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Real estate surfaces appraisal

In the appraisal of the market value of the properties are applied two important surface indexes: the market surface ratio of the secondary surfaces and the ratio of the site value to total value (allocation method). The measure of both these indexes can be revealed difficult: the data collection of the surface trade ratio in the market can get different results and in practice often the valuer refolds on the fixed coefficients brought in the handbooks and in the circulars of the public administration; the appraisal of the ratio of the site, especially in the central zones and for ancient buildings, where besides the incidence is higher, is developed extrapolating the ratios from the peripheral zones for new building or falling back on the publications of real estate sector.

For the market comparison methods are proposed a series of test of surface trade ratio and land value ratio to foresee the effect on the appraisal result.

1. Introduction

The appraisal of the real estate surfaces requires two indices: the market's surface ratio expresses the ratio between the price of a secondary surface, and the price of the main surface, and the land value's ratio equal to the ratio between the market value of the built site and the market value of the property including both the land and the building. These ratios express the relationship between two economic and real estate variables.

The surface's ratio is related to the measurement of the trade surface of the property and is expressed directly from the market in which it can be detected; such detection often presents different indications and admixtures generated by surface ratios setted by administrative and tax law. Sometimes locally operators, institutions and professional organizations offer surface ratios established in accordance with uniform current practices.

The land's value ratio expresses the incidence of the value of the built site. Usually this ratio is synthetically appraised, with regard to the position income, on a scale of measures increasing from peripheral areas to the central areas of urban centres. Sometimes the incidence of the site can be found with the real estate quotations.

The present study deals with the appraisal of the secondary surfaces considered as an integral part of the property, producing a series of indices designed to measure the influence of these surfaces on the result of the valuation. The typo-

logical indices provide information on data collected from the market regardless by the surface ratios (paragraph 2.1), the indices measure the variation in the value of appraised amounts by varying the surface ratios (paragraph 2.2).

The study proposes a series of indices in order to predict the effect of the measures of the incidence of the built site and of the outside site of buildings erected on the valuation (paragraph 3). The indexes are configured as a test to be applied to the sample of comparable properties. It's presented a numerical examples concerning the calculation of the indices to apply as test to the sample of comparable properties (paragraph 4).

2. The secondary surfaces

In the secondary surfaces ratios it is generally supposed that these are worth less than the main surface, that most important one, of the property (surface ratio less than one). However, sometimes these are surfaces more relevant and more useful of the main surface because they can be subject of significant real estate valuations (surface ratio greater than one). The market's ratio ϖ_i of the generic secondary surface i (with $i=1,2,3,...,n$) is equal to the ratio between the marginal price p_i of the secondary surface and the marginal price p of the main surface, as follows:

$$\pi_i = \frac{p_i}{p}. \tag{1}$$

In procedures based on the collection of data and their comparison, such as the market comparison approach, the adjustments made by the marginal prices lead to the correct prices for each property by comparison. Each correct price is the market value of the property being appraised (*subject*): ie the price that would have the comparable property if it had the same characteristics of the *subject*, firstly the surface characteristics.

The calculation of the correct price of the comparable property may be made referred to comparison with the subject, highlighting the adjustments to the surfaces. The calculation of the correct price of the comparable property may be made referred to comparison with the *subject*, highlighting the adjustments to the surfaces. Denoting by P_j the known market price of the generic comparable j ($j=1,2, ..., m$), with x_{js} the main surface and with x_{ji} the generic secondary surface, with x_{0s} the main surface, with x_{0i} the generic secondary surface of the *subject* and with Δ_j the set of adjustments for the not surface characteristics with index $i=n+1$, $n+2$, ..., l, the correct price V_j of the generic comparable property is equal to:

$$V_j = P_j + p \cdot \left(x_{0s} - x_{js}\right) + p \cdot \sum_{i=1}^{n} \left(x_{0i} - x_{ji}\right) \cdot \pi_i + \Delta_j. \tag{2}$$

