Chapter 3: Calculation procedures applied

The primary index is defined as the ratio of the current value of a reference housing stock to its base-period value. The method described in detail in this chapter is the same for all indices, with two reservations:

- the variables representing the quality of a property (characteristics) are not strictly the same for apartments and houses, or for the Paris Region and the Provinces;
- the procedure for stratifying the geographic area varies according to whether the observation concerns the Paris Region or the Provinces.

As we move from version 2 to version 3, the method used to calculate the indices has been changed. So that changes in the market can be better taken into account, the estimation stocks and reference stocks (cf. definitions below) will be updated more frequently (every two years). As a result, from now on the indices will be chain-linked. Three equations are used for chain-linking: the first concerns the primary indices and the other two the aggregated indices.

3.1 Reference stocks and estimation stocks

Definition 1: the housing stock and the reference period

The reference stock consists of the "basket of properties" or "portfolio" in which we will measure price variations. In this way we can be sure that the index effectively tracks price changes for the same dwellings and that it is not sensitive to variations in market structure.

We must therefore value the dwellings in the reference stock at the current date, despite the fact that they have not been sold, i.e. that we have been unable to observe their prices. To do this, we use an econometric model that links the price of a dwelling[19] to its physical characteristics and its location.

The *reference stock* consists of all the transactions in the period – called the *reference period* -, that are included within the scope of the index, except those situated at the extremes of the value distribution.[20]

In version 3 of the indices, the reference period consists of years *n-3* and *n-2* for the indices for years *n* and *n+1* (where *n* is an even number), since the stock has been updated every two years from 2008 (see below 3.5.1).

Definition 2: the housing stock and the estimation period

The estimation stock includes the transactions that are to be used to estimate the models. It consists of all transactions from the estimation period that fall within the scope of the index, except those for which the estimated value in the model diverges from the real value by more than two standard deviations. The reference stock and the estimation are divided into primary calculation areas or strata. There are 22 such areas in the Paris region and 271 in the Provinces (Table 3.2). [21]

In the Provinces, some strata consist of only one city, when there is a large enough real estate market to warrant this (in practice, over 110 transactions per quarter). In most strata, the models can bring out homogeneous price areas, using indicators. The other strata in the Provinces are defined by the set of towns obtained by combining the "region", "*département*", "urban unit" criteria, or other distinguishing geographic features (rural area, coastal resorts or Alpine region), or according to the average income per inhabitant (2006) for other municipalities.

The Paris region strata are defined according to geographic and price criteria.[22]

[19] Or more precisely the logarithm of the price.
[20] This is the price per square metre in the case of apartments and the total price for houses. We take off 1/20th at each end of the distribution.
[21] For the composition of the strata, see Appendix 2.
[22] For details of the calculation areas, see Appendix 2.

3.2 Model used for estimation

An econometric model is estimated for each area (stratum), hence for a market assumed to be homogeneous, based on estimation-stock transactions.

The model is written:[23]

$$\log p_i = \log p_0 + \sum_{a=1}^{2} \mu_a Y_{a,i} + \sum_{m=1}^{12} \theta_m M_{m,i} + \sum_{k=1}^{K} \beta_k X_{k,i} + \varepsilon_i \qquad (3.1)$$

with the following notation:

p_i : price per m^2 (for apartments) or total price (for houses) of property *i*

p_0 : price of the reference dwelling of the estimation stock

$Y_{a,i}$: dummy for year of sale of property *i*

$M_{m,i}$: dummy for month in which sale of property *I* occurred

$X_{k,i}$: physical characteristics of property *i*, indexed from *k=1* to *K*

$X_{k,i}$ are variables calculated from modalities of the initial available characteristics, Z_i , i.e. construction date, number of rooms, number of bathrooms, number of garages or parking spaces, condition of property; and in addition, for apartments only, which floor, whether there is a balcony, a cellar, a lift, the average floor space per room; and for houses only, whether there is a basement, the number of floors, size of plot and habitable space, etc.[24]

When necessary, the location of the dwelling within the stratum (neighbourhood), is regarded as a characteristic of the property, on a par with the number of rooms or floor space.

