

THE ECONOMIC ACTIVITY IN LISBON. STRUCTURAL AXIS AND SQUARES.

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Abstract

The simplifying assumption that the Central Business District is a point or featureless plain, is often made in urban economics. The main goal of this paper is to promote the relaxation of this hypothesis, with the support of empirical evidence, defending that the subsequent analysis can be elaborated on the agglomeration economies theoretical framework. For this purpose we've analysed the distribution of economic activity inside the city of Lisbon, using the employment data of 'Quadros de Pessoal do Ministério do Trabalho e Solidariedade' (Employment Datasheet of the Ministry for Social Security and Labour), for 1998. Proceeding with the address matching of this information to the street level in order to allow the use of GIS tools.

From the analysis we emphasize the existence of agglomeration economies inside the Central Business District, using as evidence the different levels of employment agglomeration that occur on different streets and testing the hypothesis that to streets with higher employment concentration correspond higher salary levels. Therefore we sustain that the CBD cannot be seen as a point or a featureless plain and furthermore we've verified the existence of an hierarchy inside the urban structure, which can be seen as a parallel of the rank-size rule.

After this analysis we argue that the streets with larger employment volume display a structural role in the spatial distribution of economic activity. The final conclusion leads us to consider Lisbon as a squares network-city, where the axis are structural streets and the nodes are structural squares.

Keywords: Agglomeration Economies; CBD; Lisbon; Urban Economics

JEL CLASSIFICATION: R12 e R14.

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1. Introduction.

This work was partially the result of the effort to answer one particular question: How does economic life occur inside Lisbon urban centre? Or, more precisely and in order to look for the outbreak of that question: Where does economic life occur inside Lisbon urban centre?

As one can observe at a worldwide scale, economic activity is located in a relative small number of places and this idea remains if one changes the spatial scale of observation, for eg. to a continental, national or even a regional level. It is also possible to believe that this idea remains inside an urban centre, meaning that inside a CBD economic life still occur in some particular places and not homogenously distributed by all the central area points in space, allowing the anticipation of what might happens if one proceeds with the relaxation of the hypothesis of the CBD as a point and featureless place.

The empirical observation that economic life tends to be located in a small number of places, leads to a framework that implies the assumption of the existence of some advantages for economic agents related with the proximity of each other. This advantages are typically gathered underneath the concept of agglomeration economies.

Since this process is observed on many different spatial scales, one must have in mind that it may hide different spatial phenomena or, at least, phenomena with some degree of similarity but with specific details related with the scale of observation.

In theoretical terms, agglomeration economies or the advantages of proximity for economic agents has been standard classified on 3 different groups (Fujita and Thisse; 1996): scale economies, localization economies and urban economies, whether this advantage is related with one firm, all the firms in one industry or all the firms in various industries at one specific point in space.

Using the scale economies one can explain why one firm concentrates the production in one point in space. Being the scale economies, in this sense, strongly connected with the firm production process, the localization economies are related with “marshallian externalities”, reflecting the advantages of the agglomeration of firms, belonging to the same industry, in the same spatial area, justifying the existence of ‘industrial districts’ or ‘clusters’. The urbanization economies resume the reasons for spatial agglomeration of economic agents regardless their industry, being, in that way, of particular importance for the understanding of the existence and the formation process of cities.

Using Camagni taxonomy (Camagni; 1992) to understand the urbanization economies, and connecting the sources of urbanization economies with the nature of the firm advantages, it’s understandable that urbanization economies occurs in two different spaces: indivisibility and interaction / synergy areas. The indivisibility area is the comprehension space that reflects the existence of a certain number of functions or services, such as public goods or public sector services, that are only provided above a minimum level of demand. The existence of such functions allow reductions to the transaction and/or production costs, increasing production factors efficiency. The synergy area comprehend the space of situations in which joint action between economic agents in coordination or cooperation, give place to the raise of better conditions for the activity. Just by being in an urban environment agents have access to a labour market potentially more efficient, to superior functions, able to reduce transaction costs and to management capital and a more complete information set that can reduce transaction costs and increase production value, by reducing the uncertainty towards the future.

The reduction of transaction costs that are achieved through the exploration of the agglomeration economies are also of significant importance for the promotion of economic growth (Martin and Ottaviano; 1996), being one of the factors that contribute to the connection of agglomeration and growth in a circular cumulative process in which agglomeration and growth tend to continuously increment each other.

