# NEW INSIGHTS INTO OFFICE LOCATION AND RENTS

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## Abstract

This communication presents a research on the reasons that shape offices locations and respective rent levels, within the scope of increasing globalization. It tests the hypothesis that the factors that shape the spatial structures and rents of the office markets are much strongly determined by urban planning and municipal investments than by variables more market-related, recognized in vast literature (Glascock et al., 1990; Bellini, 2000; Archer and Smith, 2003; Rabianski and Gibler, 2007; Ozuz, 2009). Thus an innovative methodology and model are proposed aimed at supporting the definition of urban strategies and policies concerning offices´ location and relocation, and corresponding influence on rent levels. They resort to a set of planning tools able to express the local characteristics of office markets. They are applied, as a case study, to the Porto's office market (Portugal). Implications for urban policies are inferred from this analysis. Some courses of planning intervention are further proposed that may consist, namely, in the regulation of property markets, in the indirect control on rent levels, and in a more local-based assessment of those markets.

This research is relevant for planning and public policies because it stresses the importance of urban planning interventions in office markets; it develops a urban management upgradeable information system; it overcomes some restrictions of previous location models; it settles a hedonic integrated and interactive non-deterministic model that fits the values that variables underlying rents may assume any time; it develops cartographic display and simulation functionalities (resorting to the use of geographic information systems); and it finally includes agents´ behaviours in the hedonic model of offices´ rents.

The assessment of the proposed model complements and enriches the operational application of hedonic models previously proposed in literature, and includes flexibility devices to support urban planning decisions on office markets. Besides, the results of this methodology and model will probably engender a reassessment and discussion on the role of public intervention versus market factors on urban office rents´ levels and trends.

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## 1. Introduction

Globalization processes, the structural organization of firms, information technologies and accessibility networks; the increasing importance of local markets and agents; the variables currently underlying location/relocation decisions and offices´ rents, and the concerns with the social function of land stress the importance of urban planning and municipal investments in the settlement of strategies and policies aimed at office markets.

But what is the relevance of planning options for the spatial structures and for the distribution of rents/$m^2$ in office markets? And what is the relative importance of public interventions when compared with the free initiative of promoters, builders and sellers? A better indirect control exerted by municipal authorities could launch the performance and characteristics of these markets! In order to respond to these queries, this research proposes an innovative methodology that renders operational the relation between planning and market variables, and offices´ rents/$m^2$, computing respective influences. It is articulated upstream with an urban management information system with upgrading ongoing functionalities, and downstream with a simulation and display interface (developed in geographic information systems). This operational assessment complements the application of hedonic models previously proposed in literature. The obtained results question the role of public intervention versus market performance on office rents**.**

## 2. Theoretical framework

### 2.1. Planning interventions in office markets

Should planning intervene on office markets? Within a global increasingly competitive scope, decisions on offices location/relocation depend more and more on macro-economic variables and, consequently, on public planning policies. And the future of cities, by its turn, depends on their ability to master strategic services, and to attract new office developments (Ihlanfeldt and Raper, 1990).

Municipal planning holds a series of social functions, namely to promote the public interest, to remove negative externalities, and to support the collection of decision data (Klosterman, 1996; Tang et al., 2000). In order to reach these goals, planning shall assure the availability of property for the different kinds of functional uses at acceptable prices, prevent excessive profits upstream and downstream the trade of development land, and guarantee the free the initiative of developers, builders and sellers (Rebelo, 2011), resorting to parameter setting, control over development licences, and distribution of surplus-values.

The municipality being the exclusive holder of development rights is out of question because of the risk that it involves for public finances (Rebelo, 2009). What are, then, the available ways for public intervention in office markets? It can control the development of specific uses and locations, even if it doesn't own property, or

through a temporary property ownership or even participation in public-private partnerships (Correia, 1993; Rebelo, 2009). It may also control specific general or particular developments resorting to planning or fiscal tools. Finally, it can shape property markets through the dissemination of data and guidelines on public participation. Planning intervenes in property markets through plans, regulations, administrative procedures or fiscal devices (Dunse and Jones, 2002). These interventions – through the regulation on development processes - shape the physical form of the built environment, and the territorial distribution of economic activities and values and is performed through (Ihlanfeldt and Raper, 1990; Rebelo, 2009; Rebelo 2011): straight provision of development land; zoning ordinances; legal incentives or restrictions; taxes on property; control of changes in land use or intensity of use; development costs; and investment decisions.