The $X_{k,i}$ variables may include cross-effects. They may be dummy variables, or continuous variables in the case of surface areas. Each of these characteristics has a price, assessed at the base period, relative to the characteristics of a reference property.

Definition 3: reference dwelling of estimation stock

The *reference dwelling* is the dwelling that has the characteristics used as references in the regressions (Table 3.1).

The non-observable or unobserved characteristics of dwellings are assumed to be uncorrelated with those observed quality characteristics. We assume separate markets for houses and apartments: for example, we assume that the value of an extra room may not be the same in an apartment and in a house. But in an apartment it is worth the same, irrespective of the floor it is located on. In the strata, the relative prices of dwelling characteristics are fixed. In other words, if a third-floor apartment is worth x% more than one on the ground floor, this ratio is the same for all apartments in the calculation stratum. On the other hand, the ratio may differ from one stratum to another.

[23] To simplify notations, we omit the stratum index *s*.

[24] These variables are not all present in both bases nor are they always used in the models. For details of the models used, see Chapters 3 and 4.

Table 3.1 - Characteristics of reference dwelling (estimation stock)[25]

Index	Reference dwelling in Paris Region	Reference dwelling in Provinces
Apartments	- 3 rooms, - ground floor, - average floor space per room for studios between 20 and 30 sq.m., for two rooms between 17 and 24 sq.m., for three rooms between 18 and 22 sq.m. and for four rooms and more between 17 and 21 sq.m., - no garage, - no cellar, - 1 bathroom, - Built between 1948 and 1969, - sold in the 12th month of the second year of the reference period,	
		- no terrace or balcony**, - in good condition**.
Houses	- 4 rooms, - 2 floors, - construction period not known, - 1 garage, - 1 bathroom, - 100 sq.m. living space and 610 sq.m. plot size, - sold in the 12th month of the second year of the reference period,	
	- 1 building*, - no cellar*.	- no basement**, - condition of property unknown**,

* Variable not present in database for Provinces
** Variable not present in database for Paris Region

Usually, the model introduces a dummy neighbourhood variable into the stratum. When this is the case, the reference dwelling then belongs to the neighbourhood omitted from the regression. The neighbourhood is introduced when the stratum concerns a agglomeration or a city, and when the volumes of transactions are sufficient (at least 110 transactions per year). Neighbourhoods do not necessarily correspond to administrative divisions.

Table 3.2 shows the number of strata in version 3: 22 in the Paris region, compared with 62 in version 2, 271 in the Provinces compared with 234 in version 2. The number of neighbourhoods considered has been reduced in the Paris region (from 230 to 102) and increased in the Provinces (from 1125 to 1509).

Table 3.2 – Number of primary strata in calculation and number of neighbourhoods

Index	Number of strata	Number of neighbourhoods
Paris Region	*22*	*102*
Apartments	15	66
Houses	7	36
Provinces	*271*	*1,509*
Apartments	97	516
Houses	174	993
Total	**293**	**1,611**

3.3 Current price of reference property

The same type of model can be used for the current period. The reference property has the characteristics described in the previous paragraph, but corresponds to the current sale period *t*. Its price is noted $p_{0,t}$. The change in the reference property price forms the basis for constructing the index. For this reason, it has to incorporate seasonal effects, trends and cycles. This is why seasonal and annual coefficients no longer appear in the current model.

The price per sq.m. of a property *j* sold during period *t* can be expressed using the model:

$$\log(p_{j,t}) = \log(p_{0,t}) + \sum_{k=1}^{K} \beta_{k,t} X_{k,j,t} + \varepsilon_{j,t}$$

[25] Variables are described in Chapter 4.

Note that the model (3.1) used in the estimation phase is compatible with the model above, used for current values. Year and month dummies need to be introduced because the estimation stock covers a period spanning several months. Similarly, the reference price for the estimation stock and the month *(a,m)* would be:

$$\log\left(p_{0,a,m}\right) = \log p_0 + \mu_a + \theta_m$$

We must now explain how to reconstruct the price of the reference property from current transaction data.