The spatial equilibrium regarding to the location of economic life results, as proposed by Fujita and Thisse (Fujita and Thisse; 1996) from the joint action between the centripetal and centrifugal forces, represented by the economic forces of agglomeration and dispersion of economic activity. In a simple manner, one can sustain that if in agglomeration economies leis the reason for the fact that a significant level of economic

life occurs in a particular place, in diseconomies of agglomeration lies the reason why the economic activity does not occur all in the same point in space.

This agglomeration economies that contribute to explain why economic life occurs mainly in a relatively small number of places, are also an helpful tool for the understanding of the emergence of core-periphery patterns. As the agglomeration effects, the core periphery pattern may also be observed at different spatial scales, since as we can see a dualistic world, we can study the dualism in regions or even at a local scale. The core periphery pattern based on the analysis of the interaction between demand, increasing returns and transport costs (Krugman; 1991) is a powerful framework for the analysis of the economic interaction between places, focusing on their dependence relations and the development cumulative process. If it is understandable that at a regional level, the increasing volume of economic activity in a particular point in space tends to promote the growth of that place and the dependence of it's surroundings, it is probably questionable if that also occurs at a local or even intra-urban scale. The urbanization process is formed by centre and peripheries and when moving form regional to local scale of observation we find centres or sub-centres inside the periphery and peripheries inside the main centre itself.

This discrete distribution of economic life among differed volume points in space, can also be observed by an hierarchical point of view, following the central places theory, that leads to the urban network system, as the model that studies the interactions among the different urban centres in a particular region or space.

2. The Data.

The present work is supported by the analysis of the distribution of economic activity inside the city of Lisbon, using the Employment datasheet of the Ministry for Social Security and Labour, for 1998. The address matching of this information was made at the street level¹.

This employment datasheet does not include information for the public administration neither for the economic activity that occurs in firms that use using exclusively self-employment patterns. Therefore we do not intend to make an exhaustive description of all the economic activity inside the city centre. Instead, this datasheet provide us

¹ For simplicity we will use the word street in a large conceptual frame, to mean all the urban forms that a way or a road may take inside a city, such as avenues, boulevards, streets,... or even squares.

information that allows the analysis of the spatialization of the firms that had at least one employee. The use of this data implies the consideration of employment as a suitable variable to measure volume of economic activity and therefore its agglomeration.

The address matching process of the present data was made by the author, based on the address field of the present database. Due to the characteristics of this database, that was not specifically built to allow georeferentiation, some records were not sufficiently filled in the address field in order to allow 100% success of address matching.

The analysis of intra-urban employment implies the identification of an additional territorial unit, different from the usual statistical territorial units. At an intra-urban scale, the statistical units are mainly the result of the census process and therefore established to allow the localization of residential functions in blocks or other proximity urban forms. For the present purpose and since we were looking for an intra-urban unit, to allow the georeferentiation of economic activity, the streets were considered as the most suitable unit, since it is understandable that the economic activity locates essentially according to the streets that they will be facing.

It is clear that the employment does not distribute itself in an homogenous pattern inside the streets. However, the search for a smaller territorial unit (for instance the building) brought us a much more higher level of missing records, according to the insufficient level of information in the address field. Therefore, the streets were a territorial unit sufficient enough to allow an intraurban spatial differentiation and suitable enough to allow the use of the biggest number of records included in the database.

