Creative Construction Conference 2016

Innovative Method for Real Estate Valuation Using Data Mining Software

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Abstract

This paper presents an innovative method for real estate valuation. Currently, the most common method of real estate valuation relies on comparisons with similar structures, cost and yield analysis. The innovative method proposed in this paper, called "historical market price", uses mathematics, statistical and database-founded algorithms for valuation. Input data comes from specialized software which systematically gathers, analyses and valuates data connected with real estate market development. Every six months the database expands by more than 650,000 price offers (advertisements) on purchase or rent of flats, houses, commercial buildings and allotments. This method can be used for valuation of real estate which was purchased previously if rough data is known about the original transaction (especially purchase price). The method suggested in this paper is grounded in true and exact information taken from the last purchase and identifies structural and technical differences in the condition of given real estate, as well as changes in price levels for the given location (street, neighborhood, city, region, etc.). Current valuation methods are not capable of taking into account these historical, yet exact and valuable pieces of information concerning real estate. Current valuation methods are based solely on current data and present state of the real estate market. This approach may be vulnerable to manipulation by either parties of the purchase contract.

Keywords: data mining; property market value; software; statistics; valuation of properties.

1. Literature review

At present, market value/common price is mostly valuated by comparison with other similar buildings, cost and yield analysis of the real estate. [1]

One of the most common methods for establishing yield are these: calculation of eternal fixed income (constant yield over a long period of time), yield value established by means of appraisal norm, and calculations for variable yield. [2] Valuation of real estate based on yield is also known as capitalization model, as defined in accordance with Executive Order No. 1265 of the Danish Financial Supervisory Authority, Enclosure 8. [3]

Comparative model of real estate valuation is based on comparison of appraised real estate with values of similar kinds of real estate which were sold previously in the same or comparable location. Comparative method comprises both cost value of a construction (acquisition of construction units of a building and its equipment) and possible yields of the given contract (potential rent income). [4]

Valuation model based on costs calculates all current costs needed to re-build the real estate to such state as it is valuated, including costs of allotment purchase. [5] This method appraises the area encompassed by building structures, kind of building, its life-span, current rate of detrition and other parameters. [6]

It is also possible to use different valuation attitudes apart from the ones described above. It may be efficient to use different approaches for specific buildings - for example valuing rental properties using a recursive model. The recursive method is similar to the discounted cash flow method in that it discounts future cash flows, but it differs in that it recognizes that rental income can unexpectedly change in the future and allows rental property owners to adjust to these changes. [7]

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It is also possible to use Mass Appraisal Models and Automated Valuation Models (AVM) for appraisal of mutually comparable buildings. Several valuation methods have been developed for such purposes, namely direct market models and comparable sales models. [8]

Scholarly literature comprises a number of studies dealing with the gathering of data from completed real estate transactions and the valuation of its development as well as predictions for the future real estate market. Let me name a few of them: Reference paper [9] describes a method of about creation of a real property database to determine capitalization rate of real estate. Reference paper [10] presents a method of applying the ensembles of genetic fuzzy systems to build reliable predictive models from a data stream of real estate transactions. Reference paper [11] describes data mining methods of real sales data from an assessment office in a large US city. Reference paper [12] presents a prototype system for real estate information collection and visualization.

2. Historical market price method

Lately, there has been a substantial rise in the number of business transactions which result in a change of real estate ownership. Such situation is allowed by low interest rates in mortgages which stay low even from a long-term point of view. Therefore, mortgages are available to a large proportion of population. Another reason for the rise is the fact that investments in real estate generally carry low risks and high level of legal protection. Real estate is often used as a contract pledge or for different investment purposes, and it is widely considered to be a safe form of investment. Thus, there is often complex documentation for each real estate which tracks and records its life cycle. Such documentation generally involves design drawings (ground plans, section plans, perspectives, spatial arrangement changes), legal documents (insurance contracts, rental contracts, land registry documents, purchase contracts, work contracts, market price valuations, experts' statements), and maintenance-related documents (structure passports, maintenance and replacement plans for individual construction units, invoices for construction work, auditing plans, expert technical inspections, servicing and maintenance activities).