Municipal authorities can control rent levels through direct intervention in the competitive property market (Rebelo, 2011), providing their own alternative land parcels whenever private plots reach disproportionate prices (Tang et al., 2000; Rebelo, 2009).

Legal incentives and restrictions - namely fiscal incentives, zoning ordinances, building regulations, or subsidies -, control over changes in land use or intensity of use, development costs, or decisions on investments are able to shape the profitability of certain areas through their mediation role between the economic cycles, guiding private investments towards certain locations and neighbourhoods (Hanink and Cromley, 1998). Zoning policies also shape offices´ supply and demand (Ihlanfeldt and Raper, 1990), namely through the promotion of office clusters, or through upward pressures on development costs. Different taxation forms are applied on surplus-values in the United States of America, Canada and many Latino-American countries (Rebelo, 2009), that range from the traditional taxes to development rates, and include different kinds of urban regulations. Even the types of development licences – that span from rigid to flexible ones - issued by planning authorities shape the characteristics of the markets, investments, and so the urban built environment (Tang et al., 2000).

These different policies and planning procedures often involve inelasticies in certain locations that result, namely, from bounds to land uses or respective intensities, designation of protection areas, identification of patrimonial buildings (Dunse and Jones, 2002), or delays to respond to demand queries. These inelasticities inevitably reflect on offices rents.

### 2.2 Variables underlying offices location

The main reasons that traditionally explain offices´ locations and, consequently, respective rents are: centrality/proximity to the CBD (Archer and Smith , 2003; Nitsch, 2006; Greenhalgh, 2008; Jennen and Brounen, 2009; Ozus, 2009); nearness to other businesses, especially insurance companies and financial institutions (Kutay, 1986; Shilton and Webb, 1995; Jennen and Brounen, 2009); amenities, and local

services (Bollinger et al., 1998); accessibility and proximity to transports´ infrastructures and services (Nitsch, 2006; Nappi-Choulet et al., 2007); status, prestige and symbolic meaning of certain areas (Archer et. al., 1990; Krätke, 1992); positive externalities, such as agglomeration economies (Mun and Hutchinson, 1995; Jennen and Brounen, 2009); added value that accrues from the use of productive factors (Fogarty and Garofalo, 1988; Ihlanfeldt and Raper, 1990); nearness to workmanship, providers and consumers of services (Ihlanfeldt and Raper, 1990); and planning and fiscal tools, and public investments (Wasylenko, 1980; Long, 1984; Ihlanfeldt and Raper, 1990; Tang et al, 2000). However, globalization, the structural organization of firms; the progress of informatics and telecommunications technologies, the free circulation of people, and the increasing investments in communications and transports shape new patterns of land use by tertiary activities. Thus the relative importance of these variables on offices, and their impact on respective rents should be reassessed.

Currently, European cities exhibit polycentric layouts in the location of services (Archer and Smith, 2003; Greenhalgh, 2008; Jennen and Brounen, 2009; Ozus, 2009). These result from the internationalization of businesses, the development of information and communication technologies, and the increasing investments in transports and telecommunications, the characteristics of firms, suburbanization of services, and a polycentric distribution of employment poles (Ihlanfeldt and Raper, 1990; Rabianski and Gibler, 2007; Ozus, 2009). These reasons have surmounted the traditional offices´ requirement for centrality that has lost importance on behalf of a greater flexibility in the location/relocation of services. As a result, rent gradients have slowed down, so rents still keep high values throughout a larger territorial cover (Sivitanidou, 1995). Consequently many firms have total or partially moved to metropolitan suburban municipalities, where they benefit from additional spaces with qualified environments at affordable prices/rents (Suda, 1997; Nitsch, 2006). This implies changes in property uses and values (Ozus, 2009). Despite accessibility still keeps a central role, it ceased to mean an easy physical access to certain specific locations, infrastructures and transport services (Nitsch, 2006; Ozus, 2009). It has currently a wider meaning, as it covers a broader territorial extent. So the traditionally centre-targeted activities disseminate more and more, among different alternative poles of offices. But the location and relocation choices of services depend on variables that shape profits, expressed both through spatial (Ihlanfeldt and Raper, 1990) and temporal changes (Rebelo, 2009; Rebelo and Pinho, 2011). So offices that remain in the same location, and during longer terms, undergo physical, functional, and economic devaluation. Offices tend to remain in the same location till they perceive that the differential advantages between and a new potential location and the previous one are big enough to offset the relocation costs (Ihlanfeldt and Raper, 1990). The effects of zoning restrictions on supply and demand are doubtful (Ihlanfeldt and Raper, 1990), despite they have been tackled in several studies (Wasylenko, 1980; Long, 1984; Bourassa et al., 1999; Nitcsh, 2006). When tertiary activities benefit from external or agglomeration economies, they can easily access workmanship and services they can't provide internally (Jennen and Brounen, 2009). Wage levels are also determining in offices´ demand, and can be approached by