In detail the set of adjustments for the not surface characteristics Δ_j is equal to:

$$\Delta_j = \sum_{i=n+1}^{l} \left(x_{0i} - x_{ji} \right) \cdot p_i. \tag{3}$$

Pointing with X_j the trade surface of the generic property and with X_0 the trade surface of the *subject*:

$$X_j = x_{js} + \sum_{i=1}^{n} x_{ji} \, \pi_i, \tag{4}$$

$$X_0 = x_{0s} + \sum_{i=1}^{n} x_{0i} \cdot \pi_i, \tag{5}$$

and with P^*_j the partially correct price for the adjustments of the not surface characteristics, equal to:

$$P^*_j = P_j + \Delta_j, \tag{6}$$

the marginal price p of the main surface can be calculated from the average price obtained by the ratio between the partially correct price for the not surface characteristics and its trade surface, as follows:

$$p = \frac{P_j + \Delta_j}{X_j} \cdot \sigma = \frac{P^*_j}{X_j} \cdot \sigma, \tag{7}$$

where σ is the position ratio typically less than the unity. The correct price of the property is calculated by substituting the general formula (7) in the formula (2) in the following way:

$$V_j = P^*_j \cdot \left(1 - \sigma + \frac{X_0}{X_j} \cdot \sigma \right). \tag{8}$$

For $\sigma = 1$ the correct price is equal to the partially correct price of the comparable multiplied by the ratio between the trade surfaces of the *subject* and the comparable property.

2.1 Surface ratio

To measure the effect of variations induced in the market value from the surface ratios can be used some diagnostic indexes to the comparable property and to the property being appraised.

A diagnostic index for the surface ratios considers the typological ratio between the main surface and the secondary surface respectively of the *subject* and the comparable property. The *double typological ratio* s_j of the secondary surface referred to the generic property is equal to:

$$s_j = \frac{\dfrac{\sum_{i=1}^{n} x_{0i}}{x_{0s}}}{\dfrac{\sum_{i=1}^{n} x_{ji}}{x_{js}}} = \frac{x_{js}}{x_{0s}} \cdot \frac{\sum_{i=1}^{n} x_{0i}}{\sum_{i=1}^{n} x_{ji}}. \tag{9}$$

The double typological ratio is a pure number that does not depend on the comparables prices. For s_j <1 increasing the surface ratio the searched value decreases, while for s_j>1 increasing the surface ratio the searched value increases (for the same partially correct price and position ratio). If the amounts of the surfaces of the *subject* are equal to the corresponding amounts of the surfaces of the comparable, then the index is equal to the unit and the market value of the formula (8) is equal to the partially correct price (for the same position ratio).

When the comparison concerns more than a comparable property, the diagnostic index must be presented in general terms. The double typological ratio *S* of secondary surfaces referred to the comparable properties sample may be set equal to the average of single indices:

$$S = \frac{\sum_{j=1}^{m} s_j}{m}, \tag{10}$$

or to the weighted average of the indices for market prices partially correct or for collected market prices. The overall index is interpreted in the same terms of the indices of each individual comparable property in the presence of secondary surfaces.

2.2 Surface tests

The surface ratios collected in the market vary from market segment to market segment and over time. Sometimes in the same market segment the information may indicate more than one surface ratio relate to the same situation, and ratios derived from non-commercial sources.

The test of the surface ratios may concern: ambiguous situations in which simultaneously detect two or more amounts of the surface ratio in the current market, the comparison between the surface ratios recognized in the market and the

coefficients fixed by law, and the comparison between the fixed coefficients of the different sources.

For a surface ratio equal to the unit ($\varpi_i=1$), the secondary surface is considered equal to the main one and it is no longer necessary to distinguish between them.

For a surface ratio null ($\varpi_i=0$) the secondary surface is not considered in the valuation. In both these basic scenarios a diagnostic index of interest in the surface ratios can be set on the difference between the appraised value for the surface ratio equal to the unit and the corresponding value appraised without taking into account the secondary surfaces. The *basic variation index d_j (0,1)*, referred to the generic property, identifies the range of variation in the two hypotheses ($\varpi_i=1$ and $\varpi_i=0$) and is calculated using the formula (8) as follows:

$$d_{j(0,1)} = \frac{\dfrac{x_{0s} + \sum\limits_{i=1}^{n} x_{0i}}{x_{js} + \sum\limits_{i=1}^{n} x_{ji}} - \dfrac{x_{0s}}{x_{js}}}{1 - \sigma + \dfrac{x_{0s}}{x_{js}} \cdot \sigma} \cdot \sigma. \tag{11}$$

The basic index expresses, as a percentage, the range of variation in the market value of the *subject*, induced by the choice of the surface ratio in the two extremes of secondary surface corresponding to that of the main surfaces and null surfaces. It is pointed out that the variation index doesn't depend by the price of the comparable but is related to the physical surfaces of the properties (and to the position ratio). The index can take positive and negative values.

