and similar), Cafes (and similar) and Repairs. Personal Use items weren't relevant in 1995, nor were Other items. As for Personal Use items, one might risk concluding it was a clustered activity, with that cluster having been displaced to shopping malls, and the remaining activity resisting in traditional, street level commercial neighbourhoods. The relation with Other items is very interesting: this type was created to include

all types that couldn't be included in the other 9 categories. It includes, for example, "Bazars", which in 1995 were just 69 (out of 2129) and in 2010 were already 311 (out of 2383). These are stores selling

miscellaneous goods, from clothes to household articles, to souvenirs and snacks (the smaller ones), usually managed by immigrants, with a large community settled Intendente-Martim Moniz-Mouraria (these amount for the biggest part of the positive variation on retail that can be observed east of Baixa in Figure 5, in the 2002-2010 period). It's a street level activity that almost didn't exist in 1995, but since then, was able to present itself as relevant at block size and eventually contributing to neighborhood liveability.

The relation between Foods and demographic data shows an aging population, as demonstrated by % older than age 65 in 1991: it was significant, but negative.

Shopping malls weren't relevant, and Relation with Primarily Non-Residential Building was significant and negative, although with a smaller coefficient (which might show increasing detachment between commercial activity and other economic activity).

3 CONCLUSIONS

This paper originally intended to present an overview over retail on a period that encompasses 3 decades: a longitudinal analysis on patterns that would visually reveal some expected changes (like the emergence of malls) but also some that weren't quite so obvious. Being able to visually identify the importance of an immigrant community on the resurgence of a neighborhood was unexpected.

A general conclusion is that retail maintained its relevance (10.834 establishments in 1995, 11.385 in 2010), but with a significant part of the activity being transferred to malls (almost 14% of total in 2010). In sum, it went from 10.474 establishments at street level to 9.807 – a loss of 667 units.

As for the restaurant sector, it showed persistent growth, both inside and outside malls: from 3.893 establishments in 1995 to 5.650 in 2010. From 14.241 at street level to 14.994 – a gain of 753 units.

The first conclusion, though, is that between 1995 and 2010 there was a transference of activity, from streel level to malls, and a transference of importance, with the growth in restaurants amounting for the losses in retail.

Now, considering that Foods and Personal Use items amounted for the largest part of retail in 1995 (more than 40%), if Foods had displayed the same behaviour of Personal Use items (which, as said, changed from approximately 6% located in malls in 1995 to almost 28% in 2010), the effect of malls on retail at street level would have been even more impressive. One can't say that Foods served as an anchor for retail at street level, but they had a relevant part in maintaining traditional commercial activity. An unexpected contribution came from Other items: Bazars became relevant (from 69 to 311) and presented themselves as a viable, street level commercial activity (only 10 located inside malls in 2010).

A second conclusion is that Foods and Other items held a significant part in holding retail at street level. Since Restaurants and Cafes presented themselves as parts of the "mix" of street-level activity, directly related with Foods and Personal Use items (along with Repairs), it's reasonable to state that, at block level, these types amount for a significant part of the commercial diversity in Lisboa. But with the restaurant sector growing steadily, what's the risk of losing retail activity to restaurants? And at what point will it pose a threat to neighborhood liveability? With developing neighbourhoods accounting for the bigger part of positive variation in the retail sector, and this "mix" being positively correlated with population older than 65, what are, specifically, the risks for neighborhood liveability in the old parts of Lisboa?

The third conclusion is that there might be a risk for sustainable retail systems at street level, especially in the older neighbourhoods of Lisboa, where traditional street retail still persists.

Further analysis, with recent, more disaggregated data, would be important in determining the extension of the described phenomena. The availability of other types of data (e.g. space syntax or actual employment) would also help in building a more robust model, even if considering that "as far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality" (Einstein, 1923).

BIBLIOGRAPHIC REFERENCES

Christaller, W. (1966). Central Places in Southern Germany. Englewood Cliffs, NJ: Prentice Hall. [1933].

Lösch, A. (1954). The Economics of Location. New Haven, CT: Yale University Press. [1939].

von Thünen, J. (1966) The Isolated State, Oxford, London: Pergamon Press. [1826].

Krugman, P. (1991) Increasing Returns and Economic Geography, Journal of Political Economy 99, pp. 483–499.

Clarke, D. (2003). The consumer society and the postmodern city. London: Routledge.

Jayne, M. (2006). Cities and consumption. London: Routledge.

Jacobs, J. (1961). The Death and Life of Great American Cities. New York: Random House.

Costanza, R. (1989). Model goodness of fit: a multiple resolution procedure. Ecological Modelling, 47, 199-215.

Mullins, P., Natalier K., Smith P., Smeaton B. (1999). Cities and Consumption Spaces. Urban Affairs Review, 35(1), 44-71.

Borck, R. (2007). Consumption and social life in cities: Evidence from Germany. Urban Studies, 44(11), 2105-2121.

Porta, S., Strano E., Iacoviello V., Messora R., Latora V., Cardillo A., Wang F., Scellato S. (2009). Street Centrality and Densities of Retail and Services in Bologna, Italy. Environment and Planning B: Urban Analytics and City Science, 36(3), 450-465.

Sevtsuk, A. (2014). Location and Agglomeration: The Distribution of Retail and Food Businesses in Dense Urban Environments. Journal of Planning Education and Research, 34(4), 374–393.

Thurstain-Goodwin M., Unwin D. (2000). Defining and delineating the central areas of towns for statistical monitoring using continuous surface representations. Transactions in GIS, 4, 305–317.

Batty, M., Besussi, E., Maat, K., Harts, J. (2004). Representing multifunctional cities: density and diversity in space and time, Built Environment, 30, 324–337.

Barata-Salgueiro T., Erkip F. (2014). Retail planning and urban resilience – an introduction to the special issue. Cities, 36, 107–11.

Cachinho, H. (2002). O Comércio Retalhista Português. Pós-modernidade, consumidores e espaço. Lisboa: Gabinete de Estudos e Prospectiva Económica do Ministério da Economia (GEPE).

Song, Y., G. Knaap (2004). Measuring the effects of mixed land uses on housing values. Regional Science and Urban Economics, 34, 663– 680.

Anselin, L. (2005). Exploring Spatial Data with GeoDaTM: A Workbook. Spatial Analysis Laboratory, Department of Geography, University of Illinois, Urbana-Champaign.

Einstein, A. (1923) Sidelights on relativity, New York: E.P. Dutton&Company. [1921].

INE. (2014). Censos 1991. Retrieved from http://mapas.ine.pt/download/index1991.phtml

INE. (2014a). Censos 2001. Retrieved from http://mapas.ine.pt/download/index2001.phtml

INE. (2014b). Censos 2011. Retrieved from http://mapas.ine.pt/download/index2011.phtml

CML. (2016). Geodados, Recenseamento Comercial. Retrieved from http://geodados.cm-Lisboa.pt/

ESRI. (2016). An overview of the Density toolset (Spatial Analyst). Retrieved from http://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/an-overview-of-the-density-tools.htm

INE. (2014c). Base Cartográfica. Retrieved from http://www.ine.pt/xportal/xmain?xpid=CENSOS&xpgid=censos_base_cartogr