Let us first hypothesise that the $\beta_{k,t}$ coefficients are known and let us introduce $\tilde{p}_{j,t}$ the "reference-property equivalent price" of the property j,t :

$$\log\left(\tilde{p}_{j,t}\right) = \log\left(p_{j,t}\right) - \sum_{k=1}^{K} \beta_{k,t} X_{k,j,t}$$

The model can be rewritten:

$$\log\left(\tilde{p}_{j,t}\right) = \log\left(p_{0,t}\right) + \varepsilon_{j,t}$$

Thus, if we know the $\beta_{k,t}$ coefficients, the log of the reference-property price $\log\left(\mathrm{p}_{0,\mathrm{t}}\right)$ will be estimated using ordinary least squares, i.e. from the mean:

$$\log\left(\hat{p}_{0,t}\right) = \frac{1}{J_t} \sum_{j=1}^{J_t} \log\left(\tilde{p}_{j,t}\right)$$

where J_t is the number of transactions in period *t*.

If we assume that the model estimated for the reference period is stable over time (for the period when the index is calculated, which is now two years), we can replace the $\beta_{k,t}$ coefficients by the $\hat{\beta}_k$ values estimated for the reference period when calculating the reference-property equivalent prices:

$$\log\left(\tilde{p}_{j,t}\right) \cong \log\left(p_{j,t}\right) - \sum_{k=1}^{K} \hat{\beta}_k X_{k,j,t} = \log\left[\frac{p_{j,t}}{\exp\left(\sum_{k=1}^{K} \hat{\beta}_k X_{k,j,t}\right)}\right]$$

We then estimate $p_{0,t}$,the price per m^2 of the reference property in period *t*, using a geometric mean of the reference-property equivalent prices of the J_t properties sold in the course of period *t*:

$$\log \hat{p}_{0,t} = \frac{1}{J_t} \sum_{j=1}^{J_t} \log \tilde{p}_{j,t} = \frac{1}{J_t} \log\left(\prod_{j=1}^{J_t} \tilde{p}_{j,t}\right)$$

i.e.:

$$\hat{p}_{0,t} = \left(\prod_{j=1}^{J_t} \tilde{p}_{j,t}\right)^{\frac{1}{J_t}}$$

In the following, we shall write $\hat{\alpha}_{0,t} = \log \hat{p}_{0,t}$.

3.4 Current value of reference stock

Having determined an approximate reference-property value (from estimating the reference-property equivalent price in period *t*), we can then reconstruct the approximate values of the properties in the reference stock and, by aggregation, the value of the stock itself. Calculations are performed stratum by stratum. For this reason we reintroduce the stratum index *s*.

We estimate the value of a property *i* in the reference stock of stratum *s* in the current period *t* from its characteristics $X_{k,i,s}$, which, it will be recalled, are independent of date *t*, by virtue of the very definition of the reference stock, of which the composition is stable over time.[26]

In the case of apartments, for example, the approximate value is:

$$\hat{p}_{i,s,t} = \exp\left(\hat{\alpha}_{0,s,t} + \sum_{k=1}^{K} \hat{\beta}_{k,s} X_{k,i,s}\right) A_{i,s}$$

where $A_{i,s}$ denotes the surface area of property *i,s*.

By summation of the estimated current value of the N_s properties of the reference stock of stratum *s,* we obtain the value of the reference stock on date *t*:

$$\hat{W}_{s,t} = \sum_{i=1}^{N_s} \hat{p}_{i,s,t} = \sum_{i=1}^{N_s} \exp\left(\hat{\alpha}_{0,s,t} + \sum_{h=1}^{K} \hat{\beta}_{k,s} . X_{k,i,s}\right) A_{i,s}$$

In the same way, we estimate the value of the reference stock in stratum *s*, in period *0*, called the index *base period*:

$$\hat{W}_{s,0} = \sum_{i=1}^{N_s} \exp\left(\hat{\alpha}_{0,s,0} + \sum_{k=1}^{K} \hat{\beta}_{k,s} X_{k,i,s}\right) A_{i,s}$$

3.5 Calculation method

Three major changes have been introduced in relation to the previous version of the indices.

