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Designing the housing market for 2030 - a foresight and econometric approach

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Designing the housing market for 2030 – a foresight and econometric approach
João Lourenço Marques, Miguel Viegas, Monique Borges, Eduardo Anselmo

ABSTRACT

The paper presents a foresight analysis methodology and its empirical application in the context of housing market. This work was developed in the context of a wider research project, “Drivers Of housiNg demand in Portuguese Urban sysTem” – DONUT, which analyses the Portuguese housing market. Decision making models were developed, combining technically informed subjectivity (foresight analysis) with more rigorous models (econometric models). The final outcome 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 is built.

The importance of the housing sector requires a significant effort to understand its dynamics and analyze the main drivers of the housing market. The social and economic phenomena, as well as the heterogeneity of both housing (prices and features) and consumers are important elements not always included in the analytical models commonly used. 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 economy that works as a theoretical basis for the estimation of hedonic housing prices. However, these analytical models fail on their inability to integrate the variability of exogenous factors. Forecasts on subject affects by high volatility and uncertainty require particular approaches such as foresight analysis which will be the main focus of this paper.

In short, a methodology of foresight exercise is presented, discussing the combination of two techniques: scenario analysis and Delphi surveys. This 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. In addition, the most relevant results of this exercise will be analyzed and presented, contributing to the definition of important guidelines for real estate agents.

The work is structured in 3 parts: i) framework of the foresight exercise; ii) brief description of the exogenous housing market context (scenario analysis), iii) definition of the characteristics that describe the standard houses and their distribution in space, and iv) valuation of the standard houses previously identified.

Keywords: *Foresight, Scenarios, Expert Panel, Housing Market*

1. INTRODUCTION

This paper is part of the work developed in the research project “Drivers Of housing demand in Portuguese Urban system” – DONUT”, where is developed a theoretical framework with empirical application of many of the challenges facing i) the analysis of the housing market, in particular regarding the need of knowing trends and estimating its evolution and ii) the development of decision making models that combine technically informed subjectivity with more rigorous models (econometric models).

The housing market has witnessed deep changes associated with social and economic phenomena that lead to new demands and needs. These issues, whose volatility and uncertainty of evolution are enormous, require different approaches. An important component of the analysis of the housing market, with particular interest for decision support tools, is the ability to assess and predict future dynamics. Although there are increasing efforts in order to build more rigorous analytical models, the housing market models traditionally applied (e.g., hedonic housing prices models) do not capture the complexity of the housing market that arises from the volatility of economic and social phenomena and the heterogeneity of housing and consumers (Marques, Castro, & Bhattacharjee, 2012; O’Sullivan & Gibb, 2003). The analysis of the housing market, in general, is based on the collection of information available from public and private institutions and on the application of models strongly conditioned by the available information. Simultaneously, the econometric models for predictive modeling commonly used require the availability of data in the form of time series and the acceptance that the evolution pattern can be extrapolated to the future. The structure of the territory and the lack of information and transparency of the housing market mechanisms also influence its understanding. As a result, the search and development of alternative analysis methods capable of dealing with temporal variability and uncertainty become essential.

In order to respond to these challenges, the research project is structured essentially into two 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).

The foresight exercise proposed, in which this work focuses, combines a scenario analysis, a Delphi questionnaire and an expert panel exercise. The methodology is supported

on the assumption that, by combining experts in the housing market it is possible, on the one hand, to discuss strategies in the context of great uncertainty and, secondly, to identify central tendencies and evaluate how it may evolve in the future.

This work presents the methodological framework and the results of one phase of the foresight exercise that includes the materialization, by a group of experts from various fields of expertise (architecture, geography, urban planning), of the scenarios designed for 2030, based on specific themes (population distribution, organization of urban space, housing characteristics).

For this purpose, the work is structured in three parts: i) the foresight analysis framework, ii) presentation of the DONUT-prospect exercise (structure and description of the scenario analysis and expert panel), and iii) presentation of results, which depend on the knowledge combination from various experts (demographers, geographers, planners, architects and economists) about the structure of population and housing types for a medium-sized city in 2030.

2. FORESIGHT ANALYSIS ¹

2.1. The concept

Despite the increasing number of foresight, the multidisciplinary and complexity of foresight hinders its conceptualization. The conceptual approach is generally adjusted to various thematic areas, not being possible to identify contrasting elements². However it is consensual that foresight is distinguished by i) anticipating and projecting, in a structured way, social, economic and technological changes in the long-term ii) using a set of participatory and interactive methods of debate, analysis and study of these changes and needs, often using the opinion of experts, iii) developing new networks, and iv) structuring and guiding strategic visions that depend on the acknowledgement of the implications of

¹ The work developed in the master thesis “Análise Prospectiva - O caso do mercado da Habitação” (Borges, 2012) was the basis for the systematization presented here.

² Martin e Irvine (1989) argue that foresight provides a systematic mechanism to deal with this complexity and interdependence, thus contributing to the formulation of policies where the integration of multidisciplinary activities is vital; Martin (1995) adds that foresight is the process involved in trying to look at the future of science, technology, economy and society in the long term in a systematic way, in order to identify areas of strategic research and emerging technologies that can produce economic and social effects; and Slaughter (1996) defines foresight as a capacity to anticipate, predict, model, and answer to future eventualities.

decisions and actions in the present (Comissão Europeia, 2002; Keenan, Abbot, Scapolo, & Zappacost, 2003).