variables that measure the distance to employees´ homes (Erickson and Wasylenko, 1980; Wasylenko, 1980), or by the number of workers in the upper tertiary sector (Mills, 1995; Shilton and Webb, 1995; Wheaton et al., 1997; Bollinger et al., 1998; Jun, 1999).

In a nutshell, the variables that best explain office's locations and rents concern their absolute and relative location, their accessibility to the main centres and sub centres, their location inertia, municipal planning and public investments, the dimension of the upper tertiary sector and their average surface according to the provided kinds of services.

Despite its widespread application in the analysis of housing, hedonic models are less often applied to office markets (Dunse and Jones, 2002; Nitsch, 2006; Nappi-Choulet et al., 2007; Ozus, 2009). These models relate a certain variable (price or rent) to a set of underlying attributes, so they clear up rent values (as they identify and compute the effects exerted by explanatory variables), are flexible, and characterize different real estate goods through a limited number of attributes (Knight et al., 1995). If the relation between rents and their underlying explanatory variables is linear, then the regression coefficients of each attribute explain its implicit rent, as valued by the market (even if it is merged with a set of attributes traded together with in a single unit) (Rosen, 1974; Bourassa et al., 1999; Nappi-Choulet et al., 2007). But if the logarithm of the rent is a linear function of the different characteristics, then respective coefficients point out correspondent elasticities (Bourassa et al., 1999; Dunse and Jones, 2002; Nitsch, 2006; Nappi-Choulet et al., 2007; Jennen and Brounen, 2009). Additionally, as the hedonic analysis is framed by microeconomics, it especially suits offices targeted to use (Maleyre, 1995; Rebelo, 2003).

## 3 Case study

### 3.1 The Porto office market: evolution

Porto is the second biggest Portuguese city, where the headquarters of the Portuguese Northern firms, as well as most metropolitan services[2] locate. The municipal strategy that prevailed during the nineties stressed that planning should foster the sector of services. So urban planning and public investments during the last decades strongly shaped the patterns of land use by services, and therefore the performance and

[2] Porto metropolitan area is made of nine municipalities (Espinho, Gondomar, Maia, Matosinhos, Porto, Póvoa de Varzim, Valongo, Vila do Conde and Vila Nova de Gaia). 49.1% of the services of the metropolitan area locate in Porto city (23.7% of Portuguese services activities locate in the northern region and 60.1% of the latter locate in the Porto metropolitan area) (INE, 2001). However, the metropolitan services have developed more swiftly in surrounding municipalities than in the proper Porto municipality. The expansion of overall metropolitan accessibilities during the last years, together with Porto's relative reduced surface and geographical bounds has contributed to Porto's loss of leading role. Despite the number of employees in the services sector in Vila Nova de Gaia municipality has surpassed its homologous value in Porto municipality during the nineties (85 496 versus 63 210 employees, respectively), Porto municipality is responsible for the employment of most workers of services per $km^2$ in the metropolitan area, still keeping a central symbolic meaning.

evolution of the office market. Despite the already consolidated city downtown centre (territorially enclaved), the 1993rd Porto Master Plan - through a comprehensive zoning ordinance - assigned the location of services - both for public administration and for private firms – to the *directional centre*, strategically located in the central area (in Boavista district).

But municipal planning strategies were further supported by other reasons. In the early nineties the Boavista district had many vacant or provisionally-used land plots. Many public infrastructures, equipments and public spaces - namely a set of roads aimed at reinforcing the accessibility networks to central Porto - were also under construction. These public investments have completely changed the urban morphologies, building typologies, and accessibilities to the Boavista district, Porto's intra-accessibilities, and the inter-accessibilities between it and the surrounding municipalities.

