

The spatial dimensions of trade: From the geography of uses to the architecture of local economies

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Abstract:

This paper investigates the relationship between urban space and urban economy focusing on the way centralities emerge across scales. A method is presented that combines space syntax theories and an economic model of trade-off that refers to the relation between rent and access. With the argument that economies take place in differences of space, accessibility, therefore, becomes an important matter of scale in order to understand how economic actions are materialised in urban space and how space affects socio-economic interactions at the local design scale of the city. Properties of this relationship are investigated through rent values of different real estate property markets in the city of Cardiff, UK. The method identifies the spatial distribution of activities across scales. Firstly, it is shown that trade-off modelling in the street configuration can be devised as a pattern of use mix profiles in the city. Secondly, that trading between cost and access is a local process that can take place in different locations in the city that potentially function as sub-centres. Thirdly, rent and access also encourages people to re-adapt urban spaces for economic benefits, generating the reconversion of uses contained in the same real estate, the commercial-residential building. Finally, the implications of combining space syntax techniques with urban economic models are discussed. It is concluded that while spatial configurations create possibilities for economic activity, this should also be viewed as the reverse approach of how urban economics requires proximity in distance to be produced –a relationship that has not yet been approached in space syntax research.

Keywords: *Mixed use, bid rent, centrality, urban design, space syntax.*

1. Introduction

Economies organize themselves in space and over time, resulting from materializations through 'localized actions' from society (Jacobs 1970). However, what is the logic behind the organization of economies in urban space? This paper is about the spatial distribution of socio-economic activity within and across the city. The research focuses on how spatial accessibility plays a role in the way commercial and non-commercial property markets are

distributed in the city and, in turn how the pattern of distribution of markets influence local centres to emerge over time.

Centres can be considered as self-organizing systems sustained by social and economic processes. One of the factors that affect such processes and the emergence of centres is the spatial accessibility of the city's urban network or, in terms of the physical structure, the reachability to different activities and uses. In the disciplines of urban economics and urban planning, accessibility is studied as an element that has the ability to modulate, distribute and accommodate the generation of movement. As such, access relates to the quantifiable distance that makes a space with a specific function (i.e. a property's type of use) to be located in relation to another. The hypothesis is that *distance constructs possibilities to interact socio-economically*. Being proximate in distance creates the opportunity for trade to take place. It is suggested that distance is formed in different ways because it is shaped by the network of streets and not as an absolute measure from one place to another. If economic materializations are regulated by proximities, then they also operate through differences of space. Therefore, space can be considered as a 'heterogeneous' (Netto 2011) framework that accounts socio-economic processes that shapes a city's urbanization.

To explore this proposition the research combines two methods: An economic model, called the 'trade-off' model designed by William Alonso in the 1960s, which explains the relations between property rent and accessibility in terms of land uses; and a spatial model that uses space syntax analysis to study differences of accessibility networks in the urban configuration. The results are presented in three scales of the city: a global model of commercial and residential property rents; the activity locations that take form of sub-centers; and, the local architectural scale of mixed uses within every local centre, in which property rents are located upon an architectural unit in the commercial-residential building.

1.1 Space and urban economic life

The questions addressed in this paper are focused on the Welsh city of Cardiff in the UK. Cardiff's urban transformation began as a predominant industrial core in Wales since the 1880s. From being one of the port cities with the largest coal industry in the UK, the city passed from a stage of de-industrialisation to be developed as the capital of Wales in 1955 (Hooper & Punter 2006). Cardiff's spatial and economic growth over time was based primarily on its road network structure that, since the early 1840s, has become the spatial footprint that divides the city by four main arteries (north-south, west-east).

The division of the urban network evolved as a decentralized growth concentrating activities that consequently made different urban centres to be developed over time. However, the economic growth of Cardiff has been concentrated around its city centre –the central business district constituted with large mixed-use complexes for residential, financial and commercial trades. The morphology of the city centre and its function as a consumer-based hub is largely the result of the planning doctrines that Cardiff adopted over the years.

Cardiff is an example of a post-industrial city that shows how activities have been spatially distributed over time based on its socio-economic development, which was and still is very much dependent on how the city centre was

¹ The result of what the city is now is partly by a significant political scheme that developed as part of Cardiff's planning history, and therefore the development of a planning doctrine. From the late 1950s, "a long-standing sense of purpose among the 'city fathers' in relation to promoting the city was complemented by a new consciousness of what this might entail in spatial terms –i.e. for the form and development of the city. In brief, the city came to be seen by a wide range of politicians and professionals as a planning area" (Coop and Thomas 2007, 169). Such doctrine also provided the city to be developed as a capital city role, promoting national and local relations of governments.

² Based on Von Thunen's agricultural land use model, Burgess developed the 'concentric zone model' in 1925 expanding the theory of having concentric ring patterns of urban zones of development.

³ In *The Self-Organizing Economy* (1996, 49) Krugman described the generation of new urban forms as a process he called "urban morphogenesis", in which the notion of 'order instability' and 'order from randomness' growth in cities apply.

designed. According to Pacione (2005, 157) "many of the CBD or city centres, in the US and the UK, have been transformed by their social and economic processes, such as deindustrialisation, retail activities, decentralisation of population, increased socio-spatial polarisation and reduced accessibility due to the increasing demand for car ownership." In this sense, cities are the production of social and economic processes in which the concentration of activities and diversity of uses become part of a self-organizing economy in the city.

The notion of centrality has been addressed by Hillier (1999) as a spatial process and grid deformation. In economic geography, centrality has been approached in terms of attractiveness (Christaller 1933; Losch 1952; Isard 1956; Alonso 1964; Krugman 1996; Fujita et al 2001). Von Thünen's (1826) analogy of agricultural development of a city was one of the first ideas that addressed the concept of centrality. Von Thünen's model represented the growth of the city as a self-organising network possessed by a single centre or attractor. The subsequent growth of the city would be formed in a hierarchical order of agglomerations represented in concentric rings ² from the centre outwards (Figure 1). However, when land use, transport costs and land rents are considered then "models are broken into differences of spaces that allow different centres to be identified, firstly as specialised areas and later as self-organising local economies" (Shane 2005, 28). Urban land models are an example of representations of the spatial structure of the city and how socio-economic processes seek to balance an agricultural distribution encouraging a generation of 'new urban forms' ³ (Krugman 1996).