This analysis leads to the concept of foresight considered in this work: foresight involves a systematic process that allows building interactive and future visions (used in various contexts) in order to inform decision-making and mobilize action. It is further assumed foresight as a tool for decision support, based on the need to inform decision-making in a rigorously and systematically manner, usually using for this purpose, the knowledge of experts. By assuming that the current decisions influence the long-term context it is assumed that, despite uncertainty regarding the speed and magnitude of transformations, it is possible to prepare for any surprises and discontinuities of the future, where the anticipation of future based in the aggregate knowledge of a number of experts is essential.

2.2. Foresight methods applied to the housing market

Regarding the several foresight studies, the literature shows a variety of approaches in relation to the processes and methods, challenges and styles of foresight (see, for example, Georghiou, 1996; Héraud & Cuhls, 1999; Martin, 1995; Miles, 1997; Popper, 2008; Slaughter, 1996; Voros, 2003). However, despite the various contributions providing a comprehensive knowledge base, including definitions and frameworks, there hasn't been a systematic and organized effort to explain how the methods (Table 1) are actually selected (Popper, 2008).³

Table 1 – Foresight methods

Stakeholder analysis	Conferences/ workshops	Modelling
Patent analysis	Delphi	Citizens panels
Morphological analysis	Surveys	Expert panels
Multi-criteria analysis	Scanning	Genius forecasting
SWOT analysis	Trend extrapolation /	Essays / scenario writing
Relevance trees / logic charts	impact analysis	Literature review
Backcasting	Science fictioning	Road mapping
Benchmarking	Cross-impact / structural	Polling / voting
Bibliometrics	analysis	Role playing / acting
Brainstorming	Indicators / time series	Critical technologies
Scenarios / Quantitative	extrapolation	Weak signals /Wildcards
scenarios	Simulation gaming	

³ Given the need to provide systematic information about the diversity of methods available, Borges (2012) presents a systematization of the various methods and techniques of foresight analysis based on their characteristics and objectives of each method. Such provides a framework to select the adequate methods.

Source: (Popper, 2008)

In the housing market specific context, it is essential to understand that its analysis is highly dependent on the complexity and volatility of the factors that influence the reality and its evolution, and secondly, to recognize that there is a set of information disseminated by several agents and specialists who interact in the housing market. Thus, the development of alternative analysis methods able to deal with the spatial and temporal uncertainty is decisive. As a result, this paper focuses on the contribution of foresight analysis, with particular relevance to the scenario analysis, Delphi and expert panel. The consistency of these methods is based on the recognition of the validity (and importance) of experts' tacit knowledge.⁴

3. DONUT PROSPECT EXERCISE

3.1. Exercise structure

The initially proposed objectives will be achieved through two foresight exercises. The first, is based on a discursive and interactive process (expert panel), which shows a set of quantifiable parameters, allowing to define the structure of population and housing types for a medium-sized city in 2030. The second, in turn, based on these results and applying a Delphi questionnaire, allows a simulation of the housing market in the future (the objective is to obtain, by the participants, the valuation of the standard houses previously identified in 2030).

It is possible to structure the DONUT-prospect exercise in three phases:

- Exercise framework, which involves the presentation of the study area and two contrasting scenarios (exogenous dimensions);
- Exercise 1: scenario materialization by a group of experts, involving the definition of the housing characteristics (endogenous dimensions) and housing supply (rental and owner market) in 2030;

⁴ The combination of the scenario analysis with the Delphi questionnaire and the conceptual description of these methods are already established in previous works (Castro, Marques, & Borges, 2012). However, a first exploratory exercise pointed to the need to perform an expert panel exercise to support the construction of scenarios – not originally planned and therefore not described in (Castro, Marques, & Borges, 2012).

The Delphi method and the expert panel are similar techniques, which differ in how they reach consensus: consensus on the Delphi method is obtained through a questionnaire conducted in two or more rounds to allow experts to interact and successively validate their answers until the stabilization of their opinions (Godet, 2003; UNIDO, 2004). The expert panel consensus results from structured processes of debate and discussion in order to exchange knowledge, facilitate networks, and build a frame of reference on the subject under discussion.

- Exercise 2: Simulation of the housing price in 2030 based on the results obtained in the first exercise (obtained through the Delphi method).

This work focuses on the first foresight exercise, with particular attention to the first two moments (scenario analysis and expert panel).

This exercise will be carried out through a questionnaire supported by an IT platform. The reference scale used corresponds to a standard Portuguese medium-sized city (Figure 2), based in the extended city of Aveiro-Ílhavo, and the experts answers were conditional to two contrasting scenarios.

The purpose of this exercise is related to the perception of the urban structure (concentration / dispersion), the functional and social organization (higher or lower social segmentation / segregation of uses), housing types (flats / single family houses) 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 (exercise 2), to be done with evaluators in order to simulate the housing market in the future (year 2030).