- The reference and estimation stocks are now updated every two years; the price vectors relating to the characteristics of the reference stocks, and hence their value at the base period, are also re-estimated every two years. The Scientific Board for the Notaries-INSEE indices[27] adopted this measure after observing that, over the planned new reference period (2002-2006), the hedonic models were not stable.[28] Since the coefficients and weightings are to be regularly updated, a chain-linked method was introduced. Specification of the models and definition of the strata should continue to be reviewed approximately every six years.

- The introduction of dummies into the equation (3.1) to represent months means that it is now possible to calculate monthly indices. These are calculated by PNS and Min.not but only PNS publishes them.

- In version 2, we used arithmetic means to aggregate the primary indices. In version 3, we use geometric means for infra-departmental and departmental levels. This method of calculation is used when constructing statistical indices if it is thought that there may be some switching between different goods of a similar nature. In our case, there may be the choice of buying properties in neighbouring geographic strata. We use arithmetic means for levels that are more aggregated than the departmental levels since there is less likelihood that a purchaser will switch between more distant geographic strata (region, province, whole of France) when moving house.

[26] Thus the quality of the dwellings does not vary.
[27] The composition of the Scientific Board for the Notaries-INSEE indices, responsible for supervising the indices, is described in agreements reached with the Notariat. Cf. Appendices 8 and 9.
[28] See Appendix 4, Stability test and duration of the reference period.

3.5.1 Renewal of reference stocks and estimation stocks every two years

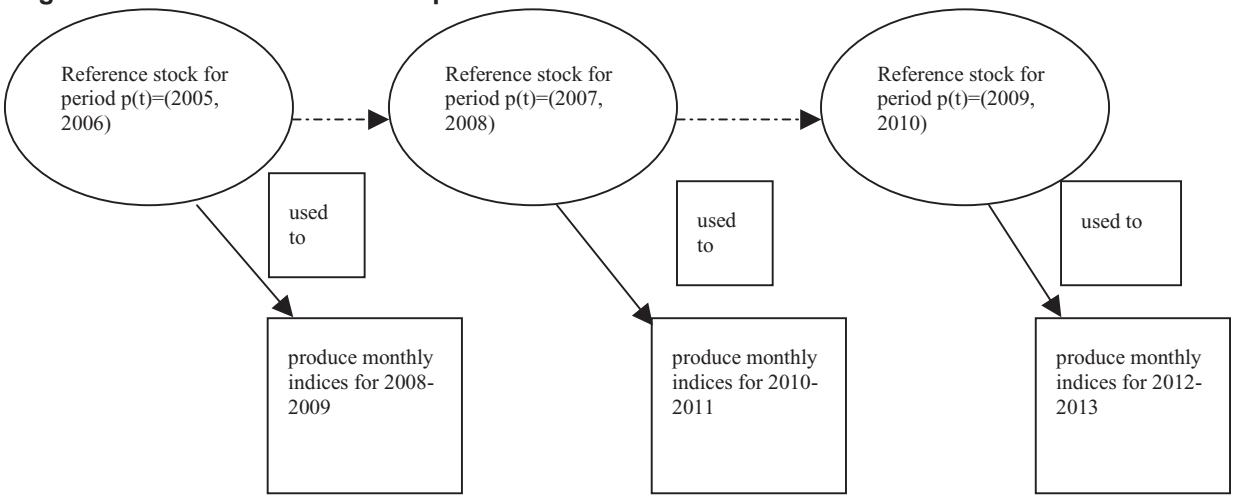
Reference stocks

In version 1 of the indices, the reference stock included transactions for between three and five years, depending on the indices (1994-96 for apartments in the Provinces, 1994-97 for houses and 1992-96 for apartments in Paris and the inner suburbs). In version 2, the reference stock included transactions from the four years 1998-2001.

In version 3, the reference stocks are updated every two years. The reference period *p(t)* is also set at two years of transactions, which is therefore shorter than before. It is defined in relation to the beginning of the current period, producing the indices in the following way: for current production of the index over the two years *(n, n+1)* where *n* is an even year, *p(t)* begins two years before, i.e. *p(t) = (n-3, n-2).*[29]

Figure 3.1 shows the succession of different reference stocks used to calculate monthly indices published from 2008-2013.