The basic index of variation referred to the sample of comparables can be set equal to the average of individual indices (formula (10)) or the weighted average of the indices for market partially correct prices or for recorded market prices. The overall index is interpreted in the same terms of the indices of each individual comparable in presence of secondary surfaces.

A diagnostic index can be referred to the standard situation in which the secondary surfaces are considered equal to the main surface ($\varpi_i=1$). In this situation, a diagnostic index of interest in the surface ratios can be based on the difference between the estimated value with the chosen ratio surface and the corresponding estimated value for the surface ratio equal to the unit. The *standard variation index $d_j(\varpi,1)$* of the generic property can then be calculated by applying the formula (8) into the two corresponding hypotheses as follows:

$$d_{j(\pi,1)} = \frac{\dfrac{x_{0s} + \sum\limits_{i=1}^{n} x_{0i}}{x_{js} + \sum\limits_{i=1}^{n} x_{ji}} - \dfrac{X_0}{X_j}}{1 - \sigma + \dfrac{X_0}{X_j} \cdot \sigma} \cdot \sigma. \tag{12}$$

The standard index expresses in percentage the range of variation in the market value of the *subject* measured between the chosen surface ratio and the unit price, in which secondary surfaces are equal to the main surface. It should be noted that the variation index doesn't depend on the price of the comparable but is related to the physical surfaces of the properties (and the position ratio). The index can take positive and negative values.

The variation index referred to the standard sample of comparables may be set equal to the average of individual indices (formula (10)) or the weighted average of the indices for market prices partially correct or for market prices recorded. The overall index is interpreted in the same terms of the indices of each individual comparable in presence of secondary surfaces.

When the detection of surface ratios is uncertain between two or more amounts, an index of applicative interest is represented by the difference between the estimated values with different ratios. Indicated the sets of surface ratios ϖ ' and ϖ'', the *index of relative variation* $d_j(\varpi', \varpi'')$ of the generic property can then be calculated by applying the formula (8) in the two situations as follows:

$$
d_{j(\pi',\pi'')} = \frac{\dfrac{X_0^{''}}{X_j^{''}} - \dfrac{X_0^{'}}{X_j^{'}}}{1 - \sigma + \dfrac{X_0^{'}}{X_j^{'}} \cdot \sigma} \cdot \sigma.
\tag{13}
$$

The index expresses in percentage the range of variation in the market value of the *subject* induced by the surface ratios tested on the comparable. It is noted that the range of variation is not dependent on the price of the comparable but is related to the surface ratios. The index can take positive and negative values.

The relative index can be applied to a surface ratio greater than unity ($\varpi_i > 1$) when the secondary surface has a price greater than that of the main, although it is not the most important surface of the property.

The relative index of variation in percentage, based on the sample of comparables may be set equal to the average of individual indices (formula (10)) or the weighted average of the indices for partially correct market prices or for market prices recorded. The overall index is interpreted in the same terms of the indices of each individual comparable in presence of secondary surfaces.

May be proposed other diagnostic indices based on comparison function concerning, for example, the range of variation between the value calculated by the surface ratio chosen and the value calculated by the null surface ratio, ie excluding the secondary surfaces.

3. Incidence of built site

The land value ratio of the built site (or the built incidence) is the ratio between the market value of the built site and the market value of the property,

including the buildings and the ground. The built site includes the site occupied and the remaining free site of the lot.

The land value ratio of the built site can be calculated: according to the market price of the built sites, according to the market price of the building sites (considering the cost of demolition), and according to the depreciated reconstruction cost of the building (such as the complement to one of the ratio with the market value of the property). In practice the valuation of the land value ratio is often carried out in an empirical way, extrapolating land value ratios calculated in peripheral and semi-central zone, where it is generally more likely to known the price of building land and the construction costs for new buildings. In general, the market of built sites is fairly small and in the central areas may lack the supply of building site and its market. In these areas the depreciated reconstruction cost may be difficult to determine for buildings more old.