In short, Table 2 systematizes a set of dimensions that should be considered throughout the discussion with experts, as they represent two approaches: i) a more macro scale, which is associated with the parameters of the quantitative exercise and ii) a more micro scale, which links the various elements (more or less quantitative) and is embodied in the design of the housing characteristics in 2030⁵. Figure 1 schematically illustrates each step of the exercise and the expected results.

Table 2: Key dimensions to be discussed in the expert panel exercise

Macro scale (quantitative exercise)	
Population distribution	Concentration vs. Dispersion
Family size distribution	Homogenous vs. Heterogeneous
Housing type	Single family houses vs. Flats
Tenure housing	Rental vs. Ownership
Urban renewal	Building requalification vs. New construction
Micro scale (dimensions to support the housing design by architects)	

⁵ Based on the results obtained in the Donut Prospect's first foresight exercise (expert panel) will be 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. This will be one of the supporting elements for the second exercise of Donut-Prospect (regarding the valuation of standard houses in 2030). This step is under construction, so it is not possible to present the results in this paper.

Zoning	Segregation vs. Mixture of uses	services
Social/spatial segmentation	More vs. Less	Internalizing or externalizing
Aesthetics and efficiency of buildings	Overall vs. Fragmented logic	
Building technical solutions	Thermal insulation, sound, water, waste etc.	
Urban design solutions	enways, blue infrastructure: mirrors of water, drainage systems etc..	
Volume	Height (m ²)	

In order to understand the contribution of the proposed methods in the first exercise, it is presented a brief description of the various steps implemented.

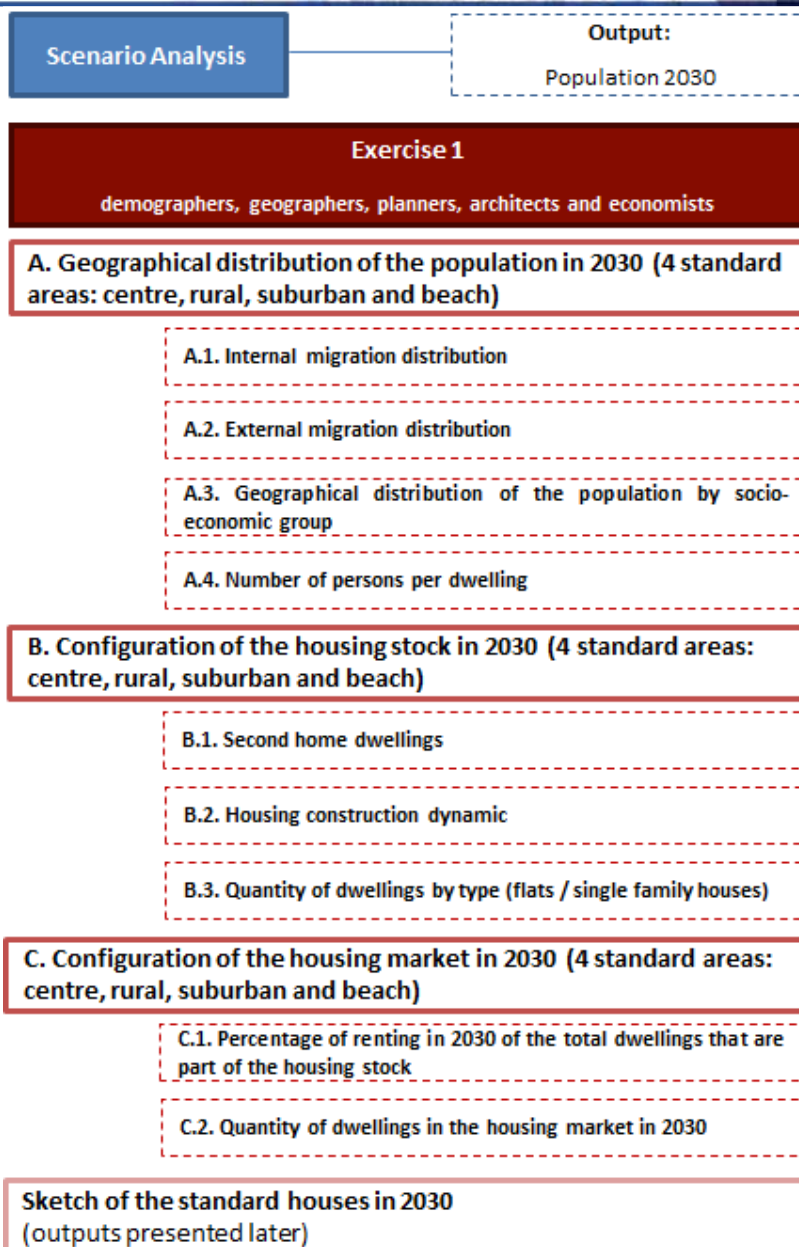


Figure 1: DONUT-prospect 1st foresight exercise outputs

3.2. Framework of the DONUT-prospect standard study area

As previously referred, the reference scale used corresponds to a standard Portuguese medium-sized city (Figure 2), based in the extended city of Aveiro-Ílhavo. The municipality of Aveiro is divided into 14 parishes (Aradas, Cacia, Eirol, Eixo, Esgueira, Glória, Nariz, N. Sra. de Fátima, Oliveirinha, Requeixo, S. Bernardo, Sta. Joana e Vera Cruz) and the

municipality of Ílhavo into 4 parishes (Gafanha da Encarnação, Gafanha da Nazaré, Gafanha do Carmo e São Salvador).