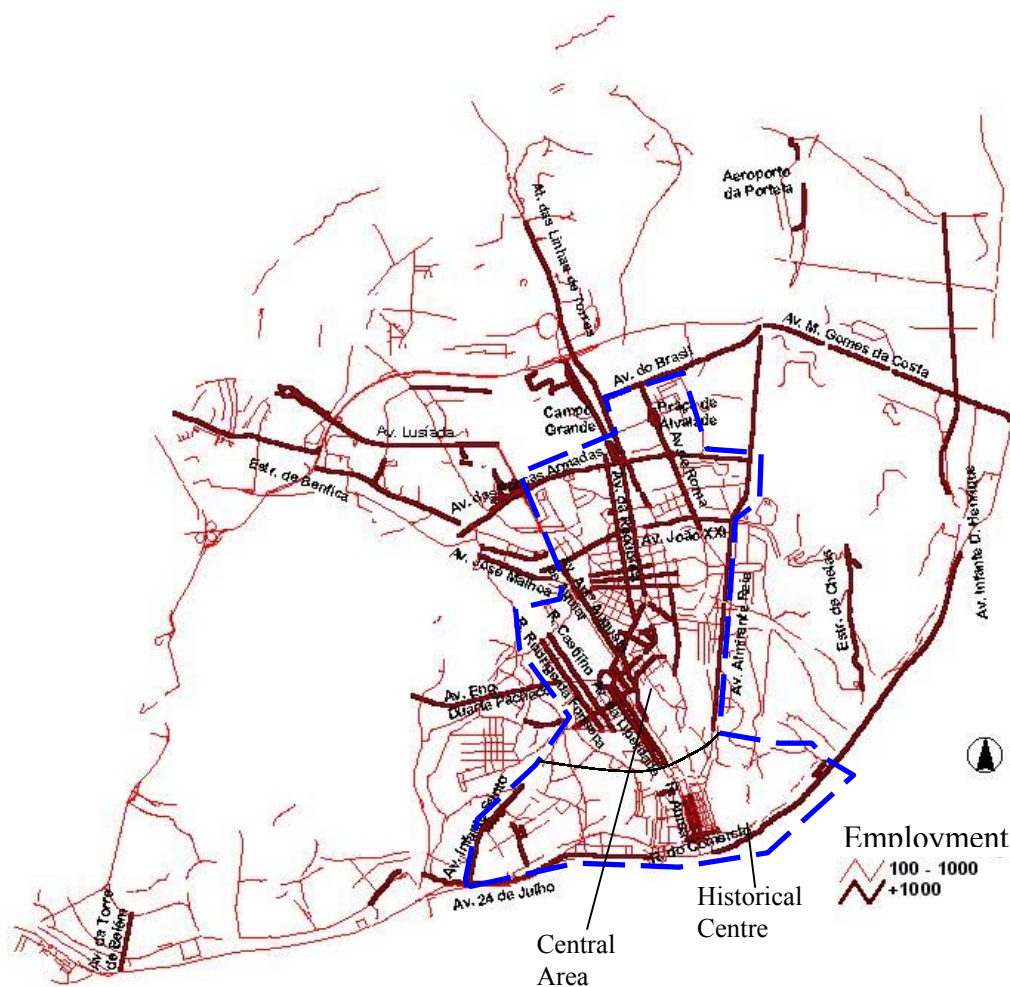
3. A brief description of economic activity in Lisbon.

Lisbon is Portuguese capital city, located in the occidental extreme of European continent at its southern Atlantic front, in the mouth of Tagus river. With an historical development of more than 2000 years, its landscape was successively transformed by many different cultures, from Romans to Visigoth and Arabs, until the settlement of Portuguese independent state at the XIIth century. The expansion of the city from inside of the primitive walls to the area confined by the perimeter of the medieval walls was developed during the XIVth century and circumscribed what would be the city of the

Portuguese overseas expansion, the nowadays historical centre. After 1755 earthquake, the urban planning left it's first significant mark in Lisbon landscape, imposing an orthogonal tissue inside the city centre, in what would be characterised as the commercial city for the decades to come. Lisbon expansion to the north was again profoundly marked by the urban planning, this time in the XIX th century, designing an orthogonal space for the central business area of our days.

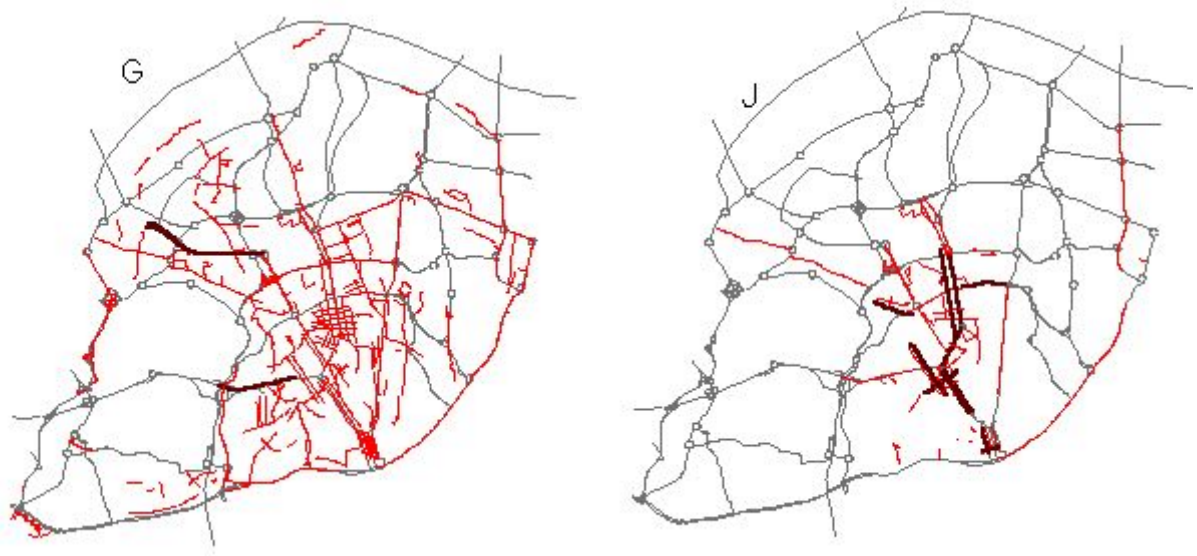
Today, economic activity is mainly concentrated in the historical centre core and in the central area (fig. 1). Outside this areas, the economic activity tends to agglomerate near the main transportation nodes (such as the airport or the port at the oriental riverside) and in the main periphery connection axis, the old ways that connected the city with it's outskirts.