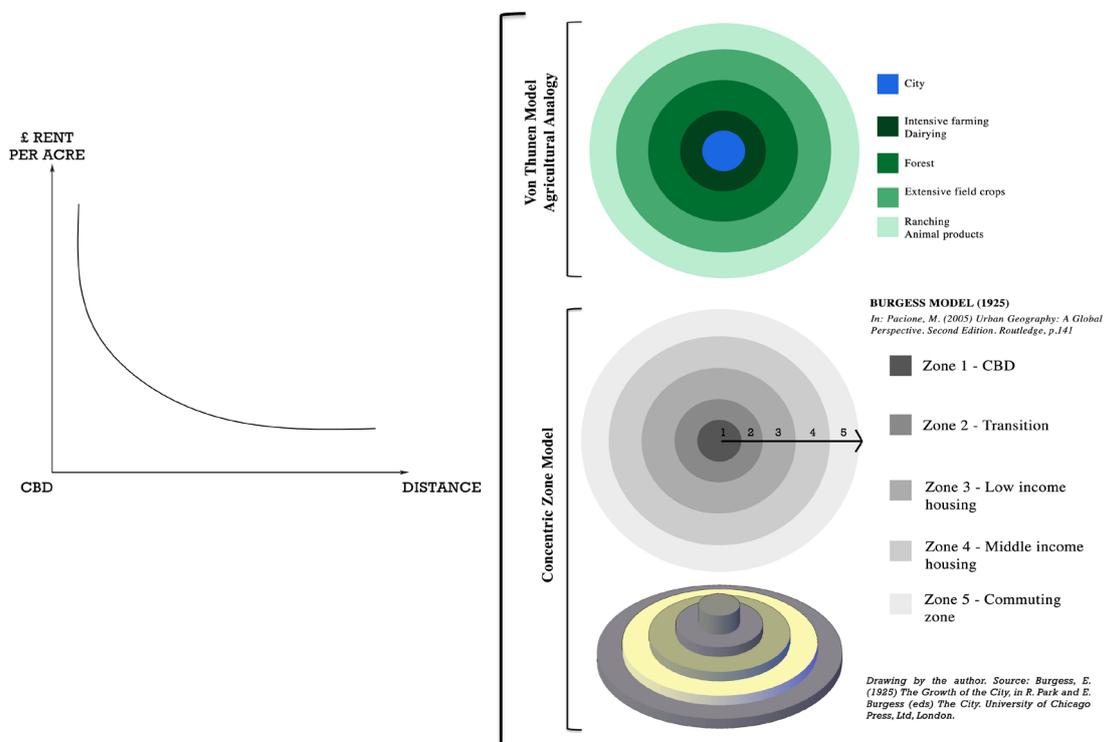


Figure 1. Relationship between distance and rent values from the CBD; Von Thunen's agricultural analogy and Burgess' concentric zone model.

The way economies are organized comes partly from the emergence of different centralities within a city. From a global scale point of view, transportation networks have the potential to increase sprawl depending on how the urban system evolves gradually. For example, faster transportation can increase convenience of commuting, increasing rent that commuters from the city centre are willing to pay, and therefore increasing the area of developed land, but without this being necessarily corresponding to an increase in population. This has happened as we see cities at times having multiple centres where even communication networks (i.e. internet) impact on the centralization of employment. At a local scale, this translates how different uses are built in a single architectural unit in the case of the commercial-residential building (Davis 2012), which represents a type of building that has the multiple function of containing living and shopping/working in the same real estate. This mixed-use building acquires an importance of revitalizing streets and centres as a new *kind of economy* that maintains centres with the choice of having more accessibility with lower costs and increasing land value by adopting diversity of activities ⁴. As distance increases, communication networks become important allowing the growth of sub-centres to function as self-organizing systems.

⁴ In *The Economy of Cities*, Jacobs (1970, 55-68) argued a new perspective on local economies and the importance of a higher diversity in cities. She contested the assumptions that specialized economies or larger businesses would make a good source for innovation. Instead, she argued that innovation could lead to imitation as 'economic borrowing'. She developed a method of local economic development based on the idea of division of labor, in which innovating economies expand and develop by adding new work to the old; she argued that small businesses created by urban entrepreneurs would make for a more stable and long-term

Centrality, then, is the place where socio-economic activities concentrate dependent on location and connectivity. The competition for location is the ordering principle of organizing the internal distances within the city, and subsequently, to form patterns of land uses. This process of self-organization is seen as 'agglomeration of economies' (Marshall 1890; Fujita & Thisse 2008), or localized aggregations in which economic space becomes the outcome of trade-offs between location and cost of living. This relationship between space and economy is studied by combining one economic model, the principle of trade-off often known as "bid rent theory" (Alonso 1964, 14), with the configurative theory of space syntax (Hillier 2009; 1999) as the central background of analysis (Figure 2).

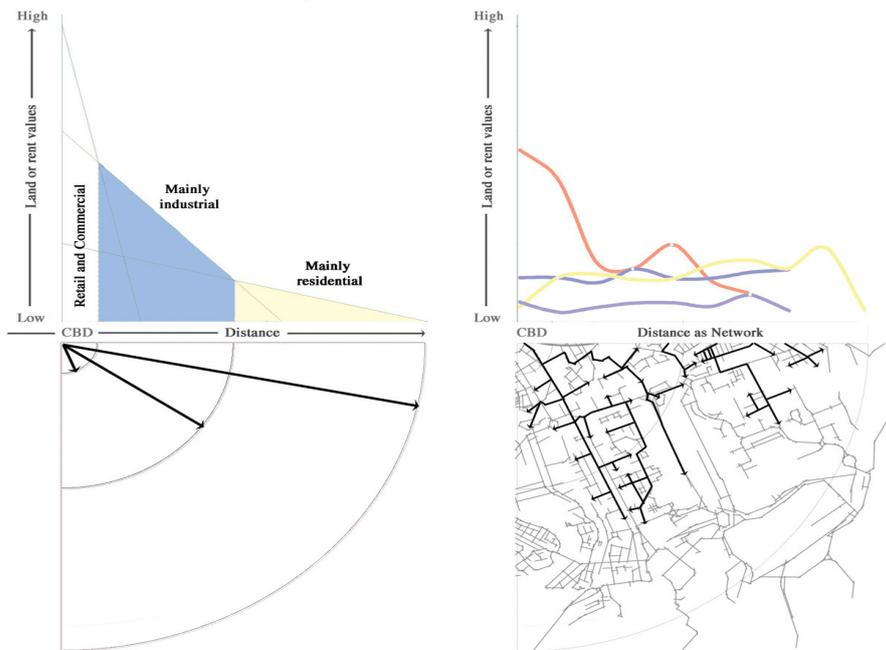


Figure 2. Re-defining distance in Bid Rent Theory: from concentric rings as crow flies into the geometrical notion of the street network.

⁵ Central business district (CBD) is a term used for American cities that denotes economic and financial development of the city. This paper will refer the CBD as the city centre, which is often the historical core in most UK cities referring to the concentration of commercial, political, and leisure dense core of the city.

1.2 Combining two methods

The logic of the bid rent model (rent versus distance) was applied to study the spatial configuration of Cardiff. The term *bid rent* refers to the amount of rent a user is willing to pay for a more central location, but is willing to accept a location further from the central built-up area at a lower rent cost in compensation. The reasoning behind the trade-off process of Alonso's bid rent model (1964) is what follows: Property markets like retail and commercial uses are willing to pay a higher cost to be in the centre, where there is a higher concentration of population and activity that tends to be more movement-rich than other parts of the city. The model suggests that as distance from the CBD ⁵ or city centre increases, land availability at a lower price diminishes. Accessibility for housing affordability and agricultural uses is offered less intensely away from the city centre. Since Alonso's model is based using the 'concentric zone model' (Burgess 1925) to express differences of land uses, the challenge of the Cardiff research was to re-adopt the principle from the model and test it with measures of network distances.

