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## Conference Paper

# Integrated Decision Support System? DONUT-Prospect

54th Congress of the European Regional Science Association: "Regional development & globalisation: Best practices", 26-29 August 2014, St. Petersburg, Russia

### Provided in Cooperation with:

European Regional Science Association (ERSA)

*Suggested Citation:* Castro, Eduardo; Marques, João; Batista, Paulo; Borges, Monique (2014) : Integrated Decision Support System? DONUT-Prospect, 54th Congress of the European Regional Science Association: "Regional development & globalisation: Best practices", 26-29 August 2014, St. Petersburg, Russia, European Regional Science Association (ERSA), Louvain-la-Neuve

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# INTEGRATED DECISION SUPPORT SYSTEM

## Donut-Prospect

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### Abstract

*The socioeconomic importance of housing and its medium- and long-term investment returns requires a significant effort to predict future dynamics to ensure that the different real estate market agents make the best decisions. Furthermore, the territory structure and the lack of information and transparency of the housing market mechanisms also influence its understanding.*

*There is a variety of literature, in the field of spatial economics that gives theoretical basis for predict housing prices and attributes valuation. However, these analytical models are subject to criticisms because of their inability to integrate the variability of exogenous factors. Therefore, predictions of housing prices and attributes valuation may be affected by not considering the spatial and temporal evolution.*

*Foresight analysis, which will be the main focus of this paper, can be considered as a complementary and useful tool to these analytical models. The paper presents an Integrated Decision Support System–DONUT-Prospect, designed as a decision making framework that combines technically informed subjectivity (foresight analysis) with more rigorous models (econometric models).*

*This empirical application has been developed in the context of a local housing market (Aveiro – Ílhavo municipalities), providing outcomes about the evolution of social and economic phenomena, as well as the heterogeneity of both supply and demand side: the former regarding housing prices and features; and the latter considering the type of consumers. An important result of this exercise is the estimation of housing characteristics and its hedonic prices in 2030, i.e., a picture of the housing market in 2030.*

*In short, DONUT-Prospect presents a way to combine two main foresight techniques (scenario analysis and Delphi surveys) with a traditional hedonic housing price model. The methodology is supported on the assumption that it is possible: i) to discuss strategies in the context of great uncertainty; and ii) to identify trends and assess future evolution.*

*The work is organized in 3 parts: i) description of the structure of DONUT-prospect; ii) presentation of how each dimension was implemented in the context of the integrated model; and iii) main outputs and result discussion. The main results show that DONUT-Prospect is useful in generating consensus between different real estate market agents, particularly because the traditional communication channels are weak and strongly conditioned by the lack of public available information and transparency of the housing market mechanisms.*

Keywords: housing market, decision support system, foresight



## INTRODUCTION

Housing is a heterogeneous good, which price depends on the valuation of several factors that vary in space and in time. The multiplicity of factors involved and their interactions require the development of highly complex analytical approaches that combine a variety of methods that can be used to describe the housing market, both in its spatial heterogeneity and evolution over time. Due to the lack of high-quality information and adequate tools to support decision making, the housing market is not transparent: objective supply information isn't clearly available (regarding the quantitative and qualitative data on the existing housing stock, and its technical and financial constraints); pricing mechanisms and buyers preferences and expectations are not directly provided. The complexity and multidisciplinary of the housing market supports the importance of data analysis techniques, either to understand the theoretical background of the mechanisms that determine the functioning of the market and define its dynamics, either to provide the basis for the development of decision support tools and policy formulation and assessment.

Notwithstanding the enormous developments in econometric techniques and, in particular, in spatial econometrics techniques, there is a great potential for progression either in the techniques, either in their application to the housing market analysis. Additionally, the combination of analytical techniques with qualitative foresight techniques is a field with enormous potential that hasn't yet been exploited, which might be explained by common trend for the division of social sciences in two components: the world of subjectivity and qualitative thinking, on the one hand, and the world of objectivity, sometimes less objective than many would like, based on numbers and mathematical models, on the other.

The challenge lies in structuring these approaches. The argument that has been developed enables the identification of the determinants of housing demand, based on the combination of two perspectives, the analysis of the present and the housing market foresight approach. These perspectives structure the housing integrated decision support system (DONUT-Prospect) that combines both a methodology and software. The work was organized in two distinct components: i) construction of spatial econometric models to understand, in a logic of revealed preferences, which attributes are relevant in explaining housing prices, as well as its distribution and territorial interaction and ii) application of foresight models to foresee the housing market in the year 2030 (regarding the assessment of the characteristics (locational and physical) and housing prices in 2030).

This approach was developed in the context of a wider research project, "Drivers Of housing demand in Portuguese Urban system" – DONUT. The conceptual basis and the general framework methodology have been presented in previous works<sup>1</sup>. This paper aims to present the integrated decision support system, the methodological developments of the last phase of the foresight exercise and the main outputs, which are presented and discussed in the context of two scenarios. Thus, the work is organized in 3 parts: i) description of the structure of DONUT-prospect; ii) presentation of how each foresight technique was implemented in the context of the integrated model; and iii) main outputs and result discussion.

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<sup>1</sup> See, for example, J. Marques, Castro, & Bhattacharjee (2012); João Marques et al., (2013)

The main results show that DONUT-Prospect is useful in generating integrated models for the analysis of the evolution of housing related phenomena that allow describing the distribution of temporal, physical and location attributes. It was also useful in generating consensus between different real estate market agents, particularly because the traditional communication channels are weak and strongly conditioned by the lack of public available information and transparency of the housing market mechanisms. Therefore this exercise has the advantage of bringing together the interests of different real estate agents, contributing to a greater transparency.

## DONUT-PROSPECT

### Overview: structure of DONUT-prospect

The research project focused on the development and implementation of methodologies which overcome the limitations of the previously mentioned approaches. This was the basis for the construction of a decision support tool (DONUT-Prospect) that predicts, with the highest possible accuracy, under the research project assumptions, the factors determining property values. Additionally, this framework supported the application of the econometric model at a local scale, studying a set of urban centres representing the main typologies of the housing market in a medium sized city (based on two Portuguese cities).

Starting with the identification of the explanatory factors for housing prices, DONUT-prospect attempts to predict the future evolution of such factors. Thus, DONUT-prospect is structured in two principal dimensions: 1. Housing market in 2011 and 2. Housing market in 2030. These dimensions include four main components: i) the housing market in 2011, including the price model and submarket delimitation, ii) the exogenous dimensions in the context of two extreme scenarios, iii) the scenario materialization, involving the definition of the housing characteristics (endogenous dimensions) and housing supply (rental and owner market) in 2030 and iv) the simulation of the price of housing (Figure 1).

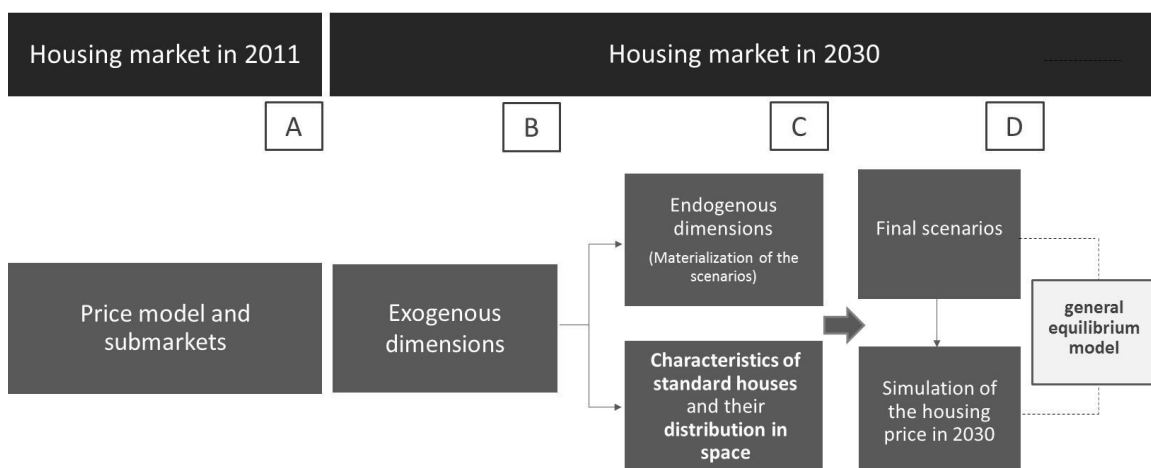


Figure 1 – Integrated Decision Support System overview

For each of the components presented above, several inter-related tools and methodologies have been developed.