Decisions of private agents were shaped by these planning incentives and public works. Thus many office buildings were built, together with the development of high-quality undertakings including housing and trade facilities. The adhesion to the European Union in the mid-eighties attracted the headquarters of many firms to these privileged office buildings, where they could further benefit from agglomeration and internal economies. By the late nineties about 1070 offices (36% of total offices) were already located in this district. As many of these represented regional/local branches of multinational companies – able to afford rents higher than local-based firms - they commanded premium rent-levels, what subsequently involved economic-territorial filtering processes. Within the scope of a strong competition where the available land was progressively shrinking, the demand was willing to pay high levels of rents, and the outstanding planning guidelines and public works increased the value of land, promoters, builders and sellers felt forced to lock up great amounts of capital and to provide better and better quality levels. Afterwards supply overtook demand, but promoters still kept high levels of construction, because they wondered if the economic cycle will invert soon, and they further needed to render profitable their investments.

But during the same decade, offices located in the Porto downtown were still devaluating because this area was tight, population and buildings were dense, buildings were decaying, and a set of planning guidelines and legal restrictions were enforced that hindered the initiatives of real estate promoters – that included a great division of land, and the application of the rent law that kept tenants in strategic locations. As a result land reached top prices, and the development of real estate for rental purposes was out of question because land plot gathering, joining and acquisition was expensive, costly and time-consuming. So offices supply in downtown summed up to second-hand refurbished detached spaces within a narrow territorial scope that involved accessibility and parking shortcomings, despite traditional trade and services mostly remained there. The city council, by its turn, sponsored public-private partnerships in order to implement rehabilitation policies, thus counterbalancing these trends. However, specific regulations towards the

protection of heritage buildings´ have worsened their rehabilitation costs, thus shaping respective characteristics and rent levels. So only the firms with a solid financial foundation – mainly financial institutions and insurance companies – could keep in these prestigious symbolic heritage buildings.

The Porto office market has lost its importance during the last two decades in favour of Lisbon and some Spanish cities, due to the development of accessibilities and telecommunications. Beyond Porto's geographic and legal bounds, suburbanization processes lead to the emergence of a polycentric pattern of offices location in the metropolitan area that mainly results from higher profit expectations in Porto's outskirts due to larger available land plots.

The current Porto's Municipal Master Plan, strategically relieves control on land uses, and is less focused on the upper tertiary sector. Offices are mainly demanded by technology, press and telecommunication firms, public services, financial services, and public administration. To keep abreast of tertiary suburbanization processes and growing competition from other metropolitan poles of offices, Porto office districts consolidated, and their rental levels stabilized.

### 3.2 The Porto office market: characterization

Porto's office market is structured into three main territorial areas: the downtown/traditional area (that conveys a sense of prestige); the recently developed planned CBD (at the Boavista disctrict); and the transition between both areas (at the Constituição/Marquês district) (Figure 1).

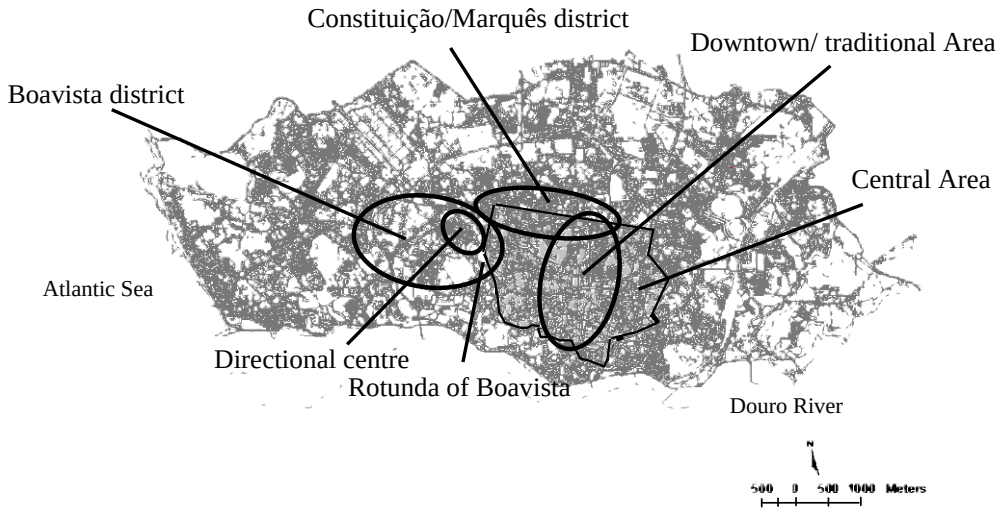


Figure 1. Main office areas in Porto city

The downtown and part of Constituição/Marquês district are mainly characterised by disconnected offices, most of them aimed at liberal professional people. In the former offices mainly belong to old heritage buildings, located in narrow low-lighted streets, almost without public spaces around. In the latter, however, offices mainly locate in middle-sized, middle-aged multifunctional buildings, likewise located along many important streets that provide trade and services. As far as Boavista district is concerned, it holds the most important office buildings of the city (most of them built during the late eighties and the nineties), located in premium bright spaces within high-quality spacious environments[3].