The proposition of the method is to construct a 'new style' of bid rents and analysis and attempts to calibrate these using metric, topological and angular friction measures. The purpose to compare these three frictions is to extend

the exploration of the bid rent theory into a more precise association of accessibility and location. For example, why does a shop locate in close proximity to other shops of the same competition? Or why does residential use tend to locate near commercial use? What is the relationship of having close proximity of residential and commercial use and the impact this has on rent values? How do these micro qualities of proximity between different uses relate to the connectivity of the urban layout? Essentially, the criteria to distinguish the different frictions are not because they are independent from each other, but how does each of them respond to different uses. Meaning, how do different uses give more weight to their physical distance between them, or how reachable it is to get from one to another depending on the topological configuration of the urban layout and how intelligible it is to move within the system (for examples of this, see Figures 3, 4 and 5).

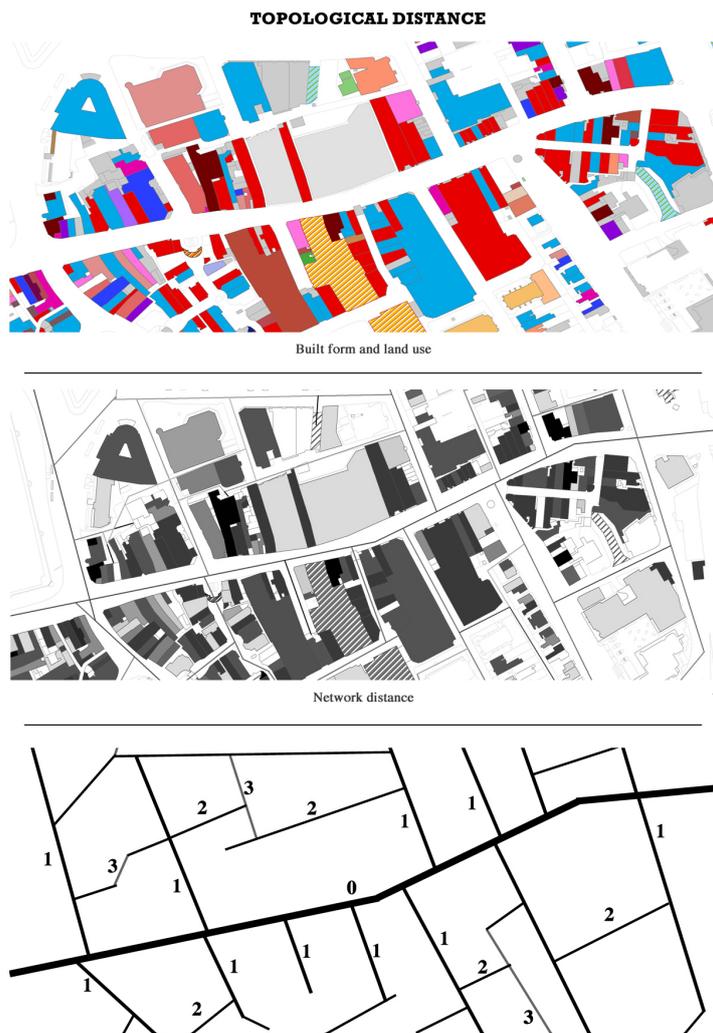
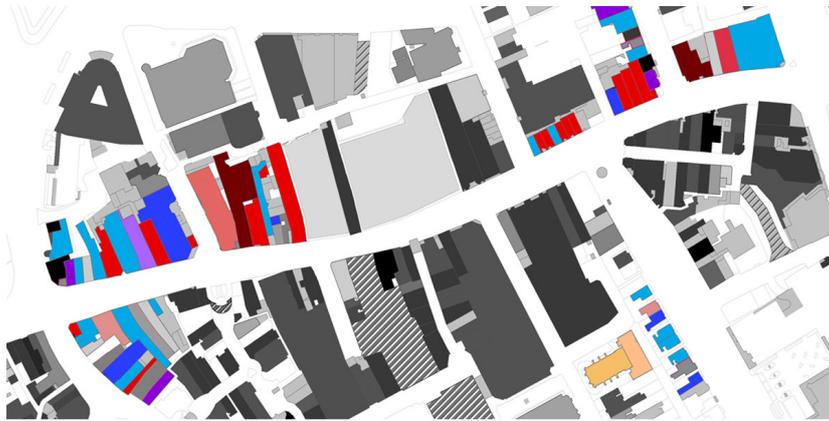


Figure 3. Topological distance measured by number of turns.



Physical distance between different uses



Step depth analysis by metric units

Figure 4. Metric distance defined as physical units.

The aim is to unfold rent values of different property markets that include retail, commercial, office, industrial and residential uses, testing them against different types of distances of the urban street network. The data to test the analyses are shown in figure 6, having a total of 3,222 properties. The unit of analysis is rent per square metre (RSQM) for every type of property market. The street network configuration becomes the spatial model to be tested as a background of distribution of land uses, movement and accessibility, in contrast with the conception of concentric ring-shaped patterns of land uses. Space syntax theory has addressed accessibility as a geometrical property that measures potential distributions of movement that relate to the multiplier effect of uses and activity distribution. However, the argument is to consider both sides of effects: how spatial configurations create socio-economic productions and how economy affects urbanization. With this in mind, the combination of a trade-off model with a configurative framework is proposed in this paper (Figure 6).

The research method is achieved in three ways: First, it uses segment angular analysis to comprehend the 'foreground' and 'background' networks of the city (Hillier et al 2007). Second, applying step-depth analysis in its three types of distance: metric, topological and angular (Hillier & Iida 2005). What is

⁶ It is important to mention that Queen Street is the main shopping street of the city centre being completely pedestrianized due to planning policies of keeping vehicular traffic out from the main shopping malls that are located along this street.

presented is a new model that shows the rent values of properties in relation to step-depth distances measured from one single street, considered as the *line of origin* from the city centre. The line of origin refers to the main street with the highest retail and commercial activity as well as the main concentration of pedestrian flow ⁶. Finally, by using the same method of step depths in other sub-centres in the city, the task is the identification at a local design scale of where the combination of living and shopping (or living and working) come together in relation to the real estate property rents: the commercial-residential building.

The paper is structured in three parts: The first part focuses on the application of the bid rent model in the street network of Cardiff measured from the city centre. The second part looks at four sub-centres applying the same model in each of them in comparison with the city centre. The third part discusses the urban location and the socio-economic function of the commercial-residential building in relation to each sub-centre.



Figure 5. Angular distance defined by the least angle change path.

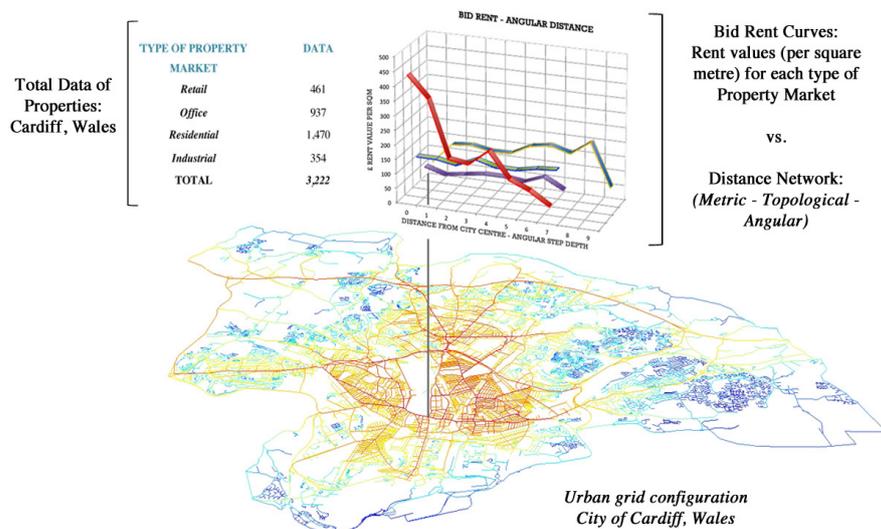


Figure 6. Combining bid rent curve model with configurational analysis of the street network, tested in three types of distances. The data sample for the whole city of Cardiff is given showing the total number of properties for each type of market.