The dimension concerning the Housing market in 2011 [A] refers to the development of a diagnostic model that is embodied in a hedonic model for 2011. Econometric models are the basis of the decision support system developed and presented here. It combines econometric techniques that have been developed over the past 60 years and, although not yet fully consolidated, they present a significant versatility. Thus, the hedonic pricing model, based on a set of assumptions related with the housing market functioning, is adaptable to different purposes, without implying changes in the theoretical bases.

The econometric model was developed to i) define submarkets and create stylized zones, ii) provide a simplified picture of the spatial distribution and housing attributes valuation in stylized zones, iii) consolidate the foresight model, as it should be directly comparable with the actual pricing model. Spatial econometric models are useful for accurately describing housing prices and housing markets features ex post, and particularly for explaining the effects of spatial constraints. However, for effective housing and territorial planning policies, it is necessary to forecast future trends, a requirement which the available econometric models cannot easily satisfy. By contrast, some techniques developed in the social sciences analyse the future in a strategic perspective, but are not designed to directly produce results for decision support models.

As previously refereed the DONUT project developed and tested several methodologies which overcome the above limitations, by combining spatial econometric models with foresight techniques.

The first component was explained above. The foresight model developed - housing market in 2030 - combined three foresight techniques: i) scenario analysis; ii) expert panel; and iii) Delphi questionnaire. Each of the techniques matches the different components [B], [C] and [D].

It should be noted that foresight analysis recognizes the importance of combining knowledge of experts from different areas, as the phenomena in analysis tends to be influenced by exogenous elements. This is the basis for analysis of scenarios [B], which involves the construction and use of more or less systematic and internally consistent views of alternative and plausible futures. There is a set of dimensions and variables that influence the decision context and cannot be controlled. Within the research project assumptions the analysis focused on the combination of exogenous dimensions that describe the availability of energy resources, the socio-economic structure and macro-scale effects on the housing market. Thus, the scenarios were structured in three parts: i) the global context, which describes what happens in the world; ii) the national context, associated with how Portugal answers and positions itself at the global constraints; and iii) the thematic background related to the materialization of the scenarios.

The scenario materialization concerns specific issues related to the impact of exogenous dimensions at the micro-scale, particularly in the population distribution, housing stock and housing characteristics. The specificity of these components stands at two levels: i) the subject area, which results from the multidimensionality of the housing market and ii) the impact at the micro-scale, which has been discussed in the context of a stylized medium-sized city. The exogenous dimensions described in the scenarios assume direct influence on these two levels, but the assessment of the actual impact depends on specific expertise in each of these areas. Thus it requires the involvement of a number of professionals from different areas of knowledge (geography, architecture, urbanism, demographics, ...). This process, which involves moments



of debate and discussion among a group of multidisciplinary experts, corresponds to the expert panel [C]. The exercise allowed not only to calculate the distribution of the population, but also to obtain the perception of urban structure (concentration / dispersion), the functional and social organization (higher or lower social segmentation / segregation of uses), housing types (flats / single family dwellings) and with the identification of the housing technical characteristics (size, aesthetics, energy efficiency, etc.) in 2030. The final outputs will support a housing supply model, which will be the starting point for the final exercise [D], which aims to simulate the housing market in the future.

One of the concerns of the agents involved in the housing market relates to the need to understand the market conditions in order to maximize their investment options and support the formulation and assessment of housing policies. The foresight exercise highlights the importance and contribution of experts' perceptions in the assessment of the influence of a set of variables in a given system. To make this possible it is necessary to identify the preferences of families, as well as the variability of housing prices across space and time. To deal with this complexity several methods and methodologies have been developed, in order to combine the econometric component [A] and the foresight component [B], [C] and [D]. In the end, the results allow identifying the explanatory factors for housing prices (absolute or relative), understanding the importance of various urban amenities and the importance of space itself in the context of all housing characteristics. The results of the scenarios analysis [B] and [C] structure the general equilibrium model developed, which, in turn, serves as a condition to the answers of the evaluators [D]. The values assigned by the evaluators are counterbalanced with the housing stock and socio-economic characteristics of the population estimated for 2030 in each scenario.

In the next section it is presented the methodology and the main results obtained in each phase.

## **Housing market in 2011**

### ***Methodology***

The housing market analysis is based on a set of econometric models - hedonic price models – which allow studying the overall multiplicity phenomena in the housing market. There is an obvious relationship between the different models that are successive derivations of a generic hedonic model, only to obtain more detailed analyzes of some dimensions of the housing market.

The absence of a scientific consensus on a single approach for incorporating the territorial dimension in the modeling of housing prices led to the development and testing of several methodologies. Many approaches were based on the use of specific spatial attributes (see for example: J. Marques et al., (2010); Batista, Castro, & Marques (2011); Marques, Castro, Bhattacharjee, & Batista, (2012), that refer to a description of the territory based on a broad set of measures, particularly accessibility measurement.

However, it is important to remember that the consistency of hedonic price models is dependent on the correct specification of the set of attributes. Thus, measurement of the territorial dimension of a limited set of attributes may cause problems with missing values, difficult to specify. Moreover, the ability to measure these territorial indicators tends to vary according to



each geographical area (availability and capacity of gathering the necessary information), which could result in different models and thus not comparable.

Within the context of the research project, several models have been developed, and a final simplified hedonic price model was obtained based on i) basic housing structural attributes - which includes a set of essential characteristics, such as area, type, location and preservation and ii) the definition of four standard submarkets, as a result of the combination of empirical territorial categorization studies and the identification of homogeneous territorial structures, developed specifically for the research project.

The database used for the hedonic price model was provided by the firm Janela Digital S.A., which owns and manages the real estate advertise portal database CASA SAPO. This portal is the largest site of real estate diffusion in Portugal. Since 2000 they store information of 5 million of properties, available for transaction in Portugal, covering all the national territory.

For the specific case of Aveiro and Ílhavo 47188 properties were identified in the database between 2000 and 2010. The models used in this empirical work consider a database with 6502 observations (15% of them related with the rental housing market), for recent years (2005 to 2010). To deal with the inconsistencies arising from the data it was necessary to define a set data pre-processing methodologies (selection, correction and data cleaning), and in some cases additional methodologies were also required such as a. georeferencing and mapping, territorial delimitation; b. metrics for measuring the characteristics of the neighborhood (accessibility to urban amenities, for example) - for a more detailed description of the main challenges the database for cleaning and general procedures used for it see Batista, (2010); Marques, (2012) and (Castro, Bhattacharjee, Maiti, & Marques, 2013)<sup>2</sup>.

The complexity associated to the information of available data, as well as the measurement of all housing characteristics encloses several challenges. As a consequence of the lack of complete information for all attributes and all dwellings several cases have to be discarded in the construction of these models, where missing values are not allowed and where the treatment of missing values, given the data structure, is not a feasible option. This question may have the effect of limiting disaggregated analysis, where the degrees of freedom are an essential requirement to be ensured. On the other hand, the informative value of some of the information collected may be a central concern.

### ***Output summary***

Statistical analysis of the collected data was the starting point for the econometric model specially designed to define the explanatory factors for housing prices in urban areas (based on the Portuguese urban system). Within the research project it was developed descriptive and explanatory models, which help to characterize the case study areas and validate/ characterize the sample of transactions obtained. Therefore, it is worth highlighting:

- i) The development of various hedonic price models, which include 4 explanatory dimensions: physical features, neighborhood, location and time;

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<sup>2</sup> The database cleaning procedures had some adaptations from the followed original methodologies: the main difference is that no duplicated records were selected for this work.

- ii) The developed models combine hedonic price methodologies with econometric techniques that allow the analysis of spatial dependence and heterogeneity;

The database supported the systematization of this information, which is presented in Table 1 and it is used as a starting point for this exploratory analysis.

We decided, therefore, by simplifying the overall hedonic pricing model, using only the key attributes identified here: Area, preservation, type. Moreover, as will be visible in the foresight component analysis: the connection between models of this diagnostic and foresight models, requires a significant simplification, otherwise foresight analysis may be compromised.