Fig. 1: Employment in Lisbon streets.



This layout is the spatial result of the overlapping of many different economic activities. The main economic sectors located inside the city are the commerce (gross and retail); the services provided to firms; the transport and communication; and the financial activities, representing, together 65% of the employment observed. If for some of those economic sectors one can find a relatively intra-urban dispersion as for commerce activities (here represented as sector G), for others the concentration pattern is much more obvious, such as for the financial services (represented as sector J).

Fig. 2: Commerce (G) and Financial Services (J) Employment in Lisbon streets.



The main reasons for this distinct spatial behaviour lies in two different aspects. Using the commerce and financial institutions example it's observable that commercial firms are usually smaller, regarding that the number of employees in each firm is lower, and then, the same number of commercial and financial firms located in one street tend to produce an output that reveals a larger amount of employment in the financial sector in that street. On the other hand, following McDonald's classification of activities location behaviour (McDonald; 1997), responding to the demand behaviour in the act of purchasing different types of goods, if some activities are needed as close to the consumers as possible, in order to eliminate purchasing transportation costs, supplying what therefore is called as "convenience goods"; other activities tend to a geographic concentration, since the consumer intend to deeply study the market before acquiring those that are called the "shopping goods". Following this location distinction, and since

it's found more often on the commercial activities the supply of what as been established as "convenience goods", is understandable that this sector tend to follow a dispersion pattern of location.

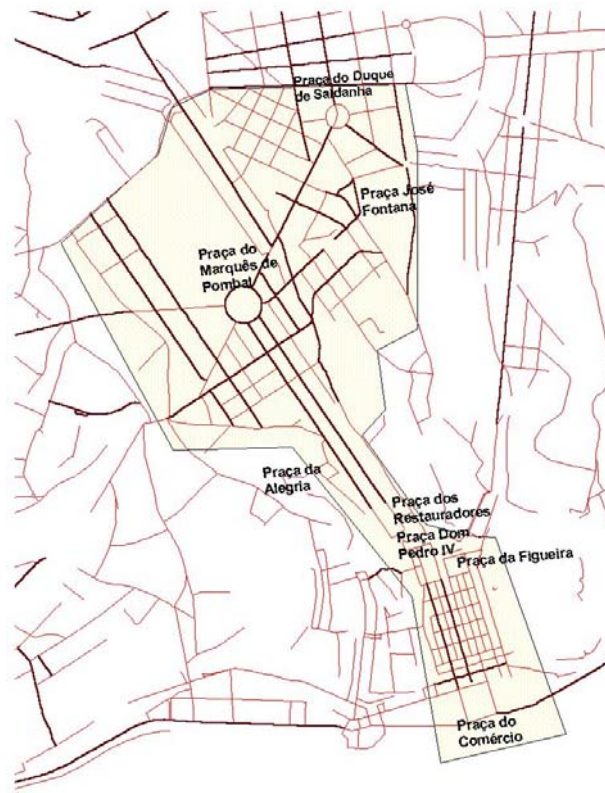
The economic activity is located in many different urban spatial forms. In this work we have adopted the word 'street' in a simplifying assumption to gather all those different urban forms. Nevertheless, a first distinction must be made between the urban form that follow a linear spatialization with an axis function, such as streets and avenues and those that represent a node function such as squares. This distinction is very important to understand the intra-urban economic activity agglomeration in a network perspective. The squares can emerge as an urban layout either from the organic urban development, being the 'empty space' that is left on the confluence of different streets, as well as from the planned urban development, assuming a more geometrical form (Kostof, 1991). The squares represent the paradigm of two of the most important aspects of economic localization: accessibility and agglomeration. A square can represent the urban layout symbol of the agglomeration principle, their roots are in the Greek or Roman agora, being a communal meeting space whether for commercial, religious, social or political purposes, their main reason of being lies in the human necessity of face-to-face interaction. Being the spatial node of several different streets, the squares are nodes of privilege urban accessibility, often assuming the transport interface function.