These territories were grouped into four major areas (center, suburban, rural and beaches), possible to represent the characteristics of other medium-sized cities.⁶

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.

It is noteworthy aspects such as the spatial distribution of activities (services, equipment, and infrastructure), that emerge as a key element in the discussion of the proposed scenarios: can be materialized, for example, in the accentuation of the phenomenon of urban sprawl, or urban centres strengthening in the supply of goods and services.

Thus, the centre appears as a polarizer urban centre, concentrating equipment and tertiary activities; outside this area raises some agglomerations with less accessibility to the centre, thereby encouraging the formation of small local support centres. The structure of the road system is defined by the EN 109 and some other secondary routes, as by the highways A25 and A17, which allow to structure and articulate the territory to neighbouring clusters and major urban centres.

⁶ It should be noted that the criterion to delimit the four zones was based on the empirical analysis of the territory (social, economic and demographic dimensions, historical contexts, urban fabric etc..) and on the analysis of specific housing market variables (structural attributes / characteristics of the property: area, type of housing (flat/ single family house), year of construction, etc.). This set of attributes contains spatial heterogeneity effects, suggesting the existence of different housing market segments.

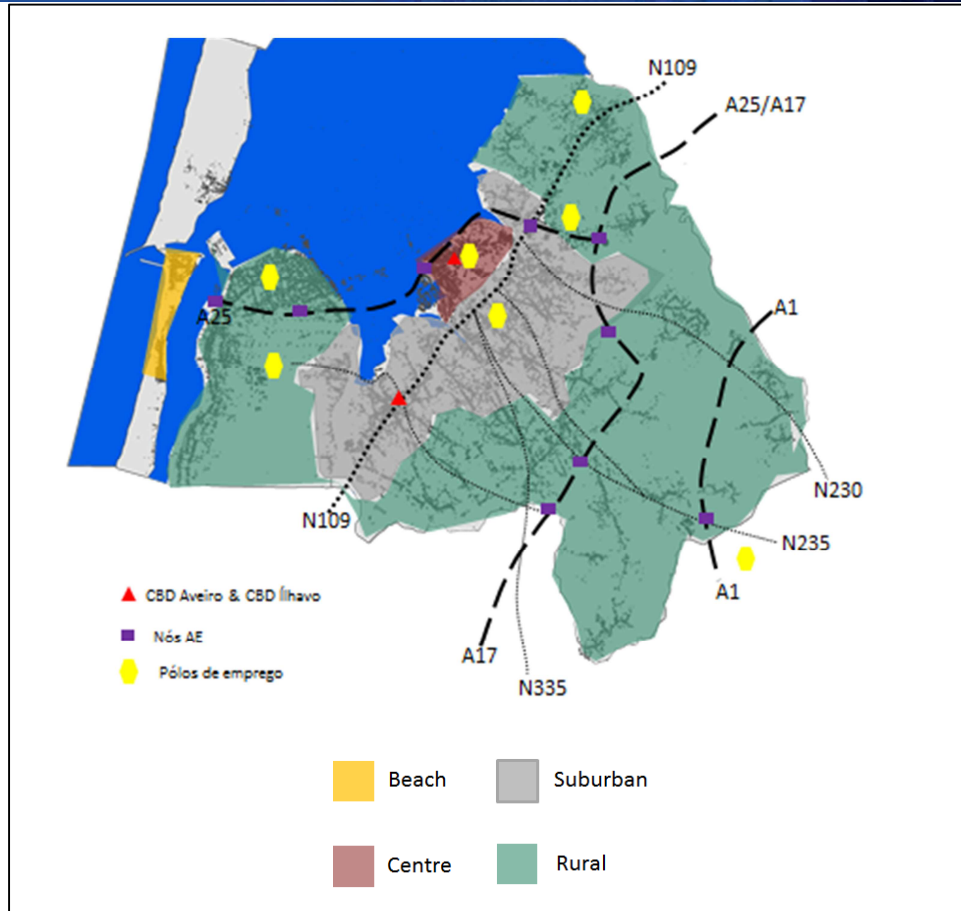


Figure 2 – Standard Study Area: representation of the 4 areas

3.3. DONUT prospect's scenario analysis

The scenarios chosen for this exercise result from the combination of three dimensions (which are explained below). It should, however, be pointed out that there is a set of consequences associated with the dimensions that structure the scenarios that will be defined by the expert group in exercise 1. This scenario exercise is divided into two stages: the first involves the description of the exogenous variables (availability of energy resources, socio-economic structure and macro-scale effects on the housing market), which define the major limitations; the second implies the materialization of the scenarios, focusing on macro scale (i.e. at the level of the four zones) specific themes (population distribution, housing quantity and characteristics; the dimension regarding the public intervention and the city assumes particular importance).