These basic territorial units consist in distinct spatial elements, obtained by the combination of empirical knowledge of experts with the results obtained by applying different statistical techniques and geographic information processing. This analysis was based on the following analytical dimensions:

- urban morphological structure and demographic characteristics: setting different concentration levels, population density, population growth rates, education levels, etc..
- historic housing growth: defining different periods of urban development;
- Special Features: identifying areas with specific functions, such as beach, industrial areas and service areas.

Table 1 – Descriptive statistics of housing characteristics (after data cleaning)

|   | Type of market: | Owner  |      |           |       |        |                                     | Rent  |      |           |      |      |                                     |
|---|-----------------|--------|------|-----------|-------|--------|-------------------------------------|-------|------|-----------|------|------|-------------------------------------|
|   | Type            | Mean   | Mode | Std. Dev. | Min   | Max    | N (for dummy variables, coded as 1) | Mean  | Mode | Std. Dev. | Min  | Max  | N (for dummy variables, coded as 1) |
| Price (€/m2)  | Scalar          | 1158.4 | -    | 366.9     | 234.5 | 4549.5 | -                                   | 4.6   | -    | 1.3       | 1.75 | 10   | -                                   |
| Time on Market (TOM)  | Scalar          | 314.9  | -    | 359.2     | 2     | 2167   | -                                   | 78.1  | -    | 181.4     | 2    | 1950 | -                                   |
| Area (m2)   | Scalar          | 138.3  | -    | 75.4      | 30    | 785    | -                                   | 106.3 | -    | 54.2      | 30   | 785  | -                                   |
| Flat (1 = is a flat)  | Dummy           | -      | 1    | -         | -     | -      | 4500                                | -     | 1    | -         | -    | -    | 894                                 |
| Dwelling (1 = is a dwelling)  | Dummy           | -      | 0    | -         | -     | -      | 1041                                | -     | 0    | -         | -    | -    | 67                                  |
| Preservation - New (1 = is new)   | Dummy           | -      | 0    | -         | -     | -      | 2219                                | -     | 0    | -         | -    | -    | 77                                  |
| Preservation - Used with less than 10 yrs (1 = is used less than 10 yrs)      | Dummy           | -      | 0    | -         | -     | -      | 1566                                | -     | 0    | -         | -    | -    | 426                                 |
| Preservation - Used with 10 to 25 yrs (1 = is used with 10 to 25 yrs)         | Dummy           | -      | 0    | -         | -     | -      | 1538                                | -     | 0    | -         | -    | -    | 399                                 |
| Preservation - Used with more than 25 yrs (1 = is used with more than 25 yrs) | Dummy           | -      | 0    | -         | -     | -      | 218                                 | -     | 0    | -         | -    | -    | 59                                  |
| Year of transaction - 2005 (1 = year of transaction is 2005)                  | Dummy           | -      | 0    | -         | -     | -      | 23                                  | -     | 0    | -         | -    | -    | 3                                   |
| Year of transaction - 2006 (1 = year of transaction is 2006)                  | Dummy           | -      | 0    | -         | -     | -      | 235                                 | -     | 0    | -         | -    | -    | 22                                  |
| Year of transaction - 2007 (1 = year of transaction is 2007)                  | Dummy           | -      | 0    | -         | -     | -      | 717                                 | -     | 0    | -         | -    | -    | 176                                 |
| Year of transaction - 2008 (1 = year of transaction is 2008)                  | Dummy           | -      | 0    | -         | -     | -      | 1404                                | -     | 0    | -         | -    | -    | 219                                 |
| Year of transaction - 2009 (1 = year of transaction is 2009)                  | Dummy           | -      | 0    | -         | -     | -      | 1246                                | -     | 0    | -         | -    | -    | 270                                 |
| Year of transaction - 2010 (1 = year of transaction is 2010)                  | Dummy           | -      | 0    | -         | -     | -      | 1916                                | -     | 0    | -         | -    | -    | 271                                 |

For a better understanding of the regional patterns (making them abstract spatial concepts, but more recognizable) it was decided to consider a territorial structure of two Portuguese medium-



sized cities (Aveiro and Ílhavo), described by 4 broad categories - this abstraction is also required for the foresight models application, that are, as previously mentioned, the approach chosen for this work.

The spatial configuration of housing market was firstly performed based on a combination of expertise knowledge and measures statistical measures. Four major zones (Figure 2) can be defined in the municipalities of Aveiro and Ílhavo. The criteria used for this spatial disaggregation is described in more detail in Marques (2012) and Castro & et al., (2013) but can be summarized as following:

- spatial urban structure and demographic characteristics: defining different levels of concentration, population density, population growth rate, education level, etc.
- settlement historical growth: defining different periods of urban development.
- special features: identifying zones with particular functions, such as, beach, harbour industrial and services areas.

These zones have the following elements:

- *Centre* – corresponds to the more consolidated urban area (with concentrated and continuous occupation). These territorial units are accessible, multifunctional and compact.
- *Suburban* – refers to an urban fabric that keeps both urban and rural characteristics, with empty, occupied, low farming or forestry activity or expectant areas.
- *Rural* – corresponds to areas with low edificatory density, but with urban living, where the settlement takes place along the highways and where agricultural activity plays an important role.
- *Beach* – delimits consolidated territories, dominated by second homes and seasonal occupation as a result of the proximity to the coastal area.

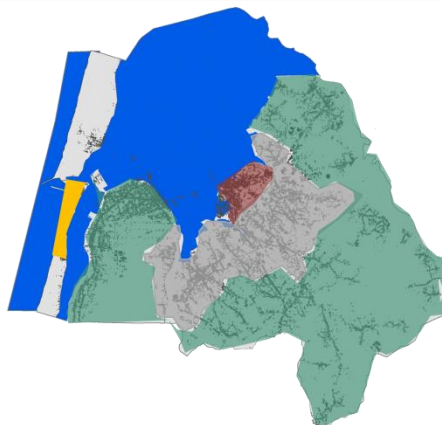


Figure 2 – Standard Study Area: representation of the 4 areas

For the pricing model developed, three different approaches were followed, including: i) the housing characteristics described by the initial variables; ii) the fundamental dimensions of a dwelling (as a result of the application of a principal component analysis); and finally, iii) the initial variables that best represent the dimensions of a dwelling (the latter with an operating dimension to apply in the foresight exercise) (equation 1 below).



$$\ln\left(\frac{P_{\epsilon}}{m^2}\right) = \alpha_1 \ln(A) + \alpha_2 \ln(TOM) + \sum_{i=1}^F \alpha_i d(F_i) + \sum_{j=1}^J \alpha_j d(Z_j) + \sum_{l=1}^L T_l + \rho W \ln\left(\frac{P_{\epsilon}}{m^2}\right) + \lambda W \epsilon + \mu \quad (\text{Eq. 1})$$

## Housing market in 2030: scenario analysis and expert panel

### *Methodology*

An important component of the analysis of the housing market, with special interest for decision support tools is the ability to assess / predict future dynamics. Indeed, existing econometric models for predictive modeling require a robust set of data, especially corresponding to the time series availability.

To answer to the challenges that arise in this context, we chose to combine technical econometric models developed with foresight analysis techniques (scenario analysis, the expert panel questionnaire and Delphi). Both techniques were combined in order to measure the value of explanatory factors of the housing price in 2030. This approach allows adapting the current explanatory econometric model to provide an estimate of the housing attribute values in this horizon (this aspect will be developed in the next section).

To support the foresight analysis it was necessary to structure a set of information. The exercise included two major steps. The first corresponds to the framework, which involved the presentation of a standard medium-sized city (Figure 2) and two contrasting scenarios, which define the exogenous dimensions. The second corresponds to the expert panel exercise, which included the discussion of the scenarios by a group of experts, involving the definition of the housing characteristics (geographic distribution of population, housing stock, housing market) and housing supply (sale and rent) in 2030.

### *Output summary*

Regarding the scenarios, they result from the combination of three dimensions - availability of energy resources, socio-economic structure and macro-scale effects on the housing market. Two contrasting scenarios were chosen. One where the context is relatively catastrophic and describes a city that survives in a context of economic stagnation and growing environmental problems; another, more optimistic, where it was possible to manage and overcome the economic crisis started in in 2008. These issues support a set of aspects that justify different choices of the population in regard to their spatial organization and housing preferences.

The expert panel under the two contrasting scenarios defined the impact of the exogenous dimensions in the context of the standard case study area. The values assigned by experts represent two approaches. On the one hand, it is related with a more macro scale, which is associated with the parameters of the quantitative exercise:

- A) Geographical distribution of the population in 2030 (4 standard areas: centre, rural, suburban and beach):
  - Internal migration distribution;
  - External migration distribution;
  - Geographical distribution of the population by socio-economic group;
  - Number of persons per dwelling.