A closer look to the employment located in Lisbon central area provide us a first hint of the structural axis and squares importance to the economic profile of the several spaces inside the CBD. Taking a brief tour through the CBD, it is often observable that the squares play the role of transition between the dominant economic activity located in the structural axis connected to them. Starting this tour (fig. 3) by the historical central core, we can say that at "Terreiro do Paço" one find a square where the financial intuitions are the dominant activities, side by side with government facilities. The next square is "Praça Dom Pedro IV", where commercial activities are dominant (as in "Praça da Figueira"), in between we have the historical downtown where we find a mix of financial and commercial activities. Following our path to the north we have "Praça dos Restauradores", a multi-sectorial square that connect us to the central area. In "Praça Marquês de Pombal" the dominant activities are in the services provided to firms sector, as well as in "Praça José Fontana" and in most of the axis connected to this squares, until "Praça Duque de Saldanha", where due to the increased proportion of the

commercial activities, compared with the surrounding areas, we find a multi-sectorial square.

The goal of this brief description is to provide a flashing overview of which economic activity occurs and where does it occurs. A more detailed description would be necessary, in order to capture the full essence of this overview, but that would largely surpass the main goal of this paper.

Fig 3 – Area in description



This first brief overview intends only to underline a first empirical conclusion, inside the central business district different economic activities occur in different places and with different intensities, which is the same as to say that inside the CBD the economic activity is not spatially homogeneously distributed.

4. Rank-Size rule revisited – the evidence of an hierarchical structure.

Following the idea of an heterogeneous distribution of the economic activity inside the city centre, provided by the previous overview, is important to underline the fact that inside the city of Lisbon nearly 90% of the employment observed is located in only 15% of the streets. In fact, the economic activity observed is located at 58% of the streets (which represents 2/3 of the total streets extension). Eliminating the streets with an employment of 10 workers or less, we reduce the number of streets with a minimum of employment level to 40% of the city streets. Proceeding with the exclusion of non significant employment levels, we can notice that 88% of the employment observed is located in only 15% of the streets of Lisbon, those streets that are used for location by more than 100 workers.

Table 1: Distribution of streets by employment breaks

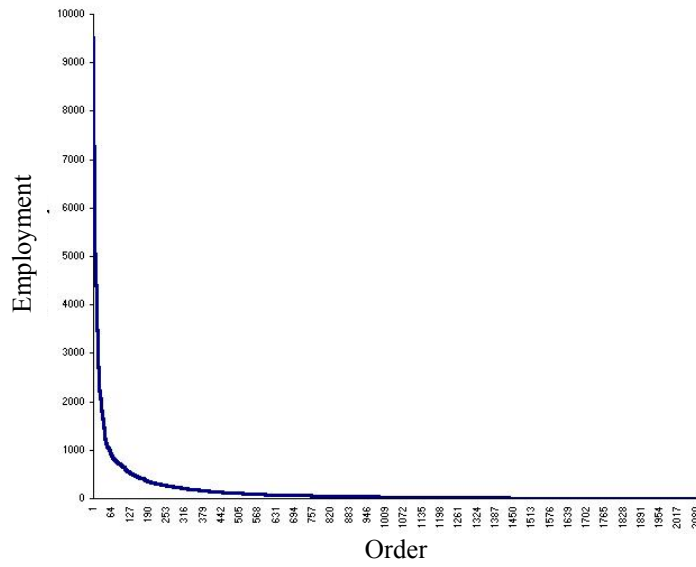
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Employment	45%	43%	6%	5%	1%
Streets	2%	13%	8%	18%	17%

By this fact one can see that as the agglomeration of population and therefore of economic activity, occur in a relative small number of places, at a global or regional level, this agglomeration is also observable at a relatively small number of places even inside a CBD. Such an evidence remind us the one that has been summarize under the concept of the rank-size rule or Zipf's Law, elaborated on empirical observation basis. Following a parallel mental path, if we start by ordering the streets by their employment level, we can notice that there is a small number of streets with high employment level and that the number of streets increases as the volume of employment decreases. If we adopt employment to measure the volume of economic activity in a street inside the urban centre, as a parallel of the population used in the mentioned rank-size rule to order urban centres and if we let Y be the level of employment of a particular street, X the order number of that street in the intra-urban hierarchy, K the biggest unit dimension and establishing the rank-size rule function, $Y = KX^{-\alpha}$ we reach to a graphic representation similar to an hyperbole in it's quadratic form (fig. 4):

$$Y = KX^{-\alpha}$$

$$\begin{cases} Y : \text{Employment} \\ X : \text{Order} \\ K : \text{Biggest unit dimension} \\ \alpha : \text{parameter} \end{cases}$$