3.3.1. Description of the exogenous variables ⁷

Energy, natural environment and spatial planning dimension

This dimension is related to environmental pressures, in particular, the availability of energy resources and the ability to replace fossil energy, ensuring a smooth transition to the use of renewable energy. This dimension raises two main questions. First, the housing and outdoor urbanized areas' thermal efficiency and, secondly, the patterns of dispersion and concentration of built environment.

In a scenario dominated by strong environmental constraints, the need to minimize transportation costs and to optimize the balance between thermal comfort and energy consumption are key elements that necessarily overlap issues related to the aesthetics and to the fruition of space that urban sprawl allows. In this scenario technological developments tend to be directed to creating insulating materials and increasing the use of the built environment as an energy source. There will be also strong pressures related to urban design concerns, such as buildings exposure to sun, the *albedo* of built and unbuilt space and the use of vegetation as a regulator of air quality. Possible consequences of climate change will also be reflected on contracting the increasing trend of soil sealing and controlling overflow areas.

On the contrary, in a scenario with lower energy and environmental constraints, the concerns referred above can be balanced with aesthetic and functional targets.

Social and economic dimension

This dimension focuses on the socio-economic structure which affects housing demand and supply.

On one hand, the demographic component has obvious impacts on the housing market, to the extent that knowing the characteristics of the population, in particular the total population, distribution by age groups, average size and structure of families; it is possible to quantify housing needs. On the other hand, the macroeconomic environment affects economic growth and financial market developments.

Economic growth is a structural element for the definition of total income and therefore disposable income of households and their consumption patterns; disparities in income distribution lead to the segmentation of the housing market. In turn, the evolution of financial

⁷ The exogenous dimensions have already been presented in a previous paper: "Foresight methodologies: Application to the housing market", (Castro, Marques, & Borges, 2012).

markets determines real estate agents' behaviour and households' investment capacity, reinforcing the role of the financial system in determining credit conditions.

Based on the information described above is possible to transform the objective needs of families in effective demand.

Public intervention and the city

The third dimension focuses on the dominant political environment that induces distinct forms of land use development and planning. The public sectors' role as regulator of market mechanisms depends on the economic situation and the political and ideological context. These determine the influence of the State, regarding the financial strength and the corresponding means to meet social policies, as well as to regulate the market and enforce land-use policies.

The financial situation of the State determines the capacity to promote social housing, provide subsidies, set fiscal policies, intervene in the land market, and as a result influence the construction costs. So, either housing is considered a basic need and the State assumes a central role in supplying housing, or must be viewed under a logic dominated by the market, in which individuals act in accordance with their preferences and capabilities.

State intervention on market regulation is also reflected in the definition of more or less urban design stringent criteria. Regarding these aspects, we highlight measures that restrict the location and aesthetics of buildings and tax policies that influence the behaviour of owners and investors. In short, government intervention consists in applying, to a greater or less extent, urban management regulatory instruments, which determine the ability of society integrating individual preferences in a collective aesthetic and functional standard, as well as taxation and financing strategies that fall within social housing policies, promote urban renewal or combat desertification of city centres.

3.3.2. Scenario description

The scenarios presented below result from the combination of the dimensions described above. Two contrasting scenarios were chosen (see Table 3): 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.

Table 3 – Scenarios chosen for the exercise

	Scenario 1	Scenario 2
D1. Economy	-	+
D2. Energy	-	+
D3. State	-	+

The exogenous scenarios are structured in three parts: i) the global context, which describes what happens in the world, ii) the national context, which is associated with how Portugal responds and stands at the conditions and global constraints, and iii) the issues to be discussed, associated with the materialization of the scenarios by experts.

We present a brief description of each scenario.

The first scenario describes the city that survives in a context of economic stagnation and growing environmental problems. The dysfunctions of the financial system, evidenced by the crisis of the early twenty-first century, have not been solved, which resulted in low economic growth and reduced ability to convert technological progress into production efficiency. The interaction of economic stagnation with the deepening of social inequality contributes for a reduced purchasing power and to an increased social dualism. Adding to the dysfunctions of the financial system are the problems arising from the lack of energy resources, as a consequence of fossil fuel depletion and insufficient capacity of alternative resources to replace them. This results in increasing restrictions on mobility, that the use of telecommunication and computing only partially compensates it. The social instability and the need to rationalize the use of scarce resources favoured the emergence of a strong and interventionist State, imposing a strict energy efficiency policy (oriented to minimize intervention and mobility costs, as well as to the location and efficiency of the building).

The second scenario describes a utopian and futurism city. The opportunities for social mobility generated by the good economic performance, combined with the important role of the State in ensuring a fair distribution of income led to a middle class society with high purchasing power. Having managed a gradual transition to the use of renewable energy and overcome the global warming threats, society meets no mobility constraints that require buildings' spatial concentration. The environmental awareness, the historical heritage

appraisal and the increasing acceptance that public transport, supported by the intensive use of information technology, is the most efficient way to combine mobility, comfort and energy efficiency, are the basis for the acceptance of a strict urban discipline by a society that values personal freedom. In this scenario, rationalism drives spatial planning and people without giving up their freedom to act under a logic of collective interest.