- B) Configuration of the housing stock in 2030 (4 standard areas: centre, rural, suburban and beach):
- Second home dwellings;
  - Housing construction dynamic;
  - Quantity of dwellings by type (flats / single family dwellings).
- C) Configuration of the housing market in 2030 (4 standard areas: centre, rural, suburban and beach):
- Percentage of renting in 2030 of the total dwellings that are part of the housing stock;
  - Quantity of dwellings in the housing market in 2030
- D) Sketch of the standard houses in 2030.

On the other hand, it focuses on the more micro scale, which links the various elements (more or less quantitative) and is embodied in the design of the housing characteristics in 2030. The results for each scenario can be systematized according to the following tables (Table 2, Table 3 and Table 4) – for further detail see, for example, João Marques, Viegas, Borges, & Castro, (2013)

Table 2 – DONUT-Prospect scenario output summary

|   | Scenario 1  | Scenario 2   |
|---|---|--|
| <b>Public policy</b><br>(active / absent)                 | Active: oriented to energy efficiency (minimize intervention and mobility costs, location and efficiency of the building)   | Active: based on a rational State that is able to integrate individual preferences in a collective aesthetic and functional standard, maximizing accessibility and efficiency. As so, it takes advantage of what exists and diversifies the rural-centre supply. |
| <b>Type of settlement</b><br>(concentration / dispersion) | Concentration   | Decentralization: articulation and organized fragmentation of the urban fabric.  |
| <b>Household type</b><br>(homogenous / heterogeneous)     | Homogenous: generalized trend for larger households, where young people ensure the quality and comfort of older, as a result of the lack of social services.      | Heterogeneous: as a consequence of the slight increase in the birth rate, youth empowerment and an aging population with financial stability.  |
| <b>Tenure type</b><br>(rental/owner)                      | Rental market: explained by the low purchasing power and access to credit.<br>Owner market: minority of population that has high income levels and can afford it. | Rental market: greater residential mobility and innovative rental options.<br>Owner market: for who sees the house as their second skin (by the outer and / or inner characteristics)  |
| <b>Public space</b><br>(more/ less qualification)         | Reduced interventions   | Public space qualification   |

Table 3 – Housing stock and housing market in 2030

|   | Alojamentos |      |               |      |                    |       |
|---|-------------|------|---------------|------|--------------------|-------|
|   | até 1 ano   |      | de 1 a 2 anos |      | com mais de 2 anos |       |
|   | 1           | C2   | C1            | C2   | C1                 | C2    |
| <b>Total dwellings</b>                      | 567         | 1069 | 654           | 1058 | 61228              | 70200 |
| <b>Vacant dwellings (%)</b>                 | 75          | 60   | 25            | 20   | 13                 | 11    |
| <b>Vacant dwellings (qtd)</b>               | 426         | 642  | 141           | 211  | 8119               | 7870  |
| <b>Vacant dwellings in the market (%)</b>   | 90          | 90   | 90            | 90   | 50                 | 40    |
| <b>Occupied dwellings in the market (%)</b> | 0           | 0    | 0             | 0    | 3                  | 4     |
| <b>Total dwellings in the market</b>        | 384         | 578  | 127           | 190  | 5653               | 5642  |

Based on the previous results it was produced a sketch of the new dwellings in 2030. This sketch includes the technical characterization of new dwellings for different basic characteristics (type, area, and income) and quality and comfort attributes (Castro & et al., 2013).

Table 4 – Characterization of the standard houses

| ID Dwelling | Characteristics |                         |              |        |
|-------------|-----------------|-------------------------|--------------|--------|
|             | Zone            | Typology                | Preservation | Area   |
| 0           | Rural           | single family dwellings | New          | Small  |
| 1           | Rural           | single family dwellings | Used         | Small  |
| 2           | Beach           | single family dwellings | New          | Big    |
| 3           | Beach           | Flat                    | Used         | Medium |
| 4           | Centre          | Flat                    | New          | Medium |
| 5           | Centre          | Flat                    | Used         | Small  |
| 6           | Suburban        | single family dwellings | New          | Big    |
| 7           | Suburban        | Flat                    | New          | Small  |
| 8           | Suburban        | single family dwellings | Used         | Small  |

This will be one of the supporting elements for the final exercise of Donut-Prospect (regarding the valuation of standard houses in 2030). The final exercise aims at structuring a process of sharing new ways of looking at the housing market future in order to relate the evolution of the housing market with the evolution of its external environment (economy, demography, architecture, geography, urban planning, public policy) based on evolutionary scenarios; and relating the price of housing with supply and demand constraints.

## Housing market in 2030: Housing price simulation

### *Methodology*

The housing price simulation for 2030 was based on the results obtained in the previous exercise (scenario analysis and expert panel). To link econometric and foresight analysis, we



used a quantitative framework based on the general explanatory model with the necessary adaptations to combine both components.

This phase determined the sensitivity of housing prices to exogenous factors (availability of energy resources, socio-economic structure and the macro-scale effects on the housing market) offering a greater understanding of their possible evolution trends. The results obtained and presented in the previous section not only constitute two extreme realities, but also determine the necessary conditions to define a general equilibrium model that constrains and controls the answers given by the real estate appraisers. Thus, the values assigned in this exercise were compared, first, with the demand determinants (willingness to pay of different social groups, determined by the estimated income) and, second, with the supply determinants (quantity and housing distribution, by area and macro categories).

The real estate appraisers based on their housing market knowledge valued each standard house under the two contrasting scenarios. The exercise had an iterative nature (giving space to confrontation of arguments among participants) supported by an IT platform (Castro & et al., 2013). So, first, the two extreme scenarios were presented, including the results achieved in the first exercise (panel of experts). Then the experts were asked to evaluate the standard houses according to each scenario. In order to take advantage of the tacit knowledge of the various experts and simultaneously establish a basis for comparison of the arguments that define the different perspectives, two moments of debate were organized; thus, this process, was organized in several rounds, enabled their interaction and consequently the systematization of results.

#### **i) General equilibrium model**

As mentioned above, the results obtained in the 1<sup>st</sup> foresight exercise present a picture of the housing stock in 2030: the quantity of housing and housing supply in 2030. As previously stated, to define the size of the housing stock, we use the present housing context (total quantity of dwellings) as the starting point for the foresight housing model, which is adjusted according to the housing construction dynamic (construction ratio and abandonment ratio during the period 2011-2030). Subsequently, using as reference the 2011 Census values, it was defined the amount of dwellings available on the market in accordance with each zone and each scenario under the following parameters:

- Number of vacant dwellings available in the market;
- Number of occupied dwellings, which were available in the market.

To determine the number of households by size (large, medium, small), it was assumed that they correspond to the socioeconomic distribution (Table 5 and Table 6, with large size => socioeconomic group with high income). Regarding the number of households by type of dwelling (single family dwelling or flat), we chose to keep the proportion found in the 2011 Census and this proportion was maintained to any of the other dimensions (location, size and preservation) and respective classes already considered.

Table 5 – Households Income distribution: scenario 1

|                         | Rural       | Praia     | Centro      | Suburban    |
|-------------------------|-------------|-----------|-------------|-------------|
| <b>Total population</b> | 34641 (29%) | 2439 (2%) | 21028 (17%) | 63091 (52%) |
| <b>% High income</b>    | 4           | 20        | 9           | 4           |
| <b>% Medium income</b>  | 30          | 30        | 40          | 36          |
| <b>% Low income</b>     | 66          | 50        | 51          | 60          |

Table 6 – Households Income distribution: scenario 2

|                         | Rural       | Beach     | Centre      | Suburban    |
|-------------------------|-------------|-----------|-------------|-------------|
| <b>Total population</b> | 34641 (26%) | 2439 (4%) | 21028 (18%) | 63091 (52%) |
| <b>% High income</b>    | 4           | 14        | 10          | 4           |
| <b>% Medium income</b>  | 33          | 45        | 46          | 31          |
| <b>% Low income</b>     | 63          | 41        | 44          | 65          |

It was also implemented a set of constraints on the demand side. The demand side involves all estimated families who come to live in the study area in 2030, and two categories were distinguished: i) the urgent demand and ii) potential demand.