The percent increase of the most representative services in Porto during the nineties was the following[4]: law (17.1%), economics (52.5%), engineering and architecture (16.6%), banks and insurance firms (84.3%), real estate activities (121.6%), informatics (209.6%), and other services to firms (15.8%). So informatics, real estate activities, and banks and insurance firms underwent a swift expansion, whereas law, engineering and architecture and other services to firms registered much lower growth rates. It is also noticeable that the offices most closed to the Boavista district or to downtown most probably remained in the same locations for over longer periods than those settled in older buildings and in less central locations (Rebelo, 2003).

### 3.3. Methodology

The methodology reported in this article aims at explaining office rents/$m^2$ [5]. The rental market was chosen because it represented almost 60.4% of total offices in Porto (during the studied period). Besides, the rental regime is more flexible as it fits short-term location goals. Indeed the rental values tend to approach offices´ real worth because offices respond to use goals rather than to investment goals. The microeconomic models to study consumers´ behaviours (including hedonic models) further fit the features of Porto's office market.

First, data was collected and treated. An urban management information system was then settled, which fed an interactive integrated hedonic model. Display and simulation functionalities of this model were further developed. The attained outcomes were subsequently discussed. Finally, conclusions, recommendations, and policy implications for municipal planning on office markets are presented (Figure 2):

[3] In the Boavista district firms can take advantage either from external and agglomeration economies (due to office buildings´ clustering) or from internal economies (due to the set of services available within each proper building).

[4] These variations were computed through comparison between the number of autonomous registered activities existent in Porto in 1999 and the ones existing in 1990, within each kind of activity.

[5] In this research was used the software SPSS 14 for analysis in principal factors and hedonic modelling.

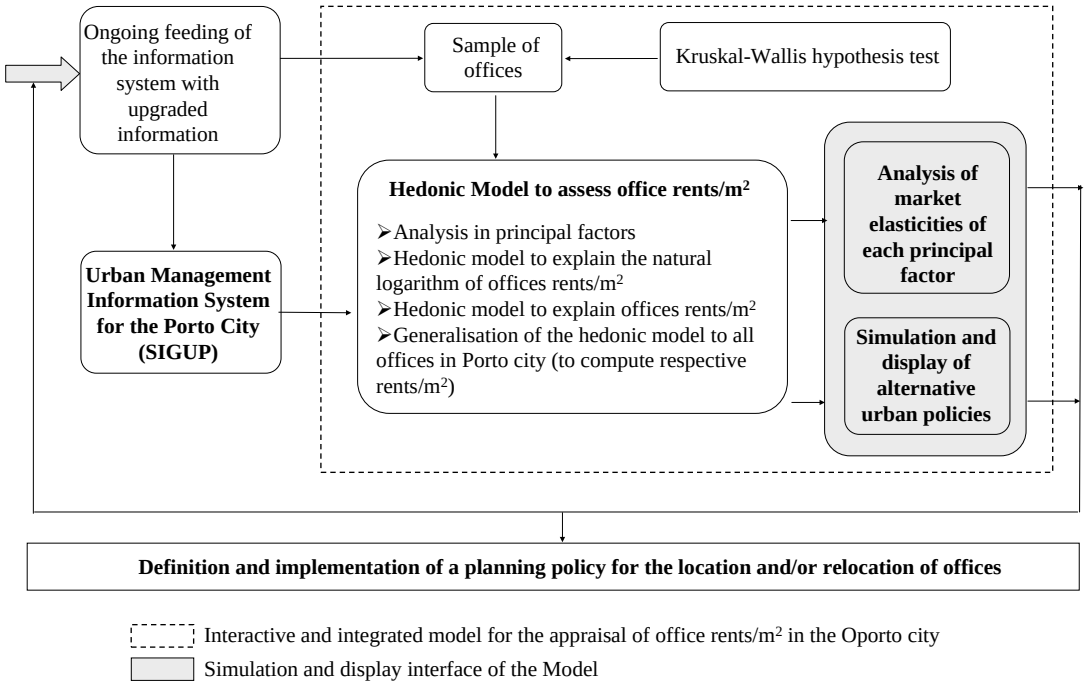


Figure 2**.** Methodological outline of the research pursued

### 3.4 Urban management information system

The dependent variable (offices rents/$m^2$) was chosen as a standardised measure of rents that can be easily generalised and compared (namely with other office rental markets studied in literature). The explanatory variables are the ones that are commonly assumed to exert significant influence on offices location and rents (Rebelo, 2009): absolute and relative location of offices; simple distance to the modern planned CBD (in Boavista district); accessibility; temporal inertia of office activities; municipal planning and public investments; dimension of the upper tertiary sector; and average office floor surface, according to the kind of services.