Figure 3.1 – reference stocks for period 2008-2013



Base period and publication base

The reference stocks are valued in the last quarter *q(t)* of the reference period, i.e. in the fourth quarter of the even year *n-2* for indices published over the period *(n, n+1).*[30] The weightings used to aggregate the primary indices are calculated on the basis of this housing stock valuation.

The quarter used to value the reference stock is called the *base period* for indices over the period *(n, n+1).* This should not be confused with the *base 100* of the published series, which was fixed in the first quarter of 2010.

Notations

The formula for calculating the value of the reference stock has to be generalised to take into account the renewal of the reference stock every two years by introducing a supplementary subscript, - written *p(t)*, the reference stock used -: the estimated value of the stock then becomes $\widehat{W}_{s,t}^{p(t)}$. In the same way, we introduce the value of the reference stock at the base period *q(t)*, which then chain-links the indices over the reference period *p(t)*. According to the different steps, it will be written $\hat{W}_{s,q(t),t}^{p(t)}$ or more simply, if possible in the context: $\hat{W}_{s,t}$ or $\hat{W}_{s,q(t),t}$ depending on the situation.

[29] For example, the first current period when indices were produced is years 2008 and 2009 thus *p(t)* = (2005, 2006). When the estimates are produced, *n-1* is not available.
[30] Thus, for example, the fourth quarter of 2006 will be the quarter when the reference stock for 2005-2006 is valued.

In the current period, the value of the reference stock becomes:

$$\hat{W}_{s,t} = \sum_{i=1}^{N_s} \exp\left(\hat{\alpha}_{0,s,t} + \sum_{k=1}^{K} \hat{\beta}_{k,s} X_{k,i,s} \right) A_{i,s}$$

with the same notation as in paragraph 3.4:

$\hat{W}_{s,t}$: current value of the reference stock in stratum s,

$\hat{\alpha}_{0,s,t}$: estimation of the log of the price/sq.m. of the reference property in stratum *s* on date *t*; the coefficients are estimated over the period $p(t)$,

N_s : number of transactions in stratum *s* during the reference period,

$\sum_{k=1}^{K} \hat{\beta}_{k,s} X_{k,i,s}$: correction to be applied to the estimation of the log of the reference property price in stratum *s* on date *t,* to estimate for this same date the log of the price of property *i* in stratum *s* purchased during the reference period,

$A_{i,s}$: floor space of property *i* in stratum *s* exchanged during the reference period.

3.5.2 Calculating primary indices in the current period

Calculating price changes

"Reference-property equivalent" prices are calculated using the price vector of the property characteristics, as described in paragraph 3.3. Using these estimated prices, we value the reference stock in quarter *t*.

By introducing dummy variables into the models for the month (3.1) instead of the quarter, we can now publish monthly indices. However, we do not have enough observations to calculate "pure" monthly indices. The transactions contributing to this calculation therefore still relate to a quarter. The monthly index is calculated using data from the last available quarter including this month: this is a monthly index, quarter-on-quarter.

Chain-linking

Price changes from quarter *t-1* to quarter *t* are obtained by comparing the value of the reference stock for quarter *t* with the value of the reference stock for quarter *t-1* observed three months earlier; *t* includes the months *m-2*, *m-1* and *m* and *t-1* includes months *m-5, m-4* and *m-3*. The formula for calculating price changes between quarters *t-1* and *t* is therefore:

$$I_{t/0}(s) = \frac{\hat{W}_{s,t}^{p(t)}}{\hat{W}_{s,t-1}^{p(t)}} \times I_{t-1/0}(s)$$

where *0* is the reference quarter and *t* is the corresponding previous quarter.

The price changes between quarters 0 and *t* are obtained by chain linking changes in the reference stock values between 0 and *t,* using the formula:

$$I_{t/0}(s) = \left[\prod_{u=1}^{t} \frac{\hat{W}_{s,u}^{p(u)}}{\hat{W}_{s,u-1}^{p(u)}} \right]$$

It has become necessary to introduce this chain-linking because the reference stock is now updated every two years, something which is new since the last version of the indices. In version 3, indices before 2008 have been calculated by applying index changes from version 2.