The urgent demand defines the demand that results from the (expected) population evolution. Includes, for the year 2030, i) the formation of new families, for which demand is weighted by a factor of urgency in the housing acquisition, and ii) a proportion of population that moves to other available dwellings, defined by considering the average time a family stays in a dwelling.

The potential demand, in turn, is applied to the remaining families, that although have no urgency in obtaining a dwelling, they display a willingness to participate in the market - acquiring a new home or second home.

Both demands were adjusted for each scenario, depending on household income. In detail, the restrictions were:

- The distribution of households' income was determined as a result of the exogenous scenarios (Table 5 and Table 6). It was defined a Gini coefficient expected for each scenario, as well as a maximum and minimum limit for each of the three income classes considered;
- The urgent demand, in both scenarios, was established considering about 12% of households (in 2030), according to the following assumptions:
  - i) The expected number of new families looking for house is defined in terms of the evolution of the estimated population, ie, internal and external migration, assuming that it corresponds to twice the volume of annual net migration;
  - ii) The average time a family stays in a house is 9 years;
  - iii) Home acquisition is defined according to the average proportion of the value of income affect to housing, for each of the three socioeconomic groups. The coefficient of income use of this set of families for market share equals 1.
  - iv) In both scenarios, was attributed to 20% of this group of families an increase in the coefficient of income, mentioned in the previous paragraph, of 20%.



- The potential demand involves the remaining families. In this case, for both scenarios, it was considered that its market share only occurs when the market value of a dwelling equals a value calculated based on its income affect to housing, adjusted by a coefficient less than 1 (the total families were ordered in decreasing order of income housing), such as:
  - 0,7 in the first 10% of families;
  - 0,5 in the following 20%;
  - 0,2 in the rest.

It is noteworthy that in the global demand, the families of different socio-economic groups have an interest in dwellings with certain characteristics (whose price tends to reflect the quality of the dwelling), being the market share adjusted considering these restrictions.

On the supply side, there were four crucial dimensions:

- Location (zones);
- Preservation (new or used dwelling);
- Type (flat or single family dwelling);
- Dimension (big, medium, small) – which indirectly illustrates the socio-economic group (high, medium or low income).

The combination of these attributes lead to 48 standard houses. In order to facilitate the process of defining characteristics and housing valuation, we used a representative sample of this group of standard houses. Thus, the valuation exercise focused exclusively on 9 standard houses, selected by the Latin square method (see Table 4, and for more details, see (Castro & et al., 2013).

Based on these criteria, a dwelling supply-demand equilibrium model was developed, that operates according to the following phases:

- 1) Value assigned by experts to each of the 9 standard houses (exercise performed in rounds);
- 2) Estimated values for the 48 dwellings calculated by interpolation of the values assigned to the 9 standard houses by each expert, from a linear model;
- 3) Vector of the total quantity of available dwellings sorted in descending order;
- 4) Vector of all households sorted in descending order of income affected to housing acquisition;
- 5) Hierarchical allocation of vector (3) dwellings depending on the position of each family in the vector (4).

## ii) Expert selection

Foresight exercises involve a structured and iterative process that allows building future visions and informing decision making and mobilizing action. Usually it uses expert knowledge, and is based on the application of a set of participatory and discussion methods that support building strategic visions, which depend on the recognition of the implications of decisions and actions in the present. The number of experts participating in an exercise of this type is variable, but its selection depends not only on the strict definition of the problems and issues to be addressed, as



well as on the information and tacit knowledge of the various experts, that should complement each other (Borges, 2012).

The complexity and multidimensionality of the housing market reinforces the need for sharing knowledge of professionals from various fields of expertise. Based on this concern, several invitations were addressed to real estate appraisers from multiple domains of expertise (tax authorities, banks, courts, consultancy etc.). The contact with the National Association of Real Estate Appraisers was also an important contribution to the promotion of the event and encouragement of involvement of valuers. The selection process also included an analysis of the applications submitted, in order to ensure the adequacy of the profile and diversity of the participants. Thus, twelve experts attended Donut Prospect exercise, who are distinguished by geographic scope, expertise domain and valuation methods (Castro & et al., 2013).

### *Output summary*

#### *Valuation analysis by scenario*

##### i) Argumentation

In scenario 1, the experts assumed that used dwellings were highly allocated to the rental market, and there is a certain aversion to used dwellings in the context of the acquisition market. It was further argued that in a scenario like this there is a set of rules that prevent excessive growth of cities, reinforcing the trend for rehabilitation; given the budget constraints of households, the priority in choosing dwellings is more associated with its location than with the state of preservation (in this context, whether it is new or used).

The dwellings “Beach-Single family dwelling-New-Big” and “Suburban-Single family dwelling-New-Big” are those with a higher price. In the first case, the value that is associated with this type of housing is confined to the population with higher purchasing power and mobility, that search for areas with higher quality standards (specialized services), and therefore have access to the best that technology can provide. In the second case the valuation is explained by the fact of the suburban zone being an area with available space, new equipment and quality infrastructure; such conditions determine a clear opportunity for the private housing market, where investors are particularly interested in single family dwellings. In contrast are the dwellings “Beach-Flat-New-Medium”, “Centre-Flat-Used-Small” and “Suburban-Flat-New-Small” with lower prices that is justified by the demand for this type of dwelling being associated with families with lower income, encouraging the demand for territories with greater accessibility, employment and infrastructure. The remaining dwellings assessment occupies an intermediate position.

However, experts tend to assume that in a pessimistic scenario, like this, it will be difficult to buy a house, even those households with greater purchasing power. The results suggest that in this scenario the differences in central areas could have been more substantial.

In scenario 2 it is emphasized that social segmentation is less clear, and the increase in the purchasing power supports an increasing trend of the demand levels, not forgetting that the willingness to pay depends on income and the proportion of income that is allocated for housing.



The values assigned by the real estate appraisers present the same trend observed in the first scenario. As it could be expected the arguments that support these valuations are different. There is, in general, a greater demand for territories that provide a better quality of life and better conditions (either by the environment, or the services and equipment). Although there are no major restrictions (economic, environmental) in this scenario it is noteworthy the existence of a public policy that acts as a control mechanism to promote a more rational planning,

ii) Housing assessment

It is now presented an analysis of the answers of the 12 experts for each standard house, conditional to each scenario (Figure 3 and Figure 4). It should be noted that, in general, the valutors were able to reflect the specificities of each scenario on the valuation of each property, thus translating different attributes valuations.