The appraiser gathers all available information concerning the valuated real estate. It will include location in order to establish market value of property. When there is a previous appraisal or purchase contract for that same real estate, the appraiser has a valuable instrument for assessing actual previous market value and current state of appraised property. However, current valuation methods do not allow the appraiser to use such information to its full potential. The appraiser will describe certain information in his current valuation but he has very few tools to use this data for calculation of current market value of real estate. Still, the original purchase price informs the appraiser about objective and concrete value of property at a given date in the past which accounts to its location and in relation to other similar estates. With such data, the appraiser does not work with fuzzy estimates. Instead, it is data connected to an actual purchase which was carried out in the past, and it gives specific details on the conditions which ruled the purchase, i.e. describes real objective market value of real estate. The previous purchase price contains and is influenced by the kind of real estate and its size, construction material characteristics and technical state of building. Also its location, availability of transport to work, scope of services in given location and orientation of real estate in relation to compass points, negative issues of the location, and a number of other important parameters which influence decision-making process of buyers are also included.

If we assume knowledge of change of price level from original to current state in given real estate category and location, we may be able to simply, yet very precisely deduce current real estate value from historical market value. Current market value is governed by this equation:

$$P = P_h * I_d * I_a * I_c \tag{1}$$

Where

P … Current market price.

P_h … Historical market price ascertained from documentation for appraised real estate (previous purchase contract, previous appraisal of value, previous expert statement, etc.).

I_d … Index of detrition in given period of time as determined by dates of previous information of market value and date of appraisal ($I_d \leq 1$).

I_a … Index of constructional and technical augmentation of real estate. It is considered for cases of renovation, reconstruction, extension or superstructure of given real estate within the interval delimited by information of historical value on one side and time of current appraisal on the other side ($I_a \geq 1$).

I_c … Index of price level change in given location and for given category of real estate within the interval delimited by information of historical value on one side and time of current appraisal on the other side.

2.1. *Historical market price of real estate P_h*

Historical market price of real estate P_h is found in documentation of appraised real estate which is ideally provided by the current owner or facility manager. Such information is most readily available in old purchase

contracts, old real estate appraisal, expert's statement, or construction contract for a new construction. If none of these documents are available, it is possible to ascertain a copy of acquisition of property document at the local land registry which only charges a small fee for these copies. If no copy or information is available whatsoever, historical valuation method cannot be used for real estate appraisal.

2.2. *Index of detrition I_d*

Index of real estate detrition I_d is calculated by a linear method as the intervals of detrition are short when compared to overall life cycle of a construction. The equation which governs index of detrition is:

$$I_d = 1 - \frac{n}{12*L} \tag{2}$$

Where

n … Number of months between the dates of information about historical value of real estate and current appraisal.

L … Total expected life-span of appraised real estate (in years).

2.3. *Index of constructional and technical augmentation I_a*

The index of constructional and technical augmentation of real estate I_a is calculated by means of an expert estimate. The index value depends on the scope of construction work realized between the date of the information about historical price and the date of current appraisal. Index values mirror the extent of costs expended on the construction work which led to augmentation of constructional and technical state of real estate. It should not take into account common operation costs, nor costs expended on long-term sustainability of the construction. It is also necessary to bear in mind that every crown/euro expended on construction loses value from the very moment it is used because of the attractiveness of the given location. The loss of value mostly ranges between 50-80 % immediately after installing a new construction unit in a building. The loss can be minimized in case of constructions in historic city centers. The statements above are confirmed by a rule used in the real estate market which suggests that it is economically unfeasible to reconstruct (e.g. a bathroom) if the owner is planning to sell the building.

If no improvement, reconstruction, annex or superstructure was not noted on appraised real estate within given period of time, the index value is considered equal to 1. In case of constructional or technical improvement of real estate, the index value will normally be higher than 1.

2.4. *Index of price level change in given location I_c*

The index of price level change I_c is a key parameter for the historical market price method. The software called EVAL was developed by the author of this new appraisal method to calculate monthly indexes of change in market prices of real estate. It sorts by category of real estate and location.