Putting the chain-linking in place

As the monthly indices are calculated on a quarter-on-quarter basis, a base is needed for the start of the chain-linking process for the three series of primary indices corresponding to the first, second and third months of the calendar quarters. The series of indices starts in January 2008. The base for the start of the chain-linking is set at October, November and December 2007.

Thus we calculate three start values in order to calculate the first three indices (for January, February and March 2008). We estimate the value of the reference stock *p(t)=(2007,2008)* in October 2007 (with the corresponding previous quarter consisting of sales from August, September and October 2007), in November and December 2007. The October 2007 index is then set at 100. The November index is obtained by comparing the November value for the reference stock *p(t)=(2007,2008)* with its October value. The December index is obtained by comparing the December value of the reference stock *p(t)=(2007,2008*) with the October value (*Table 3.3*).

For example, indices for January 2008, December 2009 and January 2010 for stratum *s* will be calculated as follows:

$$I_{janvier2008/0}(s) = \frac{\hat{W}_{s,janvier2008}^{parc2005-2006}}{\hat{W}_{s,octobre2007}^{parc2005-2006}} * I_{octobre2007/0}(s)$$

$$I_{décembre2009/0}(s) = \frac{\hat{W}_{s,décembre2009}^{parc2005-2006}}{\hat{W}_{s,septembre2009}^{parc2005-2006}} * I_{septembre2009/0}(s)$$

$$I_{janvier2010/0}(s) = \frac{\hat{W}_{s,janvier2010}^{parc2007-2008}}{\hat{W}_{s,octobre2009}^{parc2007-2008}} * I_{octobre2009/0}(s)$$

Table 3.3 – Calculation of price indices for last three months of 2007

Month of 4th quarter 2007	Estimated value of reference stock 2007 - 2008 * In month of publication	Formula	Value of index
1st month: October	500	100.0	100.0
2nd month: November	510	510/500 X 100	102.0
3rd month: December	513	513/500 X 100	102.6

* in € million

We can then start to chain-link the primary indices for the months of publication in the first quarter of 2008 using the following formula:

$$I_{t/0}(s) = \frac{\hat{W}_{s,t}}{\hat{W}_{s,t-1}} \times I_{t-1/0}(s)$$

where *t* is the corresponding quarter and *p(t)*=(2005,2006) as defined in 3.5.1.

The resulting primary indices can now be aggregated to obtain the indices for higher levels, such as the *département*, city, region, etc. For publication, the base 100 for the indices was set at the first quarter of 2010.

3.5.3 Calculating aggregate indices in the current period

To correct the non-exhaustiveness of the notarial database, we introduce an adjustment coefficient δ. This coefficient is estimated for each *département* and for each year of change of ownership, from tax data (amounts

of transfer taxes compiled by the Directorate-General for Taxation - DGFiP). This is obtained by dividing the sum of transactions in *département* d for year a, estimated from tax data, by this same amount recorded in the notarial database.

δ does not differentiate between apartments and houses. It is applied to all properties defined by the cross-tabulation (*département* x year of change of ownership).[31] It therefore modifies the term that weights the primary stratum indices, i.e. their value share of the reference stock.

First level of aggregation: calculating infra-departmental and departmental indices

For infra-departmental and departmental indices, the formula used is a geometric mean:

$$\frac{I_{t/0}}{I_{t-1/0}} = \prod_{s=1}^{n} \left(\frac{I_{t/0}(s)}{I_{t-1/0}(s)} \right) \left(\frac{\delta_s \hat{W}_{s,q(t)}}{\sum_{u=1}^{n} \delta_u \hat{W}_{u,q(t)}} \right)$$

where:

t, quarter

s, u, stratum

$I_{t/0}$, index of aggregate in t relative to reference quarter 0,

$I_{t/0}(s)$, index of stratum s in t relative to reference quarter 0,

$q(t)$, last quarter of the even year n-2 (base period),

$\hat{W}_{s,q(t)}$, value of properties in stratum s which changed ownership during period $p(t)$, estimated in quarter $q(t)$,

δ_s , correction coefficient for non-exhaustiveness of the notarial database.