Fig. 4: Streets by level of employment



By the function loglinearization $\ln Y = \ln K - \alpha \ln X \Leftrightarrow y = k - \alpha x$ and continuing with the estimation of the adjustment equation, by the linear regression on the least square method, we can conclude, by the hypothesis test (using the t statistic) on the rejection of the null coefficient hypothesis to the order parameter (α), recognizing explaining capacity to the factor (x),

Eq. 1: Rank-size estimated adjustment equation.

$$y = 14.468 - 1.662x, \quad R^2 = 0.854$$

$$t : (143.12) \quad (110.45)$$

Notice that the parameter estimated value $\hat{\alpha} = -1.66$, shows some distance to the quadratic hyperbole function (where $(\hat{\alpha} = -1)$), which indicates a relative disproportion

between the bigger streets and the subsequent ones in the intra-urban hierarchy , but still surprisingly close to 1, as usual in the others rank-size rule situations.

This recognition of the explaining capacity of the order factor implies that we can not deny the existence of an hierarchical standard, in the sense of an order relationship by which the employment dimension of each street is strongly influenced by the dimension of the street that precede it in the intra-urban hierarchy as well as influential to the one that is subsequent to it in the same hierarchy.

The rank-size rule or Zipf's law is assumed as a law by the regular observation of an order/dimension standard in different urban spaces and in different historical moments. By the observation in the present work of a some how similar order/dimension relationship, we don't presume the existence of a law or the same law, we simply observe that in the moment of this analysis, in Lisbon, a relationship of similar nature occurred. This rank-size rule parallel gives only an extra input to the importance of the role of the higher volume of employment streets inside the urban stage.

This order relationship and subsequent influence capacity leads us to a central concept for this work, that is the concept of structural streets or, in a network perspective, structural axis and squares. This concept will be used to label the streets with more than 100 persons employed. The definition of this streets as structural streets means the assumption that this particular urban forms – structural streets - are important at an aggregation and communication level inside the urban centre, with a structural implication, that results from the hypothesis that the axis or squares with larger employment volume have an important role in the determination of the dimension of the following streets in this urban order.

Therefore being the economic life inside the urban centre located at streets and since the volume of the economic activity (measured by the employment) of one street is strongly influenced by the streets with larger volume of activity, we have an intra-urban hierarchy in which the connections among streets are of extreme importance for the understanding of how and why economic activity takes place in one particular place.

5. Intra-urban agglomeration economies.

If one can notice that economic life inside a CBD might be located in a small number of places, then it is defensible that some economic advantages might be experienced by the economic agents in the agglomeration pattern of location. However, the empirical observation or measurement of agglomeration economies is a task trapped between the ambitious goal of defining indicators for its direct observation and the fact that one of the best demonstrations of the existence of agglomeration economies is the agglomeration itself.

The economic activity located inside the city of Lisbon is not homogeneously distributed. Some streets agglomerate a larger number of firms and of employment than others. In the search for some evidence of agglomeration economies inside the central business district, we can look for some manifestations of the advantage of agglomeration, besides agglomeration itself. Therefore, it is important to analyse the employment patterns in the structural streets, in order to consider if there are any specific profiles of the employment in these streets, where the employment dimension is bigger.

By this analysis and since we intend to find if there is any evidence of agglomeration advantages for the employment located in the structural streets, we have considered that a relevant evidence of agglomeration advantage for the employment would be typically represented by a situation where the average labour earnings were expected to be higher in a structural street than in the city average.

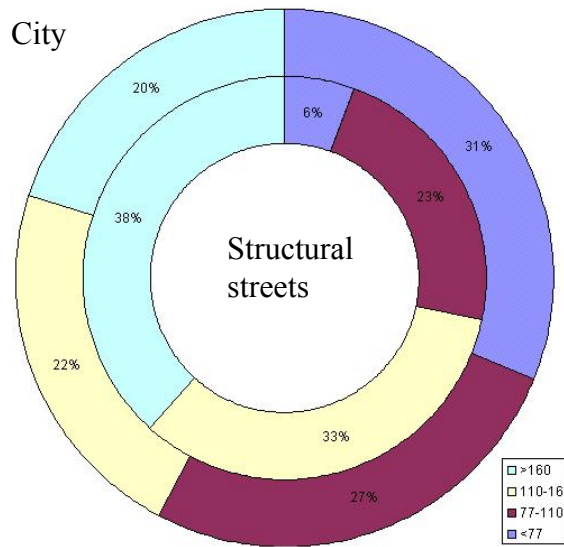
To the purpose mentioned above we've analysed 3 specific employment variables: *Average effective mensal earnings* and in order to anticipate some explanations of the differences in this variable, the *employee scholar level* and the *role performed inside the organization* by the employee. The fact that employment can achieve higher earning standards in some particular streets can be looked as a sign of advantage of agglomerating a larger proportion of activities in that particular point.