3.1 Site's indexes and tests

The calculation of the indices and tests for built site is based on the comparison function, according to which the correct price of the comparable property is referred to the comparison with the *subject*, highlighting the adjustments to the secondary surfaces, and the built site.

The calculation of the correct price V_j of the generic comparable property can be repurposed with regard to the comparison with the *subject* according to the formula (2) as follows:

$$V_j = P_j + p \cdot \left(x_{0s} - x_{js}\right) + p \cdot \sum_{i=1}^{n}\left(x_{0i} - x_{ji}\right) \cdot \pi_i + p_a \cdot \left(x_{0a} - x_{ja}\right) + \Delta_j, \tag{14}$$

where x_{0a} is the built site of the *subject*, x_{ja} is the site of the comparable, p_a is the marginal price of the built site. The marginal price p of the main surface in presence of the external site can be calculated from the average price obtained by the ratio between the partially correct price for the adjustments of not surface characteristics, considering the incidence of the site c, and the trade surface of the construction as follows:

$$p = (1 - c) \cdot \frac{P_j^*}{X_j} \cdot \sigma. \tag{15}$$

The marginal price p_a can be calculated from the average price obtained by the ratio between the partially correct price, considering the incidence of the site, and the relative surface x_{ja} as follows:

$$p_a = c \cdot \frac{P_j^*}{x_{ja}} \cdot \sigma_a, \tag{16}$$

indicating with σ_a the position ratio of the site. The correct price of generic property is calculated by substituting the formulas (15) and (16) in the formula (14) in the following way:

$$V_j = P_j^* \cdot \left[1 + (1-c) \cdot \left(\frac{X_0}{X_j} - 1 \right) \cdot \sigma + c \cdot \left(\frac{x_{0a}}{x_{ja}} - 1 \right) \cdot \sigma_a \right]. \tag{17}$$

The diagnostic index for the incidence of the site considers the ratio between the built sites and trade surfaces respectively of the *subject* and the comparable. The *double ratio of the sites* a_j is equal to:

$$a_j = \frac{\dfrac{x_{0a}}{x_{ja}}}{\dfrac{X_0}{X_j}} = \frac{x_{0a}}{x_{ja}} \cdot \frac{X_j}{X_0}. \tag{18}$$

The double ratio of the sites is a pure number that does not depend on comparables prices. For $a_j<1$ increasing the incidence of the site, the searched value decreases, while for $a_j>1$ increasing the incidence of the site, the searched value increases (being equal other conditions).

The double ratio of the sites related to the sample of comparable properties may be set equal to the average of individual indices (formula (10)) or the weighted average of the indices for partially correct market prices or for market prices recorded. The overall index is interpreted in the same terms of the indices of each individual comparable.

The ratio of the site varies from market segment to market segment and over time, depending on the market values of the two sides of the property. When the incidence is appraised in a synthetic way, one can apply a preliminary test designed to verify the variation of the result of valuation for two or more amounts of the incidence of the site. The test also can be used to compare the appraised incidence with those reported in tabular quotes.

Denoting by c' and c'' the effects to be tested (with $c''>c'$), the change in value of the site can be calculated by the difference between the corresponding correct prices V_j' and V_j'' obtained by the formula (17) in the following way:

$$V_j'' - V_j' = P_j^* \cdot \left(c'' - c' \right) \cdot \left[\left(\frac{x_{0a}}{x_{ja}} - 1 \right) \cdot \sigma_a - \left(\frac{X_0}{X_j} - 1 \right) \cdot \sigma \right]. \tag{19}$$

The *index of variation in the incidence of the built site* can be proposed in terms of the percentage change v_j in the researched value relates to the variation in the incidence of the site, in the following way:

$$v_j = \frac{V_j^{''} - V_j^{'}}{V_j^{'}} = \frac{\left(c^{''} - c^{'}\right) \cdot \left[\left(\dfrac{x_{0a}}{x_{ja}} - 1\right) \cdot \sigma_a - \left(\dfrac{X_0}{X_j} - 1\right) \cdot \sigma\right]}{1 + \left(1 - c^{'}\right) \cdot \left(\dfrac{X_0}{X_j} - 1\right) \cdot \sigma + c^{'} \cdot \left(\dfrac{x_{0a}}{x_{ja}} - 1\right) \cdot \sigma_a}.$$ (20)

The site index expresses in percentage the range of variation in the market value of the *subject* induced by the change imposed in the incidence of the site. It should be noted that the variation index doesn't depend on the price of the comparable but is related to the physical surfaces of the properties (and to the position ratio). The index can take negative and positive values (and zero for $c^{''} = c^{'}$).