Thus, an urban management information system was specifically designed and implemented in the Porto office market (SIGUP). As data concerning this office market during the nineties is sparse (due to its small dimension and recent development), different diversified data sources were used, such as the Portuguese Statistics Institute (census data: INE, 2001), advertisements in journals, real estate magazines, and interviews with people working in this field. This information system is innovative because each variable are assigned a design and spatial meaning (Bourassa et al., 1999). Data refers to the location and some characteristics of all offices existent in the Porto city in 1990 and 1999 that belong to the most representative activities of the upper tertiary sector (law, economic activities, engineering and architecture, banks and insurance firms, real estate activities, informatics activities, and other services lent to firms).

But considering that many variables in the management information system are strongly correlated, an analysis in principal factors was then pursued in order to identify the orthogonal dimensions that best explain data variance (Bourassa et al., 1999, Dunse and Jones, 2002; Jennen and Brounen, 2009). So the analysis in principal components, and the equamax method with Kaiser normalization of factor rotation were successively applied. The obtained outcome shows that seven principal factors explain 83.6% of the variance (Table 1).

Table 1. Identification, characterization, designation and interpretation of the principal factors

| Principal Factors | Most positively correlated variables | Most negatively correlated variables | Explained variance | Designation | Interpretation |
|---|---|---|---|---|---|
| Factor 1 | Public investments in urban qualification, communications and transports, housing and education | Y coordinate<br>Percentage of offices that changed location between 1990 and 1999 | 26.7% | Urban planning and municipal investments | This factor assembles the variables that planning controls directly |
| Factor 2 | Weighted distance to Rotunda of Boavista<br>Straight distance to Rotunda of Boavista | Location index of informatics activities<br>Zoning ordinances | 16.3% | Metropolitan accessibility | This factor expresses the general metropolitan accessibility (assessed in spatial/temporal terms). It is mostly due the network of streets and transport means that connect the main services poles in the whole metropolitan area (centrered in Rotunda of Boavista) |
| Factor 3 | Location index of law activities | Y-coordinate | 10.8% | Distance to Porto's downtown/traditional centre | Law activities (older steady ones) mainly concentrate around the municipal court of justice, deep inside the historical centre. So this factor represents the distance to Porto's downtown historic/traditional centre |
| Factor 4 | Percentage of offices that remained in the same location between 1990 e 1999 | Percentage of offices that left the market between 1990 and 1999 | 10% | Temporal inertia of offices | This factor expresses the tendency of offices to remain in the same location |
| Factor 5 | Location index of real estate activities<br>Public investments in the environment | Percentage of offices that changed location between 1990 and 1999 | 7.5% | Quality of the natural and built environment | This factor translates the environmental quality (green/public spaces), nearness to equipments, and characteristics of urban typologies and building morphologies |
| Factor 6 | Land Use coefficients<br>Zoning ordinances | Public investments in economic development and tourism | 6.9% | Agglomeration and internal economies | This factor positions the location of services in relation to the territorial distribution and economic characteristics of other services, and to the internal characteristics of the proper offices and respective buildings |
| Factor 7 | Total number of activities that belong to the upper tertiary economic sector | Zoning ordinances | 5.4% | Dimension of the upper tertiary sector | This factor translates the availability and proximity to specialized workmanship for activities of services |

## 3.5 Hedonic model of office rents/m$^2$ in the Porto city

A model was then settled, according to a succession of steps, in order to explain offices rents/m$^2$ in Porto city. Data on the variables of the urban management information system was available (or could be easily computed) for all offices in the

Porto city. However, in order to assess the values of rents/$m^2$, it was necessary to resort to a sample and – according to the application of the proposed model - generalize the results for the whole office market. All the offices that belonged to this sample were characterized in terms of respective location, characteristics, surfaces, and asked rents/$m^2$ (Rebelo, 2003; Jennen and Brounen, 2009; Ozus, 2009)[6]. A Kruskal-Wallis statistical test (McMillen, 1995) was used in order to test the significance of this sample (that confirmed it belonged to the whole offices population[7]).