2. City centre: Modelling property rent values and distance network

2.1 Understanding Cardiff as an urban network

The city centre area links mainly the west and east parts of the city. The development of new retail activities (i.e. large shopping malls) along the main street of the city centre, Queen Street, has made the centre to be locally structured as a predominant pedestrian traffic use and globally interconnected through main thoroughfares that run from north-south and west-east directions in the city.

The maps in figure 3 show a description of segment angular analysis (Hillier et al 2007; Hillier and Iida 2005; Turner 2000, 2007), using integration and choice measures. The measures also correspond to the distribution of land uses and rent values of commercial and non-commercial properties that identify areas as local centres (Cardiff City Council 2009). Furthermore, if we think of how trade functions it becomes a matter of how far or close one is to trade (integration) in the same way the importance of location and the easiness of how to get to that location (choice) (Hillier and Iida 2005, 479-482).

The angular choice map in figure 7a presents the urban structure of the city at a global scale (R_n) consisting of a motorway and main roads that compose heavy vehicular traffic at the north part of the city. The highest accessible route interconnecting the city centre is formed from the west to the east sides; primary roads (i.e. high streets) connect the city centre from north to the south parts. The choice map shows that the routes related to most commercial activity streets originated from the main connector from which the city centre evolved. The sub-centres, which will be addressed further on the paper, are identified at a radius of 500 metres (Figure 7b). Ranging from radii of 400m, 800m, 1000m, and 2000m (Figure 7c), there is a clear distinction of sub-centres, which show the main routes originated from the core of the sub-centres that connect globally the whole the city. These main routes contrasting

each sub-centre are also the main streets or lines of origin taken to measure the bid rent model in comparison to the city centre.

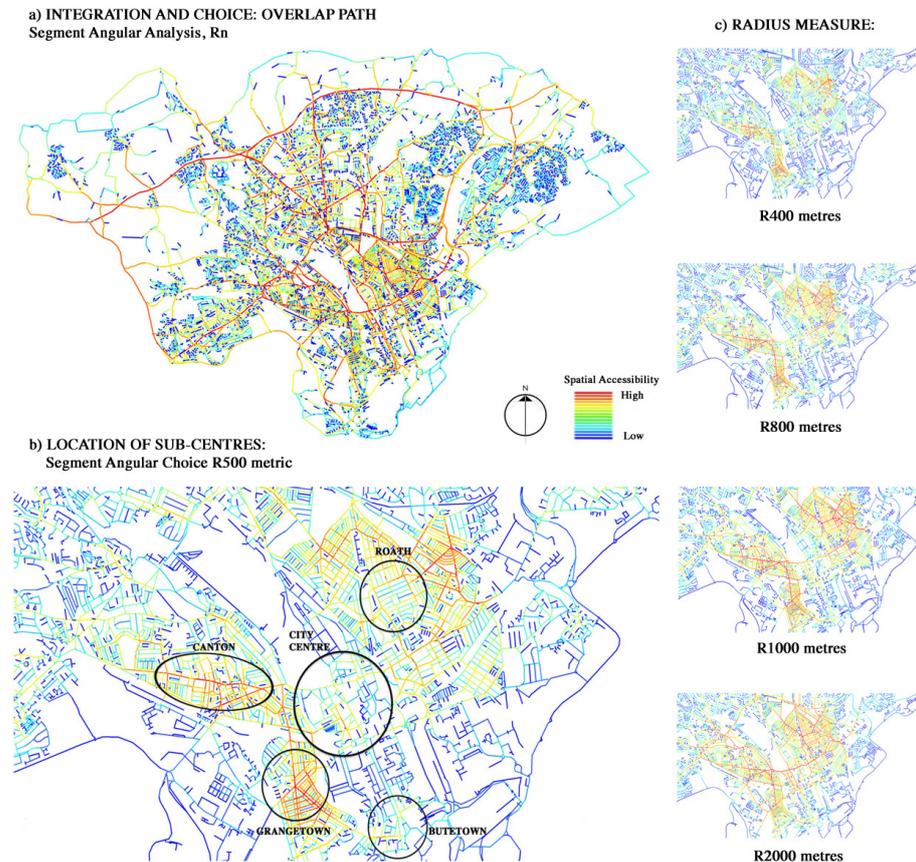


Figure 7. Segment Angular Analysis: a) Represents the global radius of Cardiff; b) Identifying sub-centres at 500 metric radius; c) Radii measures demonstrating main streets originating from sub-centres.

2.2 Bid Rent configuration model

Departing from the local scale of the city centre, the analysis of bid rents is done by taking one single street as a point of departure. In order to compare rent values and accessibility in the urban network, the research considers different variations of distances. The way to do this was to make a step-depth analysis using three types of distance network.

Selecting a street of origin, step-depth calculates distances in three ways: as fewest number of turns (topology), as physical distances that measure segment length within a street (metric) and as least angle change path in the urban system (angular) (Hillier & Iida 2005; Turner 2000). In this way, a *bid rent configurational model* is presented. The street of origin from which the step-depth analysis is performed, in the case of the city centre, is Queen Street (Figure 8). This means that all segments that compose this street have a step-depth value of zero.

The graphs in Figure 9 show the results from the step-depth analysis for each type of distance tested against the data sample of property rent values.

Given the complexity of each graph, the illustrations show an isometric view of the location of points identified in the graph where two or more markets interconnect at a same location in a similar way where one single market results in variations of peaks and troughs. For each type of distance a series