The proportion of structural streets with larger '*average effective mensal earnings*' is higher than this proportion in the city (fig. 5). This difference is more significant at the extremes, since the proportion of structural streets with lower earnings is much smaller (6% vs. 31%) as well as is much higher the proportion of structural streets with higher earning levels (38% vs. 20%).

Since structural streets are mainly located in Lisbon central area (as can be seen in fig. 1), the above mentioned fact can either mean higher labour earnings in the central area or higher labour earnings in streets with higher employment level (or even both). Then

and to establish the role of structural streets, we've tried to understand if streets with larger employment agglomeration tend to concentrate higher effective earnings. For this purpose let Ear_i represent the average effective mensal earnings registered in street i and let $D1_i$ be a *dummy* that assumes the value 1 if a street is a structural street and 0 otherwise.

Fig. 5: Distribution of streets by Average effective mensal earnings (1000 pte.) breaks



If working in a structural streets means, for the employee, that she expects a higher earning, i.e. $E[Ear_i | D1_i = 1] > E[Ear_i | D1_i = 0]$, then we must perform the regression on the equation $Ear_i = \alpha + \beta D1_i + u_i$ and proceed with the econometric tests for the significance of the location coefficient (represented by this dummy variable), that classifies streets distinguishing the structural from the non structural ones, as an explanatory variable for the average earnings.

Eq. 2: Average earnings estimated adjustment equation.

$$Ear_i = 92310 + 66067 D1_i$$

$$t : (59.939) (21.318)$$

Since we can see by the *t ratio* that the coefficient is said to be statistically significant, we cannot accept the null hypothesis and therefore we can't deny that the location factor of being in a structural street can contribute to the understanding of the *average effective mensal earnings*.

The explanation for the observation that the earning of the labour factor is expected to be higher in a structural street, must be in the labour profile of the employment located in structural streets or in the structural streets themselves.

According to labour education level, the structural streets tend to be endowed with slightly higher education levels of employment, but this difference is not as significant as the earnings differences, since we can only notice a slightly higher proportion of employees that had received a college education in structural streets, comparing with the city.

Table 2: Streets according with employment school level

	No formal education	Primary education (1st degree)	Primary education (2nd degree)	Primary education (3rd degree)	Technical Education	High School Education	College Education	Total
Lisbon	2%	26%	12%	16%	8%	22%	16%	100%
Structural Streets	1%	24%	12%	16%	8%	23%	17%	100%

Having analysed the role performed by the employees inside the organization we can say that this factor give us a nearly null contribution to the understanding of the earnings differences, since differentiation of the roles performed as little to do with the location factor alone, probably as much more to do with intra-firm organization differences or other technological aspects related with the activity sector more then location itself.

Therefore, since the expected labour earnings are higher in the structural streets then in the city average, it must be expected that the location factor alone might assume an important role in the understanding of those differences. It is known that the firms that locate inside the city centre usually face higher rents as a result of the higher land value. Such an evidence is commonly presented as the absorption through the price mechanism of the agglomeration economies. In addition to the propensity to spend an higher amount of money in rents, is the propensity to spend an higher amount of money in the rewarding of labour activity. If the firms located in the structural streets are

willing to spend higher amounts of money has a retribution to the land and labour factors employed in the production process, then it is expectable that these firms also expect higher amounts of profits in those particular locations. The difference in the firm's profits can be explained, as presented in the model by Fujita and Thisse (Fujita and Thisse; 2000).

The profit of the firm $\Pi(x)$ can be presented as a function of the gains associated to the contacts that the firm located in one particular point (x) promotes with other firms located in other points in space (y) , such as:

$$\Pi(x) = A(x) - R(x)S_f - W(x)L_f,$$

being $A(x) \equiv \int_x a(x, y)f(y)dy$ com $a(x, y) = V[q^*(x, y) - c(x, y)q^*(x, y)]$

if the firm is willing to be located in the city centre, where the land price is higher (and therefore faces an higher rent $\Rightarrow \uparrow R(x)S_f$) and if the firm is also willing to pay an higher salary level ($\Rightarrow \uparrow W(x)L_f$) then this higher costs must be compensated by the advantages that results from the level of contacts that this localization promotes $A(x)$, in other words from the 'informational spillovers', when $a(x, y)$ represents the advantages associated with the optimum contact level $q^*(x, y)$ after deducting the costs necessary to promote that amount of contacts $c(x, y)q^*(x, y)$.