Next, a hedonic regression model was adjusted in order to explain offices rental prices/$m^2$ in Porto city. Different functional alternative models were adjusted and graphically displayed using the principal factors as explanatory variables. The model that best fitted data is the one that expresses the natural logarithm of rents/$m^2$ as a linear function of the principal factors (Rebelo, 2011):

$$LN(Rent/m^2) = 0.557 + 0.226F1 - 0.064F2 + 0.021F3 - 0.319F4 + 0.177F5 - 0.294F6 - 0.021F7$$

In this model the principal factor i is represented by Fi, coefficients F4 and F6 and the constant term present a significance level of 5%, the remainder coefficients a significance level of 10%; and $r^2 = 0.904$.

As this is a logarithmic model, the coefficients of the factors represent respective elasticities, as well as their correlations with the dependent variable. Thus this model stresses the importance of each factor in the dynamic explanation of changes in rents/$m^2$. Office rents/$m^2$ are, consequently, explained by the derived model:

$$Rent/m^2 = \exp^{(0.557+0.226F1-0.064F2+0.021F3-0.319F4+0.177F5-0.294F6-0.021F7)}$$

As this sample is population-representative, this model can be generalised to all offices located in the Porto city, in order to appraise their implicit rents/$m^2$ [8] (Figure 3):

[6] This sample represented about 3.6% of the total offices in Porto, and reproduced quite well the percent distribution of offices among parishes.
[7] With a 5% significance level.
[8] Be they available or not in the rental market, in this latter situation the model points out potential rents/$m^2$.


Figure 3. Office rents/$m^2$ in Porto city anticipated by the hedonic model

The simulation and display interface further developed supports the definition of strategies and the implementation of measures by municipal authorities in order to guide the location or relocation of services, and the indirect control over their rental levels[9], taking alternative scenarios into consideration (that result from induced changes in the values of some variables). These values are included into the analysis in principal factors and, afterwards, into the hedonic redefined logarithmic model and into the correspondent model of rents/$m^2$ – in order to test their influence on offices´ territorial location and rents/$m^2$.

### 3.6 Discussion of results

The knowledge of the relevant factors in location or relocation decisions is crucial to define and implement planning policies and measures in office markets. Supply and demand inelasticities bind the quantity, location and characteristics of offices and office buildings. But as demand is shaped by the available concrete office stock, and firms seek short-term responses, planning can tackle uncertainty through a better approach to real market conditions prevailing at any moment.

The compared analysis between the characteristics and evolution of office markets among different researched European and American cities clearly show that the

[9] This model may as well be useful to real estate agents, architects and private planners, firms, and all the other remaining parts involved in office markets.

importance of the variables traditionally used in offices´ location or relocation decisions has been changing over time. These changes result from globalization processes and the proper organization of firms that highlights the need for integrated public policies. So a reassessment of the effect exerted by these variables on offices rents/$m^2$ is, thus, required.

This research points out that variables related to municipal planning and public investments are quite relevant in the explanation of the variance of urban data in Porto's office market (26.7%). Other factors indirectly modelled by planning decisions also contribute to the explanation of variance. These include agglomeration or external economies[10] (6.9%), and the quality of the natural and built environment[11] (7.5%). The increased metropolitan accessibility also expresses a strong intervention of the Porto municipality either through zoning ordinances or through the proper investment in accessibilities (16.3%).

The comparison of the current research with other studies pursued in many office markets show that the role of planning can be exerted under different ways, resorting to different planning tools, with varying intensities. In what concerns zoning ordinances, they don't exert a significant effect on offices development patterns in the Atlanta metropolitan area (Ihlanfeldt and Raper, 1990), but the same doesn't hold true in other metropolitan areas and in different periods. For instance in Hong Kong, despite planning authorities are not intended to intervene in the office market, they end up by shaping its performance, as they tend to deny development licenses in locations where the density of offices is already high. Urban planning - zoning ordinances - and municipal investments – especially in accessibility and urban qualification - (factor 1) are the variables that best explain the increases in rents/$m^2$ in the Porto office market. Indeed these variables strengthen the attractiveness of some urban areas, so they exert upward pressures on rents/$m^2$.

Globalization processes – including recent developments in telecommunications technologies (Heikkila et al., 1989; Ozus, 2009) – weaken the importance of the proximity to reference places. But this variable keeps particularly important in some office markets, as is the case of Istambul (Ozus, 2009) where the most recent office sub-centres locate along the main communication streets. This also holds true in Porto where, as expected, metropolitan accessibility (factor 2) decreases rents/$m^2$ when the distance to Rotunda of Boavista - deeply connected to other metropolitan trade and services poles – increases (Nitsch, 2006).