For $\sigma = \sigma_a$ the index of variation in the incidence of the site is equal to:

$$v_j = \frac{\left(c^{''} - c^{'}\right) \cdot \left(\dfrac{x_{0a}}{x_{ja}} - \dfrac{X_0}{X_j}\right) \cdot \sigma}{1 - \sigma + \left(1 - c^{'}\right) \cdot \dfrac{X_0}{X_j} \cdot \sigma + c^{'} \cdot \dfrac{x_{0a}}{x_{ja}} \cdot \sigma}.$$ (21)

The test of the site incidence of the comparables sample may be set equal to the average of individual indices (formula (10)) or the weighted average of the indices for the partially correct market prices, or market prices detected. The overall index is interpreted in the same terms of the indices of each individual comparable property.

4. Application

In order to illustrate the calculation of the indexes and test it is shown a schematic example of the preliminary verify operation of the collected data for a real estate appraisal by a method based on the detection and comparison of market data.

The *subject* has two secondary surfaces (balcony or terrace) and an outside area. In the same market segment of the *subject* were detected three comparable properties considered for the purpose of testing without the indication of prices (see Table 1).

The recognition of the surface ratios indicates for the balcony two alternative amounts (0.25 and 0.5) and for the terrace an unique amount (2/3). The incidence of the site is synthetically appraised equal to 0.2 and detected by the manuals equal to 0.3 (see Table 2).

The trade surfaces of comparable properties and of the *subject* are calculated based on the trade ratio (see Table 3).

Table 1. Summary grid.

Price and characteristics	Comparable property			Subject
	1	2	3	
Market price (euro)	...	...	...	-
Main surface (mq)	272.0	351.6	230.1	288.0
Balcony (mq)	28.7	21.0	33.6	22.0
Terrace (mq)	46.0	81.2	29.1	54.9
Outside area (mq)	625.3	715.9	518.4	668.6
Not surface characteristics	...	...	...	...

Table 2. Surface ratios and incidence of the site.

Index	Symbol	Amount
Surface ratio for balcony	$\varpi_{balcony}$	0.25^*
Surface ratio for terrace	$\varpi_{terrace}$	0.67
Incidence of the site	c	0.2^{**}

* In alternative 0.5.
** In alternative 0.3.

Table 3. Real estate surface (mq).

Surface (symbol)	Comparable property			Subject
	1	2	3	
Total surface	346.7	453.8	292.8	364.9
Trade surface (X_j^* e X_0^*)	309.5	410.4	257.7	329.7
Trade surface (X_j^{**} e X_0^{**})	316.7	415.7	266.1	335.2

* $\varpi_{balcony}=0.25$.
** $\varpi_{balcony}=0.5$.

Indices and test are calculated on the surfaces of buildings since preliminary diagnostic indices. The sample index is calculated as the simple average of the indices of individual comparable (see Table 4).

The double typological ratio of secondary surfaces indicates the increase or decrease in the value varying the chosen surface ratio in the valuation before to detect the amount.

For the detected properties the double typological ratio is less than the unity and consequently increasing the surface ratio the searched value decreases, in a counterintuitive mode than real estate expertise.

Table 4. Indices and diagnostic tests.

Index and test (symbol)	Comparable property			Sample index
	1	2	3	
Double typological ratio (s_j)	0.972	0.919	0.980	0.957
Base variation index % ($d_{j(0.1)}$)	-0.60	-1.83	-0.43	-0.95
Standard variation index % ($d_{j(0.25-1)}$)	-1.20	0.09	-2.60	-1.24
Standard variation index % ($d_{j(0.5-1)}$)	-0.57	-0.29	-1.07	-0.64
Relative variation index % ($d_{j(0.25-0.5)}$)	-0.64	0.38	-1.54	-0.60
Double ratio of the site (a_j^*)	1.00	1.16	1.01	1.06
Double ratio of the site (a_j^{**})	1.01	1.16	1.02	1.06
Index of site incidence % (v_j^*)	0.04	1.57	0.08	0.56
Index of site incidence % (v_j^{**})	0.10	1.51	0.24	0.62

* $\varpi_{balcony}=0.25$.
** $\varpi_{balcony}=0.5$.