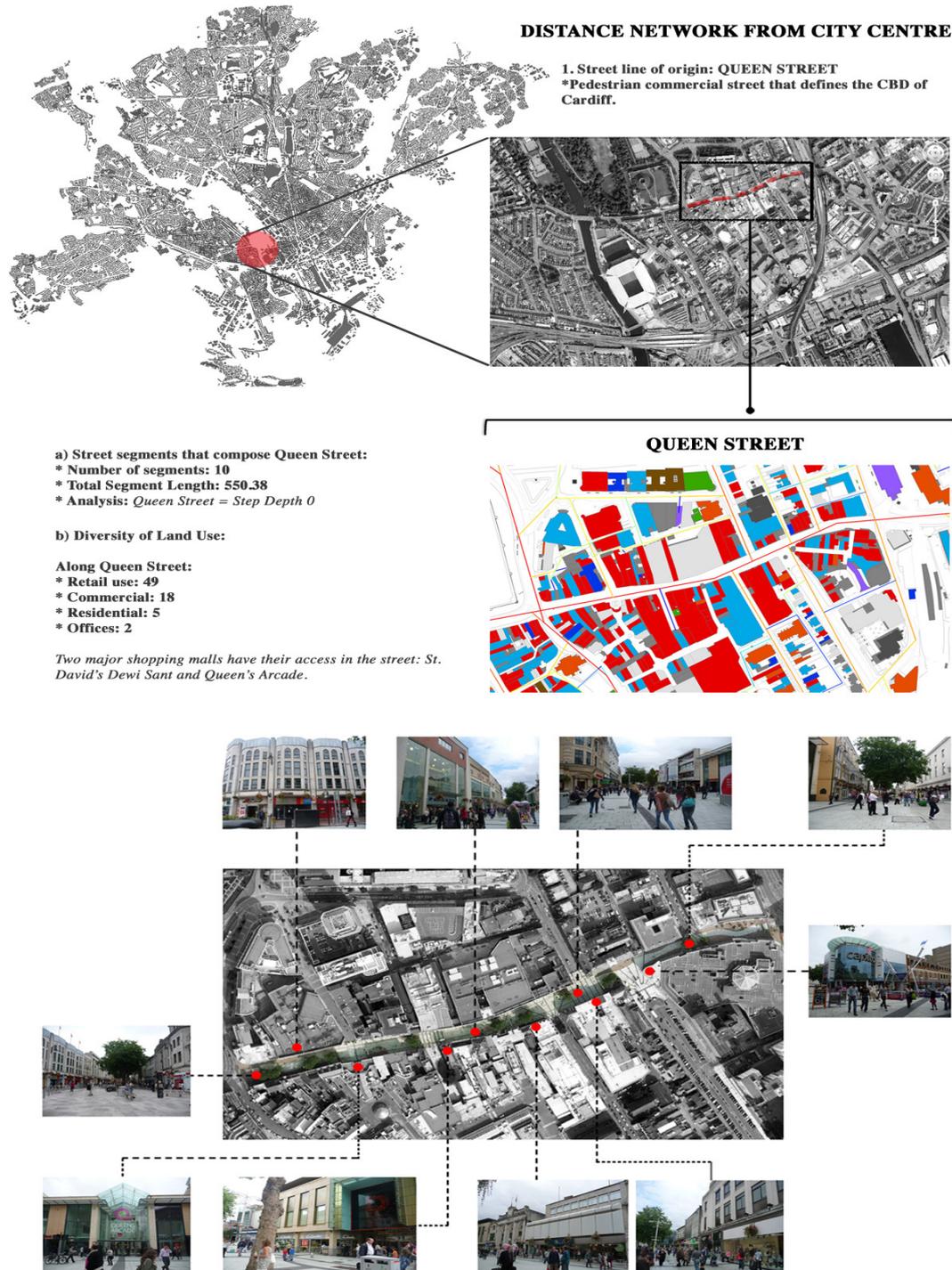


Figure 8. Queen Street: Street of origin considered in the city centre. All segments that include Queen Street are taken as a step-depth of zero where the bid rent curves are measured against the three types of distances.

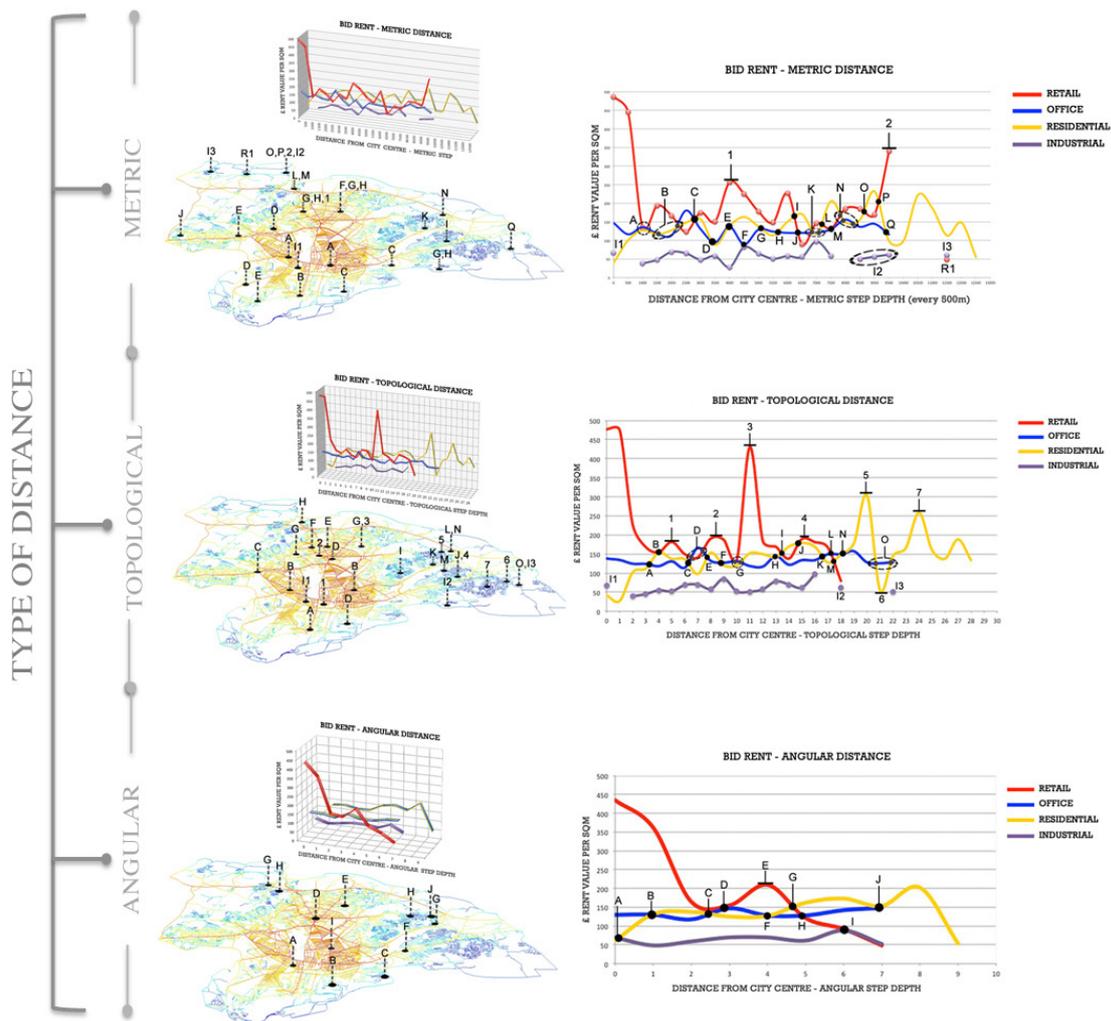


Figure 9. New bid rent graphs: rent values for each property market with each type of distance.

of graphic and descriptive tables were produced in order to *unpack* the graph as a detailed description of the results.

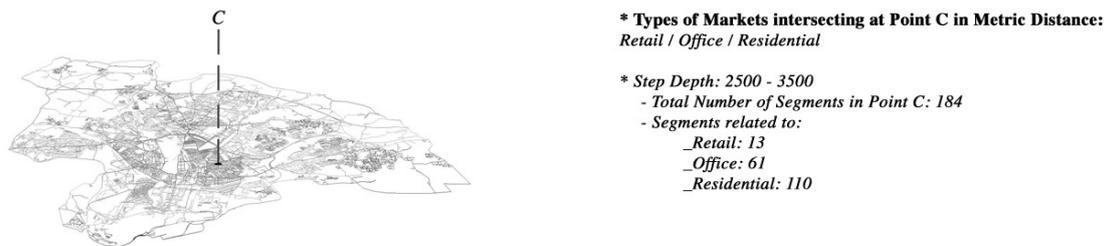
An example of this is shown in Figure 10, which presents one point (location) from the metric distance measure. The example illustrates how from an overall measure of bid rent curves, the economic value is also related to morphological attributes of location, showing: the urban layout (local urban form), street morphology (connectivity and access), function (diversity of uses) and intervals (streets composing the location of step-depth value of metric distance). This shows patterns of land use organised according to its actual spatial distribution in the configuration network without having zoning areas of uses like in Alonso's model.