3.4. DONUT-Prospect's expert panel

The scenarios are the starting point and present the materialization of exogenous variables, presented to address, as mentioned above, three dimensions: i) energy and environment, ii) economy and society, and iii) public intervention and the city (assuming that this last one will be implicitly defined by the scenarios and determined by experts).

The first exercise is organized in three stages:

- A. Geographical distribution of the population in 2030
- B. Configuration of the housing stock in 2030
- C. Configuration of the housing market in 2030

It is presented below a brief explanation of the objective in each stage, as well as the results of the consensus for each scenario in the first exercise of DONUT-Prospect.

A. Geographical distribution of the population in 2030 (4 standard areas: centre, rural, suburban and beach)

According to the scenarios previously described is presented the estimated population for the standard city in 2030. The population projections were calculated by the cohort survival method, based on the work developed in the research project "DEMOSPIN – Economically sustainable DEMOgraphy – ReverSing Decline in Peripheral RegIoNs" (for more detail see the report "Análise Demográfica e Económica das Regiões Periféricas Portuguesas", 2012). The methodology allows combining these projection techniques with macroeconomic models, having been, according to each scenario, set parameters such as GDP, employment and fertility rates. Thus, the demographic projection model, based on the inter census data and adjusting these parameters, determines populations with and without migrations (open and closed populations respectively) for each five-year period (2015, 2020, 2025, 2030).

This exercise is based on the assumption that the dominant trajectories of the population are inevitably associated to restrictions or incentives (economic, energy ...) implicit in the

scenarios leading to different demands (depending on the families' type and income) for residential spaces with specific locations and morphologies.

The demand for housing (population movements) can also be determined at two levels: a) internal migrations that occur between the areas inside the study area and b) external migrations resulting from the entry of people from other areas into the study area.

A.1 Internal migration distribution

A.1.1 Exercise description

From the closed population for each five-year period were estimated annually closed populations (from 2011 to 2030). These are the initial data for the distribution of the inter-areas migration which, in turn, results from the annual growth rates, defined by experts, which are applied to the annually closed populations.

A.1.2 Outputs

a) Scenario 1

It was considered for this scenario that the population with lower incomes tend to stay in areas where they already inhabit (immobility) or move to affordable areas served by equipment, transport, employment and housing. A detailed analysis by area showed that although there is room for new construction in rural, there will be no growth.

The rural is not seen as an attractive area due to the distance to the employment hubs and is less likely to improve infrastructure and equipment, when compared with other areas (economic constraints). However, it is not expected a population decrease because despite the mobility costs associated to the scenario, there is a set of people who already live in this area who may seek supplementary income in agriculture. The beach, in turn, is strongly affected by energy and environmental pressures. As it is far from employment centres this area sees a decrease of population with lower income. In the other hand, there is a minority of population that has high purchasing power and therefore can support mobility costs and simultaneously enjoy the amenities of the beach surroundings. The centre, despite being served by public transport and employment, tends to maintain its population. The suburban grows as a result of the decrease observed in the other zones and its enhancement as a "centrality" as a consequence of the re-industrialization that occurs in this zone.

This contributes for a significant decrease (21.5%) of the population in the beach area and a slight increase (2%) in the suburban.

b) Scenario 2

This is a scenario of high mobility, so there are many movements that balance the population in each area. But territories with specific qualities and characteristics (such as the rural, centre and beach) are more attractive for young people and for people with medium and high income. In this context, it is noteworthy the importance of the public policy: although there is room in the rural to attract investment, there is a spatial planning policy that prevents the rural from becoming suburban (erasing its base characteristics). The centre, as a consequence of the urban life and the beach because of its local amenities, are the areas with more population increases (about 35% and 13% respectively).

This contributes for a decrease of 13% of the population in the rural and a slight increase (2%) in the suburban's population.

A.2 External migration distribution

A.2.1 Exercise description

From the migration balance (2011-2030), which results from the projections, calculated by the cohort survival method for the overall study area, it is intended to obtain the geographical migrants distribution in 2030 in each of the four areas

A.2.2 Outputs

a) Scenario 1

The centre and the suburban are the most attractive in this scenario, as a consequence of the traditional tendency of living in the centre, on one hand, and secondly, by employment and housing supply.

Thus, 40% of the immigrants are located in the centre and 50% in the suburban.

The dream of having a single family house justifies the allocation of 10% of immigrants in the rural, mostly for higher socio-economic groups.

b) Scenario 2

Migrations were considered null.

A.3 Geographical distribution of the population by socio-economic group

A.3.1 Exercise description

Three socio-economic groups were established based on the distribution of population by qualification and profession, being implicit a high, medium or low income level, which corresponded to three percentiles (5°, 40°, 100°). Thus, individuals with higher levels of income are associated to lower percentiles, the 5th percentile represents the 5% richest and the

100th percentile corresponds to the 60% with the lowest income level. The distribution in 2011 was used as a reference for the new distribution in 2030.