Second level of aggregation: calculating supra-departmental indices

For supra-departmental indices with aggregate A, we use the arithmetic mean:

$$\frac{I_{t/0}(A)}{I_{t_0/0}(A)} = \sum_{d \in A} \left(\frac{\delta_d \hat{W}_{d,q(t)}}{\sum_{e \in A} \hat{W}_{e,q(t)}} \right) \left(\frac{I_{t/0}(d)}{I_{t_0/0}(d)} \right)$$

with the following additional notations:

t_0, last quarter of year n-1,

d, e, *département* or part of *département*

$I_{t/0}(A)$, index of aggregate A for quarter t relative to reference quarter 0,

$I_{t/0}(d)$, index of *département* d for quarter t relative to reference quarter 0,

$\hat{W}_{d,q(t)}$, value of properties in the *département* which changed ownership during period $p(t)$ estimated in quarter $q(t)$.

[31] This coefficient is the inverse of the coverage ratio in the notarial databases (described in Chapter 4, paragraph 4.3). However, when the coverage ratio is under 20%, the coefficient used is capped and it is therefore never greater than 5. As in version 2 of the indices, we use a value ratio rather than the volume ratio (number of transactions) that was used in version 1.

3.6 Numerical example for November 2012

There follows an example to describe the various steps in calculating a primary price index for November 2012. This example concerns apartments in stratum 2 of the Paris Region. The coefficients used for the period 2012-2013 are estimated from transactions in 2009-2010.

Step 1: extracting the base

The November 2012 index is calculated from all changes of ownership in September, October and November 2012. For the stratum and the quarter being considered, 222 changes of ownership were recorded in the base, falling within the scope of the index and providing the information necessary to calculate the indices. Prices per square metre range from €1,731 to €5,225.

Step 2: calculating the reference-property equivalent price

The first of the 222 transactions concerns a three-room apartment of 64 sq.m., with a bathroom, two garages and a cellar, located on the ground floor of a building of which the date of construction is not known; the dwelling is in neighbourhood no. 2. The selling price was €190,000, or €2,969/sq.m.

The coefficients of the characteristics that are specific to the property have to be removed to bring it down to the "reference-property equivalent" price.[32] We therefore have:

$\text{Log}(\widetilde{p}_{j,\tau})$ = Log (2,969), or 7.9959

+0.0598 (neighbourhood 2 → reference neighbourhood)

-0.0227 (1 or more cellars → no cellar)

-0.0670 (2 or more garages → no garage)

-0.1573 (date of construction unknown → 1948-1969)

= 7.8088

For the "reference-property equivalent" price $\widetilde{p}_{j,\tau}$ of this first transaction, we obtain $e^{7,8088}$, or €2,462/sq.m.

We repeat the operation for the other 221 transactions.

In each neighbourhood, transactions where the reference-property equivalent price is below the 2nd percentile or above the 98th percentile of the distribution are removed. In our example, the neighbourhood had only 36 transactions for the quarter. In this case we removed the most expensive and the least expensive properties. Across all of the five neighbourhoods in stratum 2, we withdrew 14 references where the reference-property equivalent prices were extreme values (6 in neighbourhood 1 and 2 in each of the other 4).

The price of the reference property, equal to the exponential of the arithmetic mean of the logs of the 208 reference-property equivalent prices of the remaining transactions, is Log (7.8314), or €2,518/sq.m.