The 'new' bid rent graphs details every geometrical distance that informs the accessibility and location of what people search. Analytically, the trade-off between distance and rent from the city centre is shown in figure 9. The x-axis in the graphs represents the type of distance and the y-axis the rent values per square metre for the properties. Topological distance is expressed as

number of turns (i.e. 0,1,2,3), metric as physical units (i.e. 500m, 1000m) and angular distance as a calculation of least angle changes (i.e. 0.124, 0.1.256). Theoretically, the argument is that rent values and location depend on property use and level of accessibility. Whether if a property is more proximate to other properties of the same activities; if properties have a higher value of rent being close to other uses by least number of turns; or whether we can see an overall spatial distribution of activities that shows concentration of uses in different parts of the city.

Modeling bid rents with every type of distance in the street network advances the following arguments: Firstly, metric distance shows that clustering of offices are found in residential areas. It is argued, however, *that clustering of offices is also based in physical distances within the emergence of a neighborhood*. The argument is that beyond having identified where and how markets juxtapose as physical locations in the city there is also the suggestion of how the existence of a neighborhood can act as a dual entity, an economic and an institutional one.

‘UNPACKING THE GRAPH’: EXAMPLE OF POINT IN METRIC DISTANCE AS A SPATIAL DESCRIPTION



TABLE/GRAPH			TYPE OF DISTANCE - STEP DEPTH ANALYSIS	
Symbology	ID POINT	Step Depth	METRIC DISTANCE (every 500m from City Centre)	
	C	2500 - 3000	<p>URBAN LAYOUT - FORM</p>	<p>STREET MORPHOLOGY - ACCESSIBILITY</p>
			<p>FUNCTION - USE</p>	<p>INTERVALS - STREETS AT EVERY 500M FROM THE CENTRE</p>

Figure 10. An example from metric distance graph, showing the spatial characteristics of a location that intersects three markets.

The neighborhood does not only emerge as a consumption-sharing premise, but it is also based on what is spatially and economically constructed by society. Webster (1993, 2596) proposed that the emergence of neighborhoods

⁷ Fujita et al (2001) describe market behavior as a broad concept in the field of urban economics that refers to the behavior of consumers, businesses or the stock market. It is mostly studied as a means to generate various marketing strategies to boost sales by analyzing the tendency of how consumers purchase goods.

is based on transaction costs, in which “individuals seek to reduce the cost of cooperating with each other”. His argument is that there is a relationship between the idea of people being linked together and the physical existence of a neighborhood. It is proposed that within the boundaries of the neighborhood, the community seeks shared resources that emerge as local services or businesses that mutually cooperate with each other. Therefore, an importance relies on the *physical co-location that services have in respond to other property markets; it is about the mutual benefit of co-operation and competition between activities.*

Secondly, topological distances are associated to spatial proximities rather than being mutually competing with other markets. Most residential properties (ranging from £100-£250 RSQM) are commonly located one to two steps from retail and office uses. Retail activities are the most predominant use with the highest rent value, typically located on the highest integrated streets. Topologically, however, commercial uses such as small local businesses or specialized shops are found within neighborhoods on more segregated streets (i.e. back streets that compose smaller urban blocks) than on the main high streets. This partly has to do with the nature of the businesses. Most of the commercial properties rented in one step from residential uses tend to be at corners of urban blocks and in two to three steps being along the street. Industry (i.e. storage or warehouse facilities) appears in isolated locations but more related to retail use that includes large retail stores.

Thirdly, angular distance shows a more holistic view of bid rents than the previous two distance types. The argument here is that, although angularity refers to the kind of distance that is made by making the least angle change of direction in the street network, one market is more sensitive to angle change than the others. The evidence of the angular distance graph shows retail as being the most consistent one in comparison to the rest of the uses. Angular distance relates to a question of behavior. Similarly as how people would tend to move, the relation between activities in angular accessibility relates to a ‘market behavior’⁷ (Fujita et al 2001) that is dependent on the spatial layout. Intuitively, this suggests as to how a shop or a business search for a location that would make their profits higher if they were located on well-connected streets (which are not necessarily high streets) or in areas within the threshold of residential uses. An example of this can be said about the corner shop in most common urban neighborhoods.

These different and interrelated forms of accessibility can be understood economically as transactions of services and goods; socially, as a form of culture of organizing uses and activities that produce different centralities (street-neighborhood-district-city); and spatially, as architectural productions that result from the distribution and interdependence of activities.

3. Sub-centres: Bid rent comparisons across the city

The results from the bid rent configuration from the city centre gave the opportunity to explore other locations in the city. Having an urban system of multiple centres allowed applying the same logic of the model in four sub-centres in Cardiff. The sub-centres are: Canton (west), Roath (northeast), Grangetown (southwest) and Butetown (south) (Figure 11). The reasons are as follows: Firstly, the complexity from the new bid rent graphs in figure 9 showed areas of high concentration of retail and commercial properties mainly located in streets of highest choice and integration accessibility.

Secondly, the foreground network of the city (i.e. network of primary roads) presented a system of linked centres (See figure 7). Similar to the first application of the model, the hypothesis is that *the bid rent is locally developed depending on locations in the urban grid*, that tend to be ‘naturally movement-rich’ (Hillier and Vaughan 2007), *and not only as a single process that originates from the heart of the city*. And thirdly, Cardiff Deposit Development Plan 2006 – 2021 (Cardiff City Council 2009) proposes the selected sub-centres as areas for land development and their recognition as district centres.

As a result, land use data, planning development proposals and the spatial analysis of Cardiff make a reasonable output to consider the four sub-centres of relevance for the study. The land use data, in addition to measures of segment angular analyses at various radii, demonstrated the distinction of sub-centres. This process is generated as the settlements grow and where patterns of clustering are likely to change, shifting the focus of centrality, and thus creating “attraction inequalities” (Hillier 1999, 2) that generate different spatial configurations. Based on these observations, a street of origin was also defined for each sub-centre applying the bid rent model with the distance measures.