A.3.2 Outputs

a) Scenario 1

This scenario evidences an increase of the population with high incomes in the beach by contrast with its decrease in the suburban. The centre concentrates two types of people: those who come to work in the industry (with low income) and live in the most degraded areas and those with higher purchasing power and live in more qualified areas. Therefore, both socioeconomic groups coexist, with greater residential segregation.

Thus, the population with high income level tend to increase significantly in the beach (from 7% to 20%) and slightly in the centre (from 8% to 9%). The population with lower income increases in the rural and centre (2 and 4 percentage points respectively). The population with average income increases 1% in the suburban and decreases in other areas (with significant values in the beach, 8%).

b) Scenario 2

The differences are less obvious in this scenario.

The population with high incomes tends to increase significantly in the beach (from 7% to 14%) and slightly in the centre (from 8% to 10%). There is a general increase of the population with average incomes in the four areas. Simultaneously, the population with the lowest income increases in the suburban (about 5 percentage points) and slightly decreases in the other areas (e.g. 1% and 3% in rural areas).

A.4 Number of persons per dwelling

A.4.1 Exercise description

In the exercises A.1 and A.2 was defined the population (pop. closed + external migrations) for 2030. This exercise is intended to set the number of inhabitants per dwelling in each of the four areas. The values of 2011 are the reference values for the values defined for 2030; the maintenance of these values is acceptable if the structure of families in 2011 remain the same in 2030 for the scenario under discussion.

Thus, it is obtained the total number of families. Assuming that each family corresponds to a dwelling occupied by usual residence, it is obtained the total number of dwellings for usual residence $\left(\frac{\text{Population 2030}}{\text{Persons per dwelling 2030}}\right)$ – value considered in the next step.

A.4.2 Outputs

a) Scenario 1

This scenario results into a lower demographic growth and a general trend towards larger households, as a consequence of the economic and political instability that generates great tension in relation to security systems and social support. The less access to pensions and social benefits and restricted access to old-aged homes and kindergartens lead to a greatest need for parents, children and grandchildren to live together. However, people from higher socio-economic groups have access to better condition. It is in the rural and suburban areas that are concentrated people with lower income levels and simultaneously where there are a greater number of inhabitants per dwelling.

b) Scenario 2

In this scenario there is a trend towards smaller households, a fact which is explained by the slight increase in the birth rate, the autonomy of young people and the existence of an aging population with financial stability.

B. Configuration of the housing stock in 2030 (4 standard areas: centre, rural, suburban and beach)

B.1 Second home dwellings

B.1.1 Exercise description

After knowing the total number of dwellings occupied by usual residence planned for 2030 (defined in exercise A.4), this exercise aims at setting the amount of second-home dwellings in 2030. For this purpose it is presented, as support values, the percentage of second-home dwellings in 2011.

B.1.2 Outputs

a) Scenario 1

For the scenario under discussion, in absolute numbers, there is a general decrease, though very slight, in the second-home dwellings: it is difficult to stimulate the owner market due to financial constraints of most families, contributing to the maintenance (or minor changes) of the current values.

b) Scenario 2

There is, in this scenario, a slight increase in second-home dwellings as a result of the residential mobility that is a characteristic of this scenario. The increase in the number of

second-home dwellings (also for seasonal use) is not so evident in those areas where migrations are not as favourable as in the rural (where the slight increase verified is due to the departure of the population of this area). The low attractiveness of the suburban area justifies a less expressive demand and therefore a slight decrease of second-home dwellings.

B.2 Housing construction dynamic

B.2.1 Exercise description

The present housing framework (total number of dwellings) is the baseline for the model developed, which is adjusted according to the annual rates of i) construction and ii) abandonment⁸ for each scenario.

In sum, it is expected that the experts define the structure of the housing stock in 2030, by adjusting annual rates of construction and abandonment, for the four standard areas and conditional to each scenario. Thus, it is obtained the housing geographical structure based on two main categories - new dwellings (are the sum of the dwellings with less than one year with the dwellings with 1-2 years) and used dwellings (are the sum of the dwellings with more than 2 years and less than 20 years with the dwellings with more than 20 years) in these three subcategories: occupied, vacant (correspond to the difference between the total dwellings and the number of occupied dwellings) and ruined.

B.2.2 Outputs

According to expert's opinion some considerations should be taken into account.

The average lifetime of a building is approximately 60/70 years if there is no maintenance; if there is any renewal intervention it may be considered an average lifetime of 120 years. Experts believe that in a situation where the dwellings are being recovered, as normal, the abandonment rates (in a city scale) would be expected around 0.8% / 0.9%. However, construction rates should be balanced with the demographic dynamics; such growth rates will be reflected in the total of vacant dwellings. Thus, to maintain a stable amount of vacant dwellings, the net construction rate should be equivalent to the population growth, and the assigned values should be controlled by the amount of vacant dwellings.

a) Scenario 1

In the past, the housing stock grew approximately 2% per year. Therefore, in this scenario, it is reasonable to think that this balance will significantly decrease (to less than

⁸ The abandonment rate considered in this exercise occurs at two levels: i) dwellings that degrades and diminish the housing stock and ii) dwellings that are demolished to build new dwellings.

half); in this case it is considered a 0.7% growth. Considering an abandonment rate around 0.8%, then the construction rate is about 1.5%.