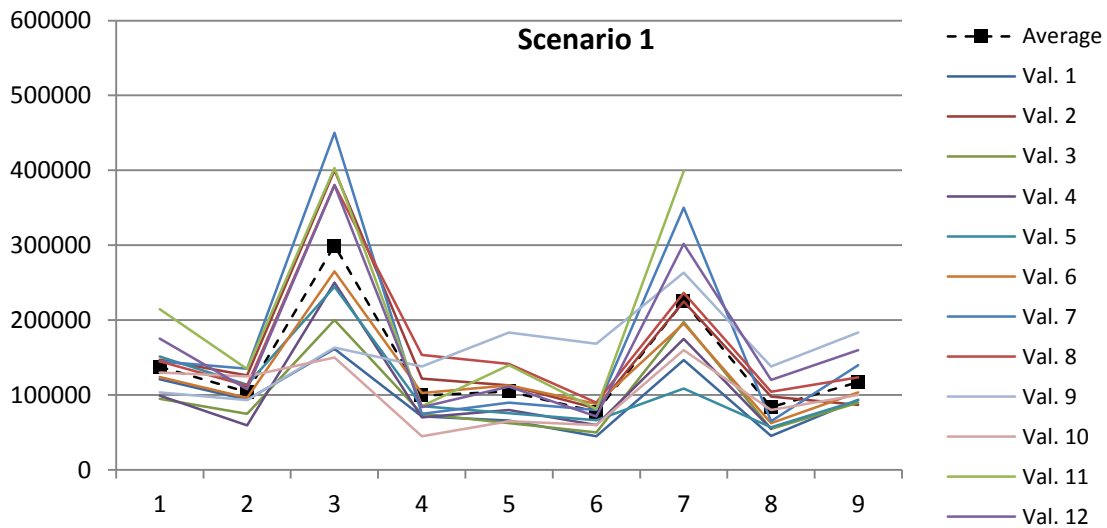


Figure 3 – Housing valuation in € - scenario 1

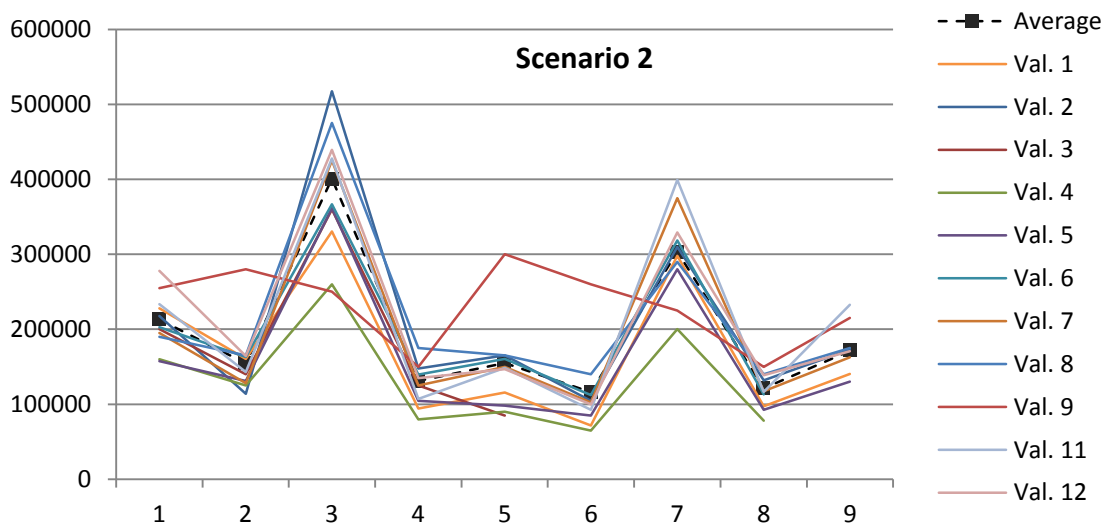


Figure 4 – Housing valuation in € - scenario 2

Strengthening the analysis of the arguments presented above, it appears that the standard houses had differentiated reviews depending on the scenario. The values assigned follow the same trend observed in the first scenario, but the values were higher in the second scenario. The figure below illustrates this analysis. It is noteworthy that the expert valuation was more differentiated in dwellings associated with higher market value (values that depend on the restrictions associated with the scenarios, and whose arguments were previously explained). We will return to this analysis in the presentation of the foresight econometric model, which identifies the relative value associated with attributes in each scenario.

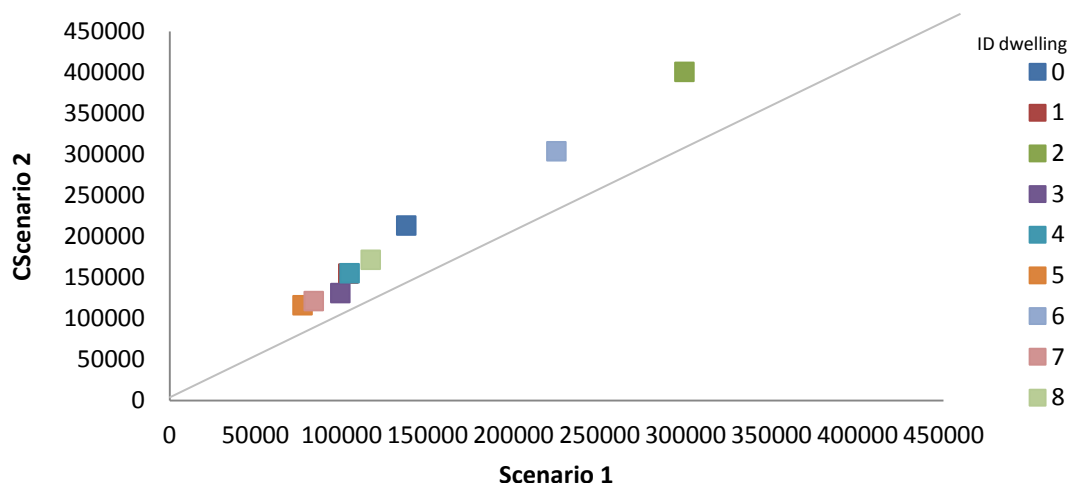


Figure 5 – Housing valuation in € – intra-scenarios comparison

### Housing price simulation

In this section we present an analysis focusing on the behavior of the valuator experts in the successive rounds of each scenario (seven rounds for the first scenario and four rounds for the second), evaluating the dynamics of convergence of the responses. The different number of rounds performed for each scenario is related to a learning component that was held over the first phase, ie, based on the discussion and (re)valuation of the standard houses in the first scenario (Figure 6 and Figure 7 show the acceleration of this process). It should be noted, in this context, that, unlike most Delphi exercises traditionally applied, consensus building, although relevant, did not appear as the main objective of the exercise. The exercise aimed, however, to construct and validate the results by comparing arguments of several specialists, enabling at the same time the comparison of responses with the expected impact in the real world, in this case, controlled by a general equilibrium model that reflected the number of dwellings sold.

In analyzing the level of convergence of responses we used the variable "Difpre", which is the difference between the value assigned by each valuator and the final average valuation of each dwelling. The results (Figure 6 and Figure 7) show that in both scenarios the values assigned in the successive rounds indicate an apparent convergence, although not statistically significant, sig. = 0.57 and sig. 0.39 (Table 7 and Table 9).

As mentioned earlier, the several rounds aim to structure the results, by allowing the confrontation of different arguments and facilitating consensus among the multiple real estate appraisers. It is assumed that this process led to a convergence of responses (Figure 6 and

Figure 7). However, the decrease of the variable 'Difpre' average over the various rounds, which shows the convergence process (Table 8 and Table 10) is accompanied by a decrease in the number of participants that change their answers (participant that confirm or change the value in platform). Thus, along this process, it appears that the standard deviation increases, which introduces some noise in the statistical analysis and interpretation of this convergence. In the several rounds, the experts not only had the opportunity to revalidate their values moving toward the average value of the other participants, but are also confronted with the general equilibrium model values (that shows the number of homes sold, given the overall average). Therefore, this information contributes to a potential gap measured by the standard deviation: as illustrated by the figures, there was a deconcentration of the cloud of points. In the second scenario this trend occurs with smaller amplitude.

Table 7 – Price simulation process and significance levels– scenario 1

| Model        | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|--------------|-----------------------------|------------|---------------------------|-------|------|
|              | B                           | Std. Error | Beta                      |       |      |
| 1 (Constant) | 23319,635                   | 8965,689   |                           | 2,601 | ,010 |
| ronda        | -1508,383                   | 2700,791   | -,028                     | -,558 | ,577 |

a. Dependent Variable: difpre

Table 8 – Convergence process - Scenario 1

| Ronda              | N   | Range     | Minimum    | Maximum   | Mean     | Std. Deviation |
|--------------------|-----|-----------|------------|-----------|----------|----------------|
| 1 difpre           | 105 | 435667,00 | -230542,00 | 205125,00 | 21428,63 | 91805,418      |
| Valid N (listwise) | 105 |           |            |           |          |                |
| 2 difpre           | 96  | 435667,00 | -230542,00 | 205125,00 | 16787,68 | 93670,79       |
| Valid N (listwise) | 96  |           |            |           |          |                |
| 3 difpre           | 71  | 379139,00 | -174014,00 | 205125,00 | 25137,06 | 84774,84       |
| Valid N (listwise) | 71  |           |            |           |          |                |
| 4 difpre           | 45  | 374139,00 | -174014,00 | 200125,00 | 17552,36 | 90366,416      |
| Valid N (listwise) | 45  |           |            |           |          |                |
| 5 difpre           | 45  | 374139,00 | -174014,00 | 200125,00 | 16684,73 | 90868,22       |
| Valid N (listwise) | 45  |           |            |           |          |                |
| 6 difpre           | 27  | 359139,00 | -159014,00 | 200125,00 | 14620,41 | 92713,95       |
| Valid N (listwise) | 27  |           |            |           |          |                |
| 7 difpre           | 9   | 319139,00 | -159014,00 | 160125,00 | -2235,11 | 94672,43       |
| Valid N (listwise) | 9   |           |            |           |          |                |