The base valuation index of surface ratios expresses in percentage terms, the range of variation of the searched value for extreme amounts of surface ratio (0 and 1). For the detected properties the test is negative in agreement with the previous index.

The overall variation index is less than 1% (-0.95%).

The standard variation index refers to the situation in which secondary surfaces are treated in the same way as the main surface with surface ratio equal to one, not distinguishing the first from the second. The index expresses in percentage the range of variation in the market value of the *subject* induced by the choice of a whatever surface ratio with respect to any surface ratio equal to one. The index is calculated respectively for the standard surface ratio 0.25 and 0.5. The average index referred to the lower surface ratio is equal to -1.24%, the average index referred to the greater surface ratio is equal to -0.64%.

The relative variation index of the surface ratios expresses in percentage terms, the variation range of the searched value for the surface ratio between two amounts (0.25 and 0.5). In these intermediate amounts, for example in the case of conflicting market indications, for properties 1 and 3, the test is negative and the building 2 assumes a positive value for the presence of the terrace in the calculation of the surface. The sample test has on the whole a negative percentage index less than 1% (0.6%).

The base index, the standard index and the relative variation index are calculated by the position ratio equal to one ($\sigma=1$).

The double ratio of the built site indicates the increase or decrease in the researched value to varying the appraised incidence of the site. For detected properties the double ratio of the site is calculated according to the set surface ratio (0.25

and 0.5) and for both the double ratio is greater than the unity and consequently increasing the incidence of the site the searched value increases.

The index of the variation of the site's incidence expresses, as a percentage, the range of variation of the searched value for the incidence of the site between two amounts (0.2 and 0.3). For detected properties the variation interval assumes positive values in average equal to 0.56% and 0.62% [according to the predetermined surface ratio and for unitary position ratio ($\sigma=\sigma_a=1$)].

5. Conclusions

In the real estate expertise, the unit values, based on the market value, increase with the increase of the amount of the surface ratio and vice versa. Consequently, the omission of surface ratios leads to an unacceptable error of under-or overestimate of the researched market value.

In the appraisal procedures based on the market comparison, the market value may increase or decrease, increasing the amounts of the ratios of secondary surfaces. In other words an increase in the ratio of a secondary surface may induce a decrease in the researched value. The same is for the incidence of the built site such as single-family homes and productive properties.

In the approaches based on the explicit comparison of the properties, surface ratios and the incidence of the site operate on the differences between the surfaces, rather than on the entire surfaces, so the adjustment is balanced by the comparison itself and the consequent impact on the outcome of the valuation is lower, and sometimes negligible, in particular when the surfaces of the *subject* are practically equal to those of the comparable.

The examination of these situations is carried out according to the comparison function in order to prepare a series of indices and test on the surface ratios and on the incidence of the built site.

For secondary surfaces is proposed the double typological ratio as a diagnostic index. It can provide an a prior indication on induced changes on the market value increasing or decreasing the surface ratios without to know their amounts. The double ratio works on the sample of comparable properties detected.

As verification tests are proposed indices of variation that compare the fluctuations in the searched value generated by changes in the surfaces in ambiguous situations: for example, when there are two or more amounts of surface ratio in the current market, or we want to assess the impact on the valuation result of the comparison between the surface ratios recognized in the market and the coefficients fixed by law.

For built sites is proposed the double ratio of the sites as diagnostic index which gives an a priori indication on the variations of the searched value increasing or decreasing the incidence of the site without to know its amount. The double ratio works on the sample of comparable properties detected.

As a verification test of the incidence of the site is proposed a preliminary test designed to verify the variation of the valuation result for two or more appraised

amounts of the incidence of the site. The test can be used to compare the estimated incidence with those reported in the quotations tables.

The use of the market comparison approach has many advantages such as the possibility of assessing the surface ratios detected and estimated incidence of the site. Thus showing that it may be preferable to consider the main and secondary surfaces as such rather than the surface ratios of uncertain origin, often counterverse or erroneous: thus replacing an incorrigible detection error with a predictable divergence in valuation and above respecting the reality of real estate.

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