



**BANK OF GREECE**  
EUROSYSTEM

## **Compilation methodology of real estate price indices**

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Choosing an appropriate methodology to compile a Real Estate Price Index (REPI) depends on a number of factors, most notably the intended purpose and the expected use of the index, the peculiarities and characteristics of the real estate market, as well as the available statistical information. For instance, for the purpose of monetary stability analysis, the focus is on reliable monitoring of the evolution of real estate prices over time; as a result, changes in quality characteristics should be taken into account. By contrast, portfolio management analysis, it is more important to accurately calculate the value of a representative property within a portfolio. Moreover, due to the low frequency of residential property resales and the difficulty to identify these properties over time, it is impossible to calculate an REPI based on the methodology of repeat sales, which is used in other countries, most notably in the USA.

Individual REPIs are assessed mostly on the basis of their regularity and timeliness (i.e. frequency of publication and updating), how the sample composition characteristics are utilised, as well as the stratification criteria applied to accurately reflect small regional real estate markets. Other issues include coverage by type of real

estate and geographical coverage (coverage completeness), reliability of approximation of the real transaction value (i.e. the actual price of the transaction), as well as whether or not data are adjusted to allow for seasonal variations and reflect market trends more accurately.

Until the “hedonic approach” becomes applicable to Greek data,<sup>1</sup> the Real Estate Market Analysis Section of the Bank of Greece currently uses a variation of the “mix adjustment” approach in order to directly estimate house price indices. To standardise properties and define segments of markets comprising property groups with – as far as possible – similar characteristics, the multiple stratification technique is used. Specifically, houses are classified into small homogenous groups by location, age and size; the average price (per square metre) is calculated for each group using the geometric mean. Finally, these prices are aggregated, after being weighted on the basis of the total transaction value of each group.

Below follows a detailed description of the methodology in use.

### **Present methodology**

- Mix adjustment through multiple stratification.

### **Raw data**

- Detailed data on the value and quality characteristics of residential properties underlying loan agreements (based on appraisal reports by banks’ engineers).
- Total credit institutions and total estimates.

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<sup>1</sup> Based on international experience, the most widespread and reliable method to estimate REPIs seems to be the “hedonic models”. A successful application of this method calls for a gradual approach, which includes estimating alternative models that take into account the peculiarities and special characteristics of each real estate market, assessing the adjustability of these models to the data concerned, resolving any econometric issues which arise during the process (model specification, explanatory variables interdependence etc.), as well as the sensitivity check of results to alternative analysis solutions (weights, aggregate of individual indices etc.). A gradual approach of this type is already being implemented by the Real Estate Analysis Section of the Bank of Greece.

## Stratification

Stratification criteria used to identify small homogenous regional markets.

### 1. Geographical region (50 groups):

Grouping the country's regions into composite regions. This grouping was based on the postal code of each residential property. Around 1,250 different postal codes were matched with some 800 regions, which were then classified into 50 groups.<sup>2</sup> Through this process, particular emphasis was placed on the degree of urbanity of each region, while the following criteria were also taken into account:

- Geographic proximity
- Comparable price level
- Similar price development
- Adequate number of comments

### 2. Property age (2 groups):

- New (0-5 years)
- Old (over 5 years)

### 3. Property size (3 groups):

- 15-70 square metres
- 70-110 square metres
- Over 110 square metres

### 4. Floor:

Given the constant floor-to-floor average change in prices (per square meter) over time, all estimates of apartment values were converted into first-floor apartment equivalents.

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<sup>2</sup> The Athens regions were classified in around 20 homogenous groups. Other regions of the Attica Prefecture ("other Attica") were classified in three groups. The city of Thessaloniki was also divided into three groups. Lastly, capital cities of prefectures and other regions of the country (excluding Attica) and, accordingly, "other urban, semi-urban and agricultural areas" were classified in 12 groups.

Thus, the apartment floor was accounted for as a criterion to standardise properties without, however, creating separate sub-groups.