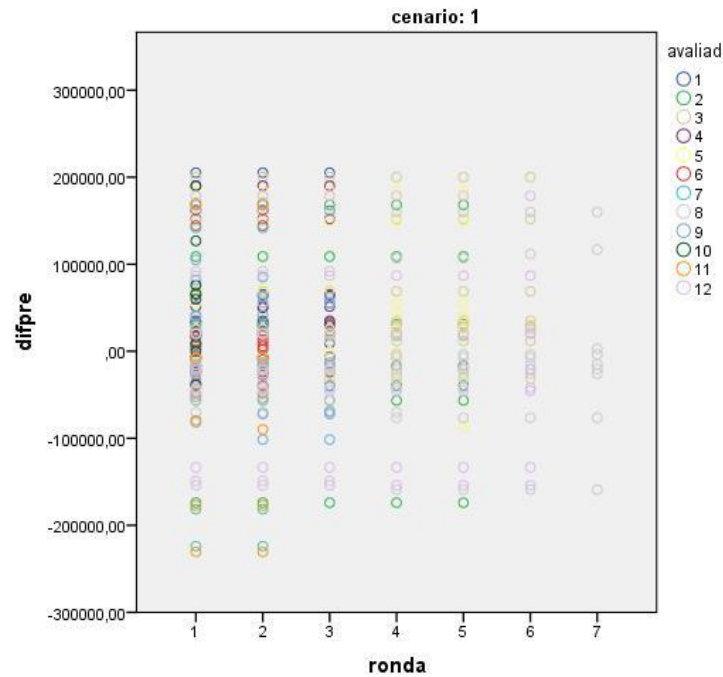


Figure 6 Convergence process - Scenario 1

Table 9 – Price simulation process and significance levels– scenario 2

| Model |            | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|------------|-----------------------------|------------|---------------------------|-------|------|
|       |            | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant) | 20872,607                   | 18082,994  |                           | 1,154 | ,250 |
|       | ronda      | -8595,985                   | 9942,779   | -,064                     | -,865 | ,388 |

a. Dependent Variable: difpre

Table 10 – Convergence process - Scenario 2

| Ronda |                    | N  | Range     | Minimum    | Maximum   | Mean        | Std. Deviation |
|-------|--------------------|----|-----------|------------|-----------|-------------|----------------|
| 1     | difpre             | 93 | 460724,00 | -220982,00 | 239742,00 | 12348,0108  | 102740,06739   |
|       | Valid N (listwise) | 93 |           |            |           |             |                |
| 2     | difpre             | 71 | 484224,00 | -250982,00 | 233242,00 | 4127,4366   | 106059,49496   |
|       | Valid N (listwise) | 71 |           |            |           |             |                |
| 3     | difpre             | 9  | 450724,00 | -250982,00 | 199742,00 | -14177,8889 | 130423,01148   |
|       | Valid N (listwise) | 9  |           |            |           |             |                |
| 4     | difpre             | 9  | 451724,00 | -250982,00 | 200742,00 | -8511,2222  | 129495,57137   |
|       | Valid N (listwise) | 9  |           |            |           |             |                |

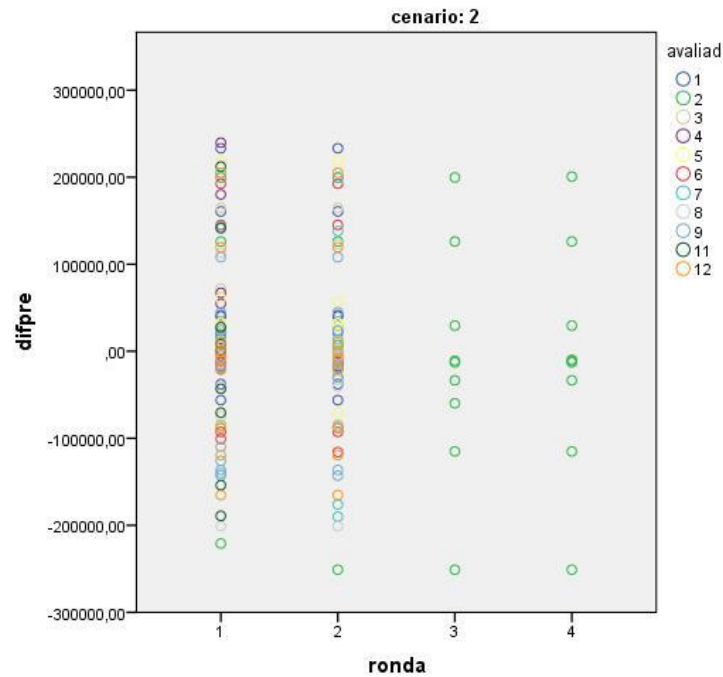


Figure 7 Convergence process - Scenario 2

### **Evaluator profile**

When analyzing the influence of the profile of the real estate appraisers in the answers, and applying the nonparametric Kruskal-Wallis test, it is concluded that there are significant differences (sig. = <5%) in the assessment of experts in scenario 1 and in scenario 2 these differences (sig. = 0:22) are not significant. In the first scenario these differences are related to the method of valuation (cost, income and empirical knowledge), geographical origin and training area (Table 11). In the second scenario, although there remain significant differences, some of the methods used, specifically the cost method and income method, present high levels of significance.

It is noteworthy that in terms of geographical origin, although the exercise has been based on a Portuguese standard medium-sized, some reviews were not entirely uniform: in both scenarios the highest values were assigned by evaluators of Porto and Arouca and lower values by evaluators of Aveiro.

This analysis reveals another interesting aspect. Empirically remains the idea that real estate appraisal can vary depending on the context in which it is performed. The results show that, contrary to what might be expected, the area in which the assessment activity is performed there is no differential impact in this process, which allows assuming some robustness to the results.

Table 11 – Real estate appraisers profile and significance levels

|                    |                     | Asymp. Sig.  |              |
|--------------------|---------------------|--------------|--------------|
|                    |                     | Scenario 1   | Scenario 2   |
| Valuation method   | Cost                | <b>0,014</b> | <b>0,027</b> |
|                    | Income              | <b>0,001</b> | <b>0,026</b> |
|                    | Comparative         | 0,872        | 0,153        |
|                    | Prospective         | 0,738        | 0,822        |
|                    | Empirical knowledge | <b>0,024</b> | 0,263        |
| Scope of valuation | Tax authorities     | 0,117        | -1,644       |
|                    | Bank                | 0,605        | 0,943        |
|                    | Court               | 0,252        | 0,446        |
|                    | Consultancy         | 0,454        | 0,208        |
|                    | Heirdom             | 0,429        | 0,602        |
| Geographic area    |                     | <b>0,029</b> | 0,163        |
| Expertise domain   |                     | <b>0,017</b> | 0,132        |

***Foresight econometric model***

As mentioned above, the foresight exercise is an element of interaction between experts in the housing market, bringing them (and their knowledge and opinions) into the decision-making process. Moreover, this exercise adds predictive information in the quantitative models already developed.

To typify the set of concrete houses from the information of the first group of experts in the context of each scenario, and combining this information with the assessments of experts, the necessary conditions to carry out an adaptation of the final price of the current housing econometric model are set-up (Castro & et al., 2013)..

By transforming the set of available attributes (transactions in 2011) a typified set of attributes – area, preserving – new/used, type – single family dwelling/flat, location – four zones (center Suburb Beaches, Rural ) – it is obtained an econometric model that can be extended to the data of each scenario on the horizon in 2030 (Eq. 2).

$$Ln (P_{\text{€}/m^2}) = \sum_{i=1}^3 \alpha_i (F_i) + \sum_{j=1}^5 \alpha_j (Z_j) + \alpha_{\text{tom}} Ln (TOM) + \sum_{t=1}^T T_t + \varepsilon \tag{Eq. 2}$$

Table 12 presents the results for the three estimated econometric models. Note that the estimates on the horizon in 2030 are held in constant prices (being therefore necessary to purge the transactions of this annual inflation, using for this purpose the annual time dummies in the econometric model).