The economic crisis justifies slight growth rates. The difficulty in investing in the building recovery leads to the existence of a relatively depreciated housing stock, which is expressed in the abandonment rates.

b) Scenario 2

Although there is not a significant increase of the population in this scenario (as it was assumed null migrations and a natural balance positive however low) the number of inhabitants per dwelling decreases (because there is greater financial stability and autonomy for young people). The existence of an active policy drives the rationality of land-use planning and encourages an efficient use of the existing housing stock. Thus, for the whole city is considered an annual growth of 0.8%. The construction increase is explained by the i) increase of new construction to address the need for first residence dwellings; ii) increase in building renewal; and iii) cyclical depreciation of buildings.

B.3 Quantity of dwellings by type (flats / single family houses)

B.3.1 Exercise description

The data available (from the Census) allows the identification of the composition of the housing stock (number of flats and single family houses) in 2011. After the annual rates, previously defined, it is possible to update this information for the year 2030: experts will define the amount of flats and single family houses in 2030. Consequently, by the sum of these new dwellings with the existing ones in 2011 it is obtained the housing stock by type in 2030.

A.3.1 Outputs

The results are being validated.

C. Configuration of the housing market in 2030 (4 standard areas: centre, rural, suburban and beach)

C.1 Percentage of renting in 2030 of the total dwellings that are part of the housing stock

C.1.1 Exercise description

The reference values initially shown correspond to the relative percentage of rented dwellings in the total dwellings that are part of the housing stock in 2011. The acceptance of these values means that it is accepted that the structure of the rental market in 2011 remains

the same in 2030 for the scenarios under discussion. So, with this exercise it is obtained the amount of rented dwellings in the standard study area in 2030.

C.1.2 Outputs

a) Scenario 1

The rental values rise in all areas as a result of the general low purchasing power and access to credit. There is, however, a minority of the population that has access to the best that technology can provide and invests in the housing market (the house is seen as an investment or income source).

b) Scenario 2

There is greater residential mobility in this scenario, but the increased weight of rental dwellings is associated with the demand for qualified spaces. In this context, the reinforcement of the urban centre (which contributes for a more attractive urban living) contributes to the increase of 7% of rental dwellings. Simultaneously, the suburban area appears as a (cheaper) alternative because of its proximity to the centre, employment, equipment, and services.

On the other hand, there is part of the population who sees the house as their second skin (by the outer and / or inner characteristics) and, therefore, pursues for areas with specific characteristics and qualities (as in the rural and the beach); this accounts for the decrease of the rental dwellings in these areas.

C.2 Quantity of dwellings in the housing market in 2030

C.2.1 Exercise description

The quantity of dwellings that correspond to new dwellings (equivalent to dwellings with less than 1 to 2 years) and used dwellings (equivalent to dwellings with more than 2 years) was previously defined. Consequently, this exercise aims to foresee the amount of new and used dwellings that are vacant. It is also expected to determine the amount of these dwellings that are vacant in the housing market (for sale or renting). It will also be considered a small percentage of occupied dwellings that are on the market (corresponding essentially to households who intend to move from their current dwellings, but have not yet moved out from their current residence).

C.2.2 Outputs

a) Scenario 1

In this scenario, the rental market emerges as the best alternative according to the needs and economic vulnerability, which, in turn, justifies a considerable percentage of new vacant

dwelling. This amount of new dwellings in the market reflects the fragility of the owner housing market, which only few households can afford. Given the limitations inherent in this scenario it is considered that there is a set of buyers who choose not to have their property in the housing market, waiting for better sale conditions. Additionally, there is a small percentage of 'turnovers' (people who are moving from their current residence but haven't completed the process) since there is low residential mobility.

b) Scenario 2

It should be noted that the scenario under discussion does not represent a homogenous cycle over the 20 years, and so should be considered two phases: a 1st cycle of 10 years more controlled where everything is resolved; 2nd cycle that benefits from the measures previously implemented. Therefore, the amount of vacant dwellings in 2030 is associated with the transition of these cycles. Eventually there will be a recovery of the investment which leads to an increased demand for new dwellings. There are also, as a result of the high purchasing power, a greater number of dwellings resulting from self-building processes that should not be included in the percentage of vacant dwellings. Finally, as a result of the increased residential mobility, it is considered that there is a set of occupied dwellings that are available on the market.

3.5. Output summary

The results for each scenario can be systematized according to the following table.

Table 4 – Resumo do exercício DONUT-Prospect

	Scenario 1	Scenario 2
Public policy (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.
Type of settlement (concentration / dispersion)	Concentration	Decentralization: articulation and organized fragmentation of the urban fabric.
Household type (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.
Tenure type (rental/owner)	Rental market: explained by the low purchasing power and access to credit.	Rental market: greater residential mobility and innovative rental options.



	Owner market: minority of population that has high income levels and can afford it.	Owner market: for who sees the house as their second skin (by the outer and / or inner characteristics)
Public space (more/ less qualification)	Reduced interventions	Public space qualification

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