Each sub-centre has a distinctive characteristic how they emerge at their core (profiles 1,2,3 and 4 in figure 11). The morphology of the street network changes in comparison to the city centre having different urban structures and organization of activities. The street configuration in every sub-centre presents different urban forms at their core (Figure 12). It is argued that the different shifts of forms of configurations may be partly an influence of why such areas became local centralities. Canton emerged in a linear structure of retail and commercial activity connecting from the west side to the city centre. Roath, on the east side, shows a structure of gridiron shape composed of two main high streets intersecting and delimiting a superblock of neighborhoods. Grangetown, on the southwest, emerges in a radial order of streets in its centre and connecting to Canton to the north. Finally, Butetown on the south part is composed of an isolated nucleus concentrating mainly office and leisure activities, influenced also by its location near the port of the city, Cardiff Bay

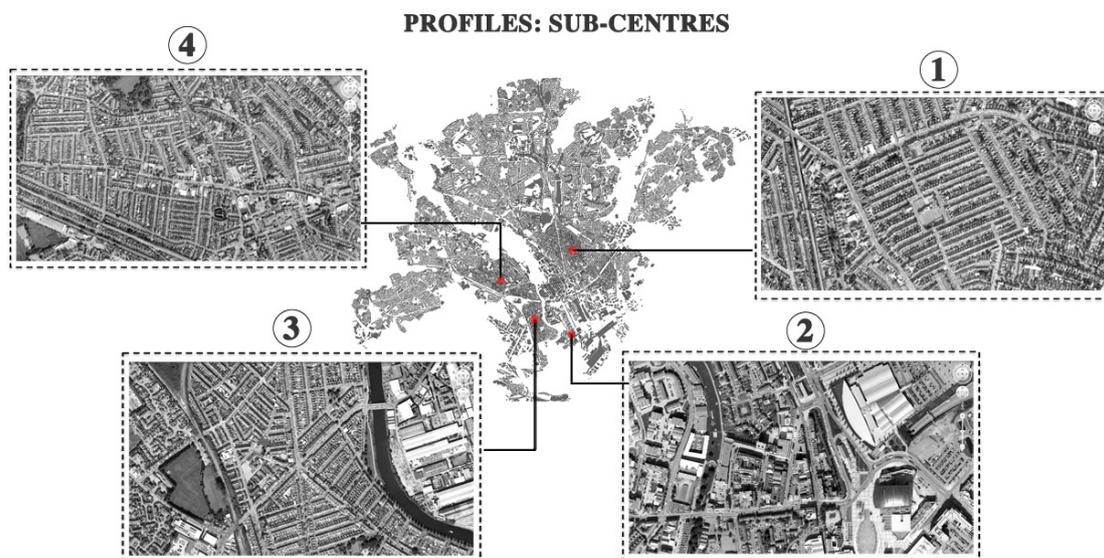


Figure 11. Location of sub-centres in Cardiff.



Figure 12. Sub-centres of Cardiff detailed with their streets of origin and their corresponding bid rent graphs with each type of distance.

Area. However, the connection of Butetown to the city centre, as well as to the rest of the city, is more segregated and locally accessible primarily through public transport links.

The results of the bid rent analysis for the sub-centres in figure 12 confirmed the hypothesis that trading between differences of spaces with cost of location is a local process that can take place in different forms of centralities and not necessarily at the core of the city. Canton, Roath and Butetown all present a tendency of being a centre where retail and commercial activity remains as the highest rent value expanding outwards. Naturally, the highest peaks of retail activity in all graphs correspond to the city centre location. The most irregular pattern is shown in Grangetown, suggesting that having a core with multiple choices of distribution (radial) can generate a more dispersed form of centrality than in a linear fashion.

Retail remains the predominant market that outbids the rest of the markets. Industrial activity shows gaps between distances, specifically in topological and metric distance. This suggests that industrial spaces in these local centres are located with the purpose to provide a self-sustaining cost to local businesses (i.e. same real estate with retail shop on front facade and storage facility on the back side of the building). The process of organizing distances, cost and location makes accessibility a matter of scale.

The organisation of spatial and socio-economic activities that create the local to global bid rents is better understood in the content of local neighborhoods generated in sub-centres. The argument is that *local neighborhoods provide an architectural flexibility to re-convert spaces that can minimise the economic cost of supplying goods, namely a higher economic return of a business and benefit from local accessibility*. Therefore, the bottom-up process of trades between cost and access exist on the mixed-use activities that contribute to a spatial process of emerging centres of economic, social and cultural importance.

4. The 'local trade': The commercial-residential building

So far, we have seen how an urban economy, from the perspective of the organisation of centralities, is organised through its patterns of property use and rents in the particular case of Cardiff—a relationship of how socio-economic processes shape the urban configuration of activities in the city. Now, the view is the reverse. It is about how space shapes socio-economic interactions that form a substantial part of how the economy of the city emerges. The way to view this is approached through the architectural unit of the commercial-residential building.

The existence of the commercial-residential building has been historically present in various cultures that appeared in cities partly as an economic necessity of living and working in the same place (Davis 2012; Davis et al, 2011; Davis 2009). The commercial-residential building is a spatial unit that results from a building transformation influenced by an economic condition as well as a cultural adaptation (Davis 1999). Over time, rules of zoning, such as location and building codes of use and form, have provided the flexibility of transforming a dwelling into a unit of work or shop, or the inverse (Talen 2012).

We can think of working and living as a relation of how access and location complement each other by changes in building use and architectural

⁸ *The survey was carried out by the author making interviews to shop owners and retailers.*

adaptability. When non-residential use is adopted in a dwelling, location becomes highly important as well as the cost of access. Retail and commercial functions require a certain degree of catchment area of pedestrians to be sustained. Thus, commercial-residential buildings tend to be located in streets that allow a more public use (busier streets) than in private ones (quieter streets). This strategic decision of where to locate public use in close proximity to private use is relevant to how levels of accessibility are shaped in the urban street network. The spatial pattern of this typology of building, commonly found in local neighbourhoods and composed by the terraced house in the UK, was mapped in the four sub-centres previously described. This paper will present one case on a single sub-centre as an example of exploration and analysis.

4.1 The case of Roath

The gridiron structure of Roath composes two main perpendicular streets in which the bid rent modeling was measured, Albany Road and City Road. Albany Road has larger frontages on the north side of the street having smaller number of plots whereas in the south side of the street, in which the length of the block is parallel to the road, there are a larger number of plots with smaller frontages. Historically, the blocks from the north side of the street are those with the least changes over time of reconversions of residential to commercial spaces.

Most of the commercial-residential buildings along Albany and City Road are not independent from the residential spaces. In the case of Albany Road, many of the commercial-residential buildings are occupied by the owner ⁸ (cases A and B in figure 13). For example, two properties on one single block that are in-between two large retail shops, in which the entrance in both of the properties is through the shop. Many of the facades of the buildings in Albany Road present a double entrance separating the shop and the dwelling in the upper floor, suggesting that commercial spaces are independent within the building.

In both cases, the appearance of the corner store located at one topological step depth from the high street occurs often in the area of Roath. The orientation of the same block happens in reverse in City Road (cases C and D in figure 13), where a smaller number of plots are facing the main street, many of them purely of retail shops at street level. In both cases C and D, the number of dwellings in each block, 62, is the immediate housing density threshold that local commercial activities need to maximise and sustain their economic profits.

The balance between separating and yet combining different uses is also a factor of levels of accessibility at a finer grain in the city. The location of commercial-residential buildings can also determine how services are accessed within neighborhoods. This can be seen in figure 14 where the pavements are highlighted from the street layout, in which vehicular traffic from the main street changes typologically in one step depth or turn to a residential street. In some cases, the full restriction of vehicular access is realized by the continuation of the sidewalk and the addition of green spaces or urban furniture. In Cardiff, this is a constant characteristic of the local neighborhoods. It is how the location of commercial-residential buildings are in relation to what people decide what to separate and what to have in close proximity for services. It means distancing housing from the public street to maintain the privacy, quietness, and to some extent related to the safety, of residential areas.