Step 3: calculating the monthly stratum index for November 2012

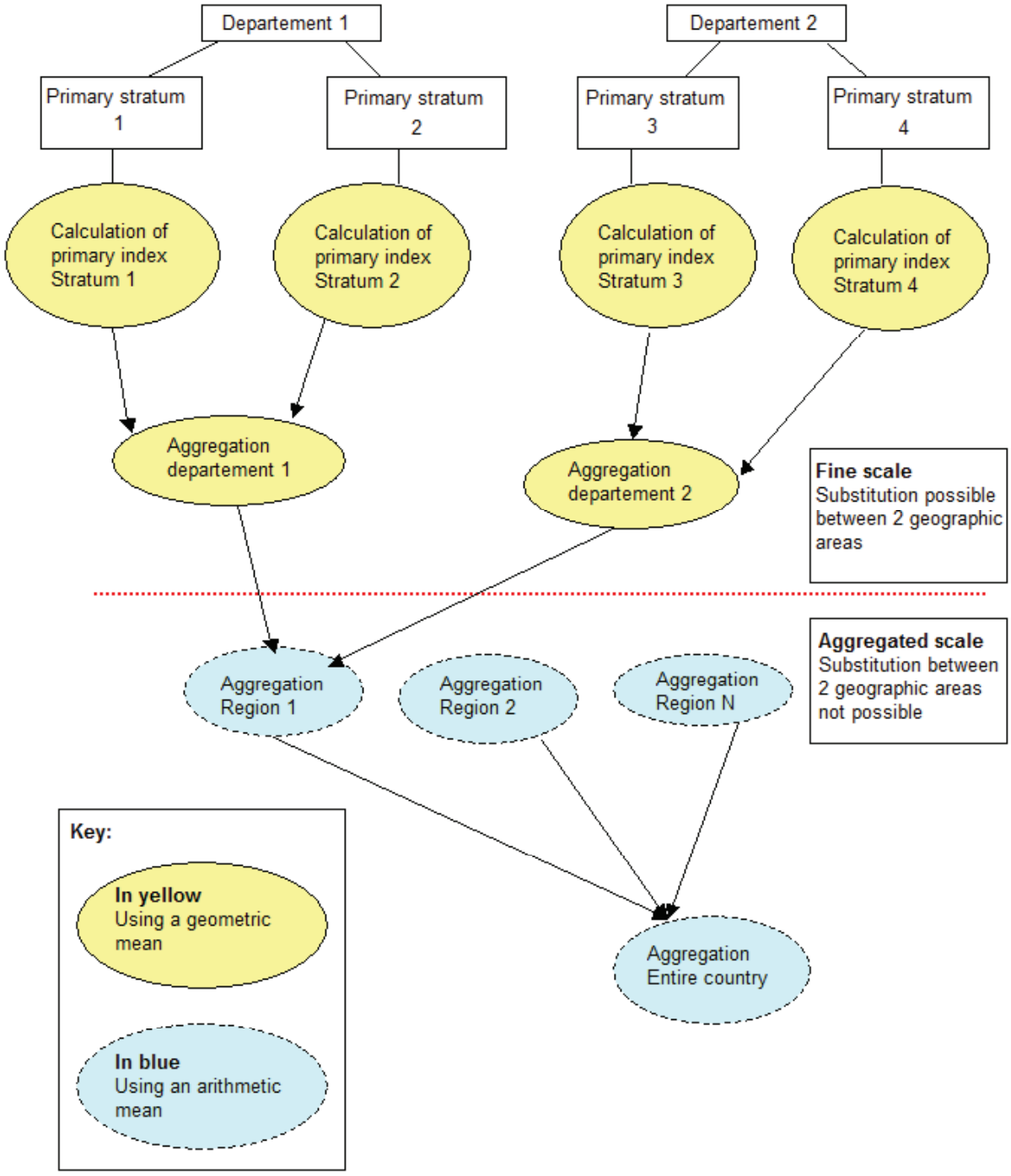
To determine the provisional monthly index[33] for a stratum in November 2012, we calculate the definitive price per sq.m. for the stratum in August 2012 (from transactions for June, July and August 2012), as the geometric mean of prices per sq.m. obtained in step 2 for each property in the stratum, or €2,498/sq.m. This price is compared with the provisional price three months later (€2,518/sq.m.) to determine the quarterly change in the stratum. It is this change in price per sq.m. in relation to the definitive price per sq.m. estimated for the stratum in November 2011 (reference period for price changes in 2012 and 2013) that will be aggregated to departmental and regional level to determine price changes by *département* and region.

[32] Cf. Table 3.1 on page 19.
[33] The definitive index is published three months later.

From primary indices to the national index: aggregating primary indices

Figure 3.2 below shows the different steps in the transition from primary index to the national index. *Départements* 1 and 2 belong to region 1. The geometric mean is applied for infra-departmental and departmental levels. The arithmetic mean is used for levels that are more aggregated.[34]

Figure 3.2 - Aggregation of primary indices



[34] Cf. page 21.