The distance to the Porto downtown (factor 3) stresses the relevance still kept by the traditional centre on offices location and rents/$m^2$ that mainly results from its prestige, status, and magnificent patrimonial buildings.

[10] Through promotion of a privileged area for offices location, Porto municipality indirectly induced agglomeration effects over offices prone to locate there.

[11] Despite the majority of the variance explained by this factor accrues from the activities of promoters and builders, the applicable plans, municipal licensing decisions, and public investments are important inputs that underlie this factor.

Porto's offices inertia, reflected on their tendency to remain in the same location (factor 4) – strengthened by the longstanding rental agreements in the historic/traditional centre - exerts a downward pressure on their rents/$m^2$, as a result of building's age, filtering processes in offices´ uses, and subsequent property devaluation. This comes in line with what happens in other European office markets, such as Amsterdam (Jennen and Brounen, 2009) and Glasgow (Dunse and Jones, 2002). This effect is less noticeable in Paris due to the recovery and re-qualification of office buildings (Nappi-Choulet et al., 2007). However, this variable is not quite relevant in the Istambul office market (Ozus, 2009), especially because of the recent development of simultaneous office sub-centres.

The characteristics of office buildings in the Boavista district – with a good finish, equipments, infrastructures, conveniences and common internal services (factor 5) - tend to push rents/$m^2$ up. The same effect has been exerted by the positive externalities and amenities attached to the high quality of the urban environment, opposite to what happened, for instance, in Istambul, where the sights over the sea don't add any value to office rents.

Agglomeration economies (factor 6) don't exert such a strong impact as suggested in literature in the Porto office market. Indeed they push rents/$m^2$ downwards due to tertiarization processes, competition among different office location poles, and also due to the excess supply in high-dense office areas (in order to secure the occupation of offices promoters rent for lower values/$m^2$ than they are willing to). On the office market of Amsterdam, on the contrary, rents are pushed upwards by location externalities, even if a direct relation between office clusters and urban concentration isn't clear (Jennen and Brounen, 2009). In the Istambul office market external and internal economies, as well as accessibilities, are not so determining as other variables (Ozus, 2009) (namely the number of building's floors, vacancy rates in the neighbourhoods, social equipments, building's aesthetics, and floor surface for rental purposes).

Despite in the office markets of Amsterdam and Istambul the number of offices is strongly correlated to the employment in finance, insurance and real estate activities (Jennen and Brounen, 2009; Ozus, 2009), in the Porto office market this kind of employees tend to decrease mainly due to the strengthening of the information-intensive component of work (what generally improves working conditions in tertiary spaces). Additionally, services employees tend to settle in suburban areas, so they have stabilised or even decrease in the proper Porto city. That's why the dimension of the upper tertiary economic sector (factor 7) exerts a slightly negative effect on office rents/$m^2$.

## 4. Conclusions and implications for urban planning

Within the scope of globalization and overall urban competition, municipal planning should stimulate private initiatives aimed at tertiary sector developments, on the one

hand, and regulate and control office rent levels, on the other, keeping them close to local economic conditions, and attractive for both supply and demand.

This article proposes an integrated, interactive and flexible set of tools that - together with different planning and fiscal policies - should support the implementation of municipal strategies and interventions in office markets. It is more flexible than other models referred to in literature, because it fits the conditions prevailing in each moment, and adapts to different urban settings, as it grounds on a strong management information system that can be regularly feed with new and upgraded information on office variables and respective rents. Through the proposed approach, the behaviours of the agents, and the performance of the market can, thus, be monitored. Indeed, the coefficients of the relevant factors underlying rents/$m^2$ in the model represent respective elasticities. Consequently, any intervention of municipal authorities on the explanatory factors shall strengthen their control over rents/$m^2$, thus promoting the accomplishment of planning's social function. The mathematical and computational simulation and display device further supports the analysis of alternative decision scenarios for urban intervention (considering that the variables that underlie rents/$m^2$ may assume different values). This methodology can, thus, be applied to feasible alternatives set up by municipal authorities, in order to select the policies that best fit planning and management-settled goals. It can additionally be replicated in the same city, at different moments, and in different office markets, provided that proper management information systems are implemented and upgraded. This methodology can further support the harmonization of planning policies on offices among different cities and countries, what is becoming increasingly important within the scope of global environments.

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