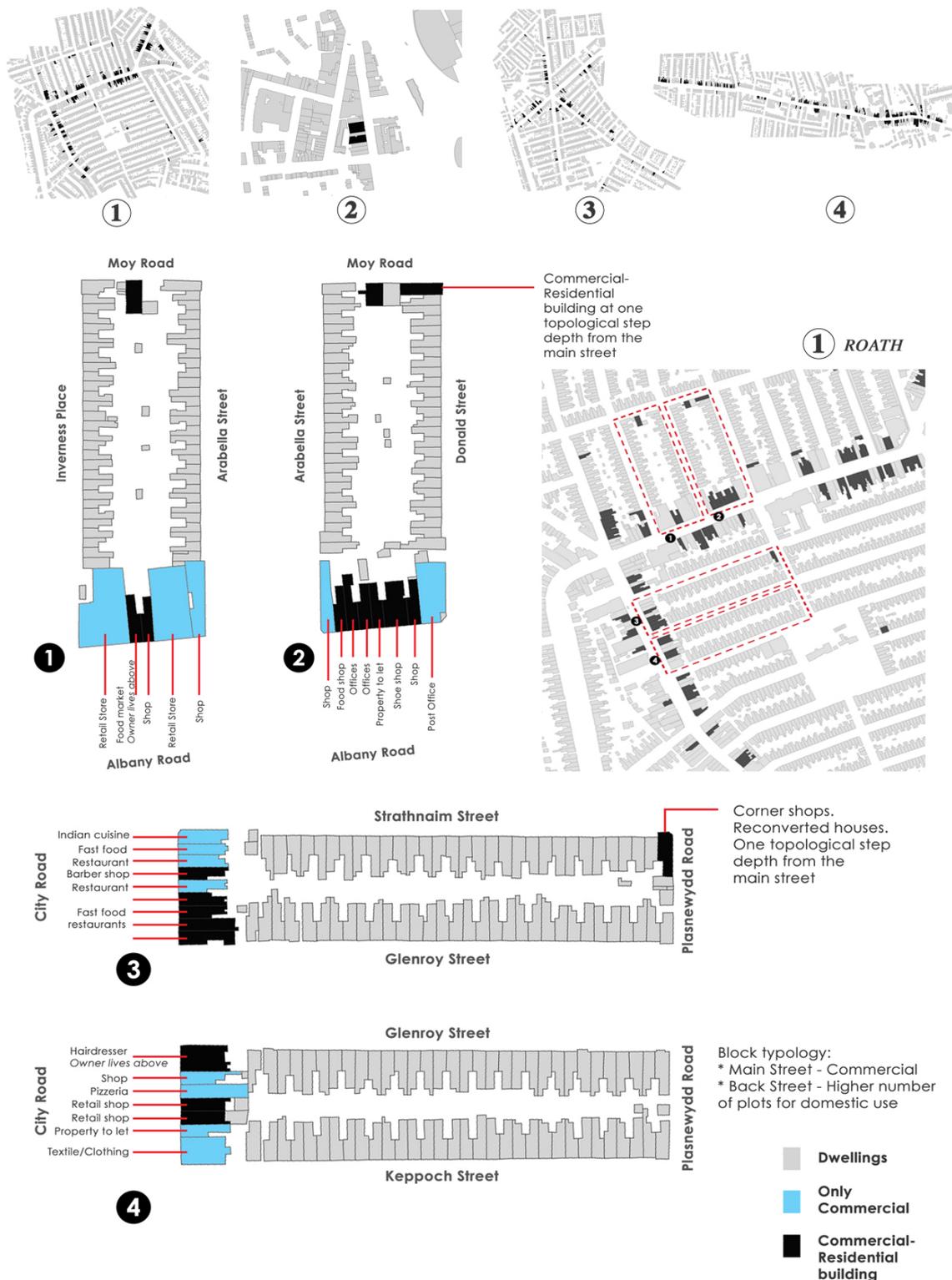


Figure 13. The commercial-residential building was mapped for every sub-centre. An example is illustrated in the case of Roath (1), describing the block-plot organisation in relation to the commercial-residential building. The blocks were considered in the streets of origin from where the bid rent measure was taken. Each activity was mapped by the author, which included interviews with local tenants and shoppers.



Figure 14. Albany Road showing how local shops contained in the commercial-residential building competes with larger retail stores upon the same location. There is a restriction of access through the main streets to the back –residential- roads, making vehicular movement to be accessed through backsides of the residential blocks. This restrictions are found consistently also in the sub-centres of Canton and Grangetown.

The connectivity and accessibility of a commercial-residential building can have a significant impact on how easy it is to reach a destination or how frequently a specific location is more likely to be used as a route to pass through. Interestingly, the distinction relies on how two functions, residence and commerce (the public and the private) are being optimized in the same location and how one single property value can have a financial return (rents) that then leads to a mixed-use district (Davis 2012). The effect becomes a shift from a top-down application to a bottom-up intervention of producing local centralities.

5. Concluding comments

This study has presented the relationship between bid rents and spatial configuration of Cardiff. The research presented a study across scales in the city, which combined three different types of distances in the street network – metric, topological and angular- with rent values of commercial and residential properties. The aim was to understand how urban economics is approached in an analytical way by using space syntax techniques with Alonso’s bid rent curve model. The results showed that testing new bid rent curves with syntactical analysis created the opportunity to apply the model in different locations in Cardiff. This allowed an interesting observation of how the bid rent can bridge the gap between the geography of land structure and the urban design scale of how mixed uses are produced.

The paper potentially contributes in two ways: Firstly, an interesting aspect of these new or *pseudo* bid rent curves are that they tend to overlap in relatively new developments, mostly on the city periphery of Cardiff. This implies that where land uses are allowed to compete openly (new green/brown field site, all uses can openly compete), land values equalize. This is what we would expect from a competitive, market-led mixed-use development. If they co-locate without subsidy, they are obviously paying the same rents at that location. For instance, if one rent was much greater than the other then the highest bid rent would dominate and it wouldn't be mixed use. And secondly, the combination of the two methods resulted in the generation of new bid rent graphs that successfully describe use mix profiles in the various distance ranges. This form of representation and analysis makes an innovative methodological tool that contributes in the fields of space syntax, urban economics and urban morphology.

The original bid rent model of Alonso is far from reality of explaining real distribution of land uses. However, the logic behind it still works. The interesting issue here is the way we can think about distance not only as a measure, but also as a form of relatedness of urban architecture. Distance is a process that combines mutual polarities at different scales. These polarities can be seen as the top-down distribution of markets versus the bottom-up human practices, the market price trends versus the rent value of properties, the separation of uses versus the allocation of mixed uses, and the planning system of the city versus the local design scale of creating trade in an architectural unit that has the ability of having multiple functions in accommodating commercial and residential uses.

The relationship of space-economy can be summarized as follows: *economy requires proximity and proximity creates opportunity for economic activity*. It is a relation that still remains as a major gap to be addressed in many ways. Whilst space syntax theories and tools have cast light on the 'generic structures' of cities (Hillier 2009) and has studied spaces that interconnect local to global patterns, this is only one side of the equation of how to view urban space and economy. Constructing a new model that considers syntactical measures of distances and bid rents can contribute to study cities in different perspectives and to better understand both sides of spatial and socio-economic processes within different scales of a city.

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