Table 12 – Housing price model: 2010 e 2030 (foresight model)

|                           | BASE (2010)  |                |                         | SCENARIO 1 (2030)                                 |                |                         | SCENARIO 2 (2030)                                 |                |                         |
|---------------------------|--|----------------|-------------------------|---|----------------|-------------------------|---|----------------|-------------------------|
|                           | R  | R <sup>2</sup> | R <sup>2</sup> Adjusted | R   | R <sup>2</sup> | R <sup>2</sup> Adjusted | R   | R <sup>2</sup> | R <sup>2</sup> Adjusted |
|                           | 0,769 a  | 0,591          | 0,590                   | 0,911b  | 0,830          | 0,819                   | 0,938b  | 0,880          | 0,872                   |
|                           | Coefficients (a)   |                |                         | Coefficients (a,b)                                |                |                         | Coefficients (a,b)                                |                |                         |
|                           | N. Standard Coef.  | Standard Coef. | Sig.                    | N. Standard Coef.                                 | Standard Coef. | Sig.                    | N. Standard Coef.                                 | Standard Coef. | Sig.                    |
|                           | B  | Beta           |                         | B   | Beta           |                         | B   | Beta           |                         |
| <b>(Constant)</b>         | 7298,000   |                | 0,000                   | 8,290   |                | 0,000                   | 8,618   |                | 0,000                   |
| <b>Area</b>               | -0,002   | -0,551         | 0,000                   | -0,009  | -0,526         | 0,000                   | -0,009  | -0,586         | 0,000                   |
| <b>Flat</b>               | -0,160   | -0,205         | 0,000                   | -0,753  | -0,471         | 0,000                   | -0,714  | -0,482         | 0,000                   |
| <b>Used</b>               | -0,143   | -0,231         | 0,000                   | -0,425  | -0,265         | 0,010                   | -0,364  | -0,245         | 0,003                   |
| <b>Beach</b>              | 0,502  | 0,492          | 0,000                   | 0,718   | 0,380          | 0,000                   | 0,659   | 0,375          | 0,000                   |
| <b>Centre</b>             | 0,274  | 0,403          | 0,000                   | 0,415   | 0,219          | 0,057                   | 0,309   | 0,176          | 0,080                   |
| <b>Suburban</b>           | 0,167  | 0,213          | 0,000                   | 0,275   | 0,161          | 0,123                   | 0,257   | 0,161          | 0,090                   |
| <b>fixed time effects</b> |  |                |                         |   |                |                         |   |                |                         |
|                           | a Dependent Variable:<br>LOG_Precolnicial_m <sup>2</sup> |                |                         | a CENARIO = 1                                     |                |                         | a CENARIO = 2                                     |                |                         |
|                           |  |                |                         | b Dependent Variable:<br>LOG_PRECO_m <sup>2</sup> |                |                         | b Dependent Variable:<br>LOG_PRECO_m <sup>2</sup> |                |                         |

In this analysis we intend to understand the magnitude of changes in an intra-scenarios comparative context. Figure 8 shows the difference between high and low quality and comfort attributes (the difference between "too expensive" and "very cheap"), compared with scenario 2.

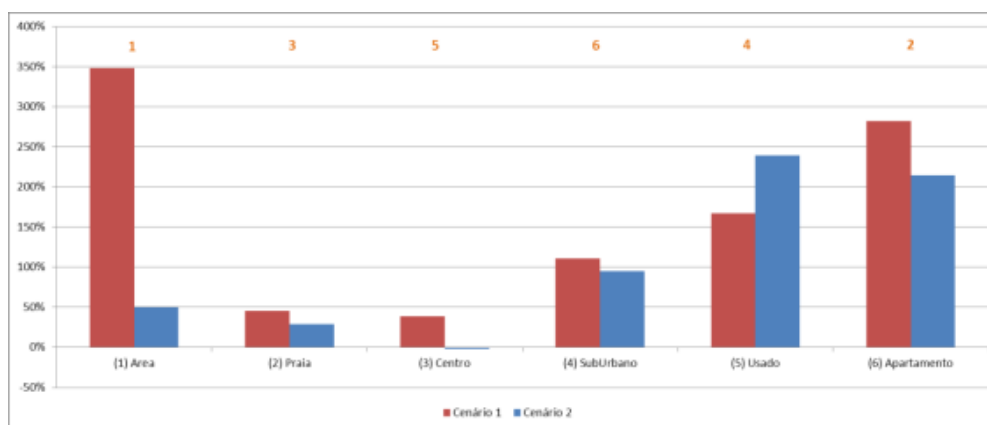


Figure 8 – Variation in the hedonic price of dwelling attributes, for each scenario

This result confirms the empirical hypothesis that, in situations of greater economic weakness, there is a tendency to the overvaluation of the attributes of quality and comfort, as the premium to get it is significantly higher. Thus, the differential values of different locations in relation to the Rural area (less valued) grows significantly, as well as the differential between the dwellings of smaller and larger areas (less and more valued) and between flats (less valued) and single family dwellings. The only exception to this trend is the attribute preservation, where the gap between new and used is smaller than in Scenario 2. This fact may be related with the existing

restriction in scenario 1, and so the "new" solutions constitute a less valued attribute when compared with Scenario 2 (where the lower economic constraints promote the benefits of this attribute).

A second analysis concerns the structure of attributes valuation (degree of importance of the attributes). The standardized values show that in the base year (2011), there is significant relative valuation of the attributes of location (when analyzed individually, it shows an explanatory capacity of 63% of the variability in house prices). Nevertheless, for the future (and in both scenarios), it is expected a greater preponderance of the attributes directly related to the quality and comfort (in the case of housing type and location of the beach). This change is empirically expected given the constraints associated with Scenario 1, which will make the quality and comfort as the most distinctive attributes with price changes, or in Scenario 2, where it is expected the natural evolution of consumer demand (Table 13).

Table 13 – Importance of the attributes

|                                       | Importance of the attributes |            |            |
|---------------------------------------|------------------------------|------------|------------|
|                                       | Actual - 2011                | Scenario 1 | Scenario 2 |
| Area                                  | 1                            | 1          | 1          |
| Beach                                 | 2                            | 3          | 3          |
| Centre                                | 3                            | 5          | 5          |
| Suburban                              | 4                            | 6          | 6          |
| Used                                  | 5                            | 4          | 4          |
| Flat                                  | 6                            | 2          | 2          |
| R <sup>2</sup> Global model           | 59%                          | 82%        | 87%        |
| R <sup>2</sup> Physical attributes    | 58%                          | 91%        | 91%        |
| R <sup>2</sup> Territorial attributes | 63%                          | 16%        | 19%        |

## CONCLUSION

The main results characterize the housing market in two temporal moments: in 2011 and in 2030. For this purpose it involved the physical and territorial housing dimensions, including the definition of submarkets, attribute specification and (absolute and relative) valuation of attributes and its variation in space.

These results were based on a simulation exercise, but it is assumed that the values obtained have a high explanatory power. This explanatory power results from the adherence of participants to the exercise, indicating that the logic and basic principles were globally perceived. In the real market context, the transactions values are much more variable because: i) there is an incomparable variety of evaluators (supply and demand agents), ii) the valuation is based in a wider range of criteria (the number of attributes available are higher when compared with the more complete econometric models developed under this study). Thus, the idiosyncrasies of the valuation process in the real world are much more complex and valuation is diluted in the largest variety of attributes (it should not be forgotten that that the market price is always subject to budget constraints).





In methodological terms, the foresight exercise is an important instrument of interaction and sharing of knowledge of experts from various fields of expertise, and, in this sense, it was developed a set of mechanisms that consolidate the exercise and make the results more robust.

By combining econometric and foresight models, the assessment tool developed integrates these two analytical dimensions, space and time. Even though it wasn't the main purpose of this study, it is considered that the work, by allowing the transfer of knowledge between different actors involved in the real estate market and providing confidence intervals for the value of a given dwelling depending on the specific attributes along a period of time, is an important instrument to support real estate agents and owners, as well as the definition of housing policies. The analysis of the results must recognize not only the instrumental options adopted, but also the specific profile of the real estate appraisers. In this respect it should be recognized that there is a trade-off between the feasibility of the tool and the technical requirements.

There is also a set of challenges that must be mentioned in order to improve future approaches in this domain. The available data and, more importantly, its level of disaggregation are directly related to the ability to perform a more or less robust housing characterization. The available information sustains three main challenges: i) the data used corresponds to part of the set of the explanatory factors for housing prices. Although they are considered to be the most relevant, it is understood that it would be appropriate to have access to other types of data, in order to improve the explanatory power of the models, and hence obtain a more detailed perception of housing preferences. ii) Despite the reference scale used corresponding to a standard medium-sized city, the extension of this approach to other territorial areas is dependent on the amount and quality of information and requires that the data presents a similar structure to the one used in this research. iii) The methodological options adopted for understanding the various territorial structures depend on the specific study goals and on the constraints related with the available information, which might suggest systematic discussions about the adopted options.

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