### **Standard data checks**

Raw data collection from banks includes certain automated procedures to control data completeness and accuracy. When new data are reported, the computer application used by the Bank of Greece generates a test results report, which is returned to the originating bank. These tests include a series of automated procedures for checking the internal consistency and completeness of data. In particular, the "logical rules" governing these procedures mostly are as follows:

- ❑ All compulsory fields must be filled in (see table in Section 7, "Detailed specifications for the residential property data reporting system"  
<http://www.bankofgreece.gr/Pages/el/Statistics/datasubmission/homes.aspx>).
- ❑ The variables used or the data reported must be in line with the specifications defined in the Annex to Bank of Greece Governor's Act 2610/2008 (depending on the field: integer or non-negative or simple numerical values, date, wording etc.). For instance, the postal code must be an integer positive five-digit number.
- ❑ There are standard values of variables. This test examines data consistency per variable, based on formally predetermined values, so as to identify and correct any mistakes. For instance, the postal code number is acceptable when the numerical value is an integer between 10431 and 85900.
- ❑ Consistency of responses across variables.

### **Effective data checks and outliers**

In addition to the above computer-generated controls upon receipt of reported data, before these data are processed to construct REPIs, a more thorough test of their plausibility is conducted, using logical and statistical rules. Values outside a plausible

range for each variable are excluded,<sup>3</sup> while values close to the limits are treated as “outliers”; finally, values with more than 2.5 standard deviations from the average value of each substrate are also excluded. These checks precede all other statistical procedures to estimate real estate volume and value indices.

## Imputation

Regarding estimates for the 2006-2008 period, where certain compulsory fields had not been filled in, efforts were made to complete them reliably by using other available data for each property. For instance, unfilled postal code fields were completed by developing an application which uses available address, municipality, region and prefecture data for the specific property. However, where the necessary additional information was not enough to give reliable data, the relevant entry was excluded from the analysis.

## Mathematical formula and weights

After concretising individual strata, the first step is to estimate analytical indices for each stratum. For a group of homogenous properties in each stratum, the price index equals the ratio of average prices per square meter. The average price per square meter for the property group of stratum  $i$  ( $i=1, \dots, n$ ) for each quarter  $t$  is calculated using the geometric mean. In fact, this refers to the calculation of Jevons-type indices, while on the basis of different strata other sub-indices can be calculated through an appropriate aggregation of strata.<sup>4</sup> Thus, the real estate price index for quarter  $t$ , as against the basis quarter  $0$  (if  $I_{0,t}$ ), is given by the formula:

$$I_{0,t} = \frac{\sum_{i=1}^n w_i \frac{p_t^i}{p_0^i}}{\sum_{i=1}^n w_i}$$

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<sup>3</sup> Naturally, the range of acceptable values differs by type of property (apartment, single-family house, building plot etc.). For instance, in the case of apartments, values totalling below €1,000 or over €20,000,000, values of total floor area below 15 square meters or over 400 square meters and values per square meter below €100 or over €15,000 were excluded.

<sup>4</sup> This method is preferred by international literature and Eurostat (Technical manual on owner-occupied housing for Harmonised Index of Consumer Prices, June 2008).

The weights ( $w_i$ ) used are the ratios of the transaction values of each property group of the stratum  $i$  to total transactions in the period from the first quarter of 2006 to the third quarter of 2009. Thus, it is easier to approximate the total value of the stock of available real estate, and this is more suitable for the purposes of financial stability analysis, which needs a clear picture of the total value of properties underlying loan agreements. The base year is 2007, as it is thought to represent typical conditions, without peculiarities that could affect the indices produced.

### **The advantages of the Bank of Greece Real Estate Price Index**

Based on the above information, residential property price indices constructed by the Bank of Greece present certain interesting advantages:

- Standardised, fast and secure qualitative and quantitative data reporting system for real estate appraisals (within 20 days after the end of the reference month)
- Census of all appraisals by all credit institutions operating in Greece
- Implementation of a modern methodology with mix adjustment through multiple stratification
- Construction of indices on a quarterly basis with a minimum lag (t+1 month)
- Timely and reliable recording of short-term developments, accurate and regular reflection of market trends
- Cross-country coverage with meaningful breakdowns (Athens, Thessaloniki, urban areas etc.) and distinction between new and older properties, apartments, single-family houses etc.
- Lastly, an official and reliable compiler.