Therefore, the location factor alone can be used to justify some of the earning differences using the informational spillovers provided by the location as a tool to the comprehension of the earning differences.

6. Network city - Structural axis and squares.

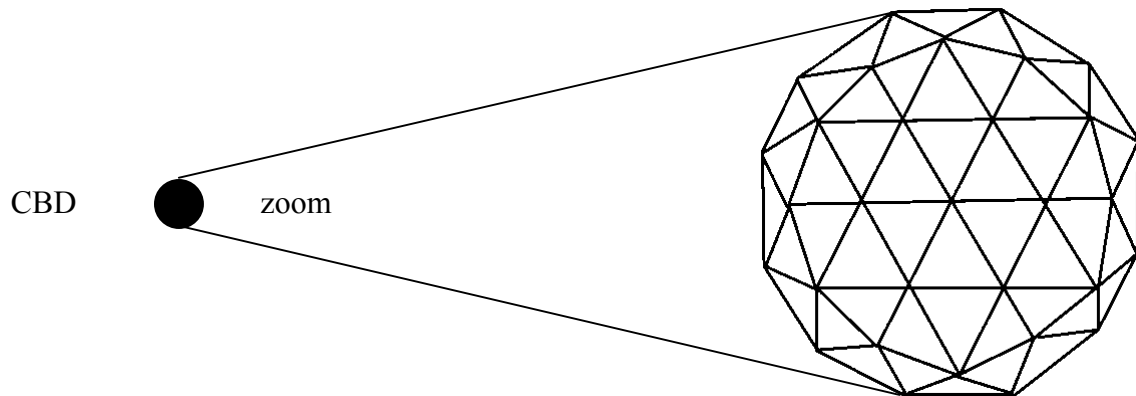
As a conclusion to this paper we would like to emphasize the idea that inside the city of Lisbon the economic life is mainly located in structural axis and squares, those 15% of the streets where is located nearly 90% of the employment observed. This axis and squares are said to be structural in the sense that by being the streets with a significant volume of employment, they influence the economic profile of the other streets of the city, strongly defining the economic life of the city.

Once noticed that there is an evidence of the existence of agglomeration economies in the city of Lisbon, since the employment is mainly located in a relatively small number of streets, is possible to defend the idea that CBD is not a point, but a space with heterogeneous characteristics, where some particular areas seems more attractive for the location of economic activities.

Considering that streets are able to be ordered according to their employment dimension, revealing an hierarchical pattern of organization, in the way that when the spaces with larger dimension generate a strong influence on the economic life of the streets that follow them in the intra-urban hierarchy, they reveal their structural function.

In this sense, we consider the spatialization of the economic activity inside the Lisbon urban centre as a network of structural streets (axis and squares)

Fig. 6.: CBD is not a point



When we observe that a small number of places, that follow an intra-urban hierarchy, are the places that agglomerate the larger proportion of economic activity inside the city, we find a significant manifestation of economies of agglomeration at an intra-urban scale of observation. The conclusion on the existence of intra-urban agglomeration economies is also supported by the idea that the labour earnings are expected to be higher in the structural streets comparing with the city average. The previous facts tend to confirm the recognition of the existence of agglomeration economies, that promote the localization of economic activity in a small number of places inside the city centre. Therefore and as occurs at other spatial scales of analysis, the agglomeration economies theoretical framework will be an important tool for the analysis of economic activity intra-urban spatialization.

This network structure could also be analysed through the hierarchical point of view, using tools similar to the ones that are used to understand the urban network at a regional level, since the number of points in space decreases as increases their intra-urban hierarchy importance. Although the use of the central place theory framework can not be made without the necessary adaptations, regarding the scale of observation. It is known that, according to this theoretical framework, in an urban centre of higher hierarchical importance can be found all the urban functions of a centre of lower importance and some functions more. In an intra-urban analysis that might not be the case, since the economic activity that occurs in a street of higher intra-urban importance can be completely different from the activity that occurs in a street of lower importance. In this sense, it is said that the economic activity inside the city of Lisbon is developed in a network of axis and squares that are complementary to each other. It is from the aggregation of all the axis and squares that the city centre acquires its urban importance in the regional network to whom it belongs.

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