EVAL is a software application which gathers, analyzes and valuates price offers of real estate as published on real estate servers. The current scope of software application allows for recording most real estate advertisements published online in the Czech Republic. Information from real estate servers is gathered monthly by means of automated mechanisms, and stored in a database. The application has been operating since 2007. To demonstrate the volume of data acquired, in the first half of year 2015, the database has stored 650,000 new records of price offers on real estate purchases or rent - flats, houses, allotments and commercial real estate. The software tool allows for detailed analysis of market price development in time (in monthly periods) in all municipalities in the Czech Republic, and in all common categories of real estate for rent or sale.

The index of price level change in a location I_c is governed by the following equation:

$$I_c = \prod_{i=1}^{n-1} I_i^{kl} \tag{3}$$

Where

I_i^{kl} … Monthly index of market price change given for month *i*, category *k* and location *l*. Index value is calculated by EVAL software by means of development trend in real estate market price.

i … value *i=0* is valid for the month which states information on historical market price of appraised real estate, e.g. if a purchase contract was signed on 15th September 2007, *i=0* is valid for the month of September 2007, *i=1* is valid for October 2007, etc.

n … Number of months between the date of historical price information and current date of real estate appraisal.

Real estate category ***k*** is defined by EVAL when valuating accommodation unit by parameters as follows. Real estate category does not have to be denoted by all parameters, it may be defined by any given combination:

- Space arrangement of the accommodation unit - 1 room + kitchenette (kk), 1 room + 1 kitchen, 2 (rooms) + kk, 2+1, 3+kk, 3+1, 4+kk, 4+1, 5+kk, 5+1, other.
- Ownership - private, housing association, other.
- Kind of building - brick, panel, wood, other.
- Technical state - very good, good, bad, new building, to be reconstructed, newly refurbished.

Location ***l*** is defined by EVAL when ascertaining the value of the accommodation unit. The software uses a set of predefined parameters. Location does not have to be expressed by all of the parameters; it can be defined by any given combination:

- Region - Prague, Central Bohemia, Southern Bohemia, etc.
- Municipality - Beroun, Kladno, etc.
- Street - Jablonova, Americka, Pplk. Sochora, etc.

Historical market price method allows us to calculate price level change in given location I_c, making use of one or several bases for comparison. Several locations and categories may be summed up for comparison if they are applicable to given valuated real estate. The index of price change in certain location I_c is governed by the following equation:

$$I_c = \frac{\sum_{j=1}^{m} I_{cj} * v_j * k_j}{\sum_{j=1}^{m} v_j} \tag{4}$$

Where

I_{cj} … The index of price change in a given location for comparative basis *j*. General calculation of the index for one basis of comparison is designated by the equation (3). Comparative basis represents the same or similar location of a specific category of real estate compared to the real estate which is being valuated.

v_j … Value of comparative basis *j*. This parameter expresses the value of the comparative basis *j* for appraising real estate when contrasted against other comparative bases. For a comparative basis which is defined by the same category and location as the appraised real estate, a comparative basis with the highest value should be used. As the number of categories and locations rises (street → municipality → region), the value of comparative basis will drop.

k_j… Coefficient of adjustment for comparative basis *j*. The coefficient expresses how much better (or worse) a category/location of real estate is than the appraised real estate. For a comparative basis defined by the same category and location as the appraised real estate, the coefficient equals 1.

m … mass (total sum) of comparative bases ($m \geq 1$).

3. Case study

An example of historical market price method is illustrated for better understanding. The following example will show the valuation of accommodation unit with given input data:

Category: flat
Layout: 1 room +1 kitchen
Technical state: good
Address: Jablonova Street, Prague
Ownership: private
Kind of building: brick
Original price: 1 350 000 CZK (price ascertained from original purchase contract signed on 15th September 2007)
Valuation date: 15th November 2015

Figure 1 displays EVAL window for accommodation unit valuation. The user enters the historical purchase price (P_h = 1 350 000 CZK) of the valuated real estate at the beginning of valuation process, and chooses from a range of dates - month in which the historical price was obtained (September 2007) and month of valuation (November 2015). Next the user needs to establish the value of detrition index (I_d = 0,98) and constructional and technical augmentation index (I_a = 1,05). There is no need to establish floorage or usable space of accommodation unit as the flat which is being valuated is exactly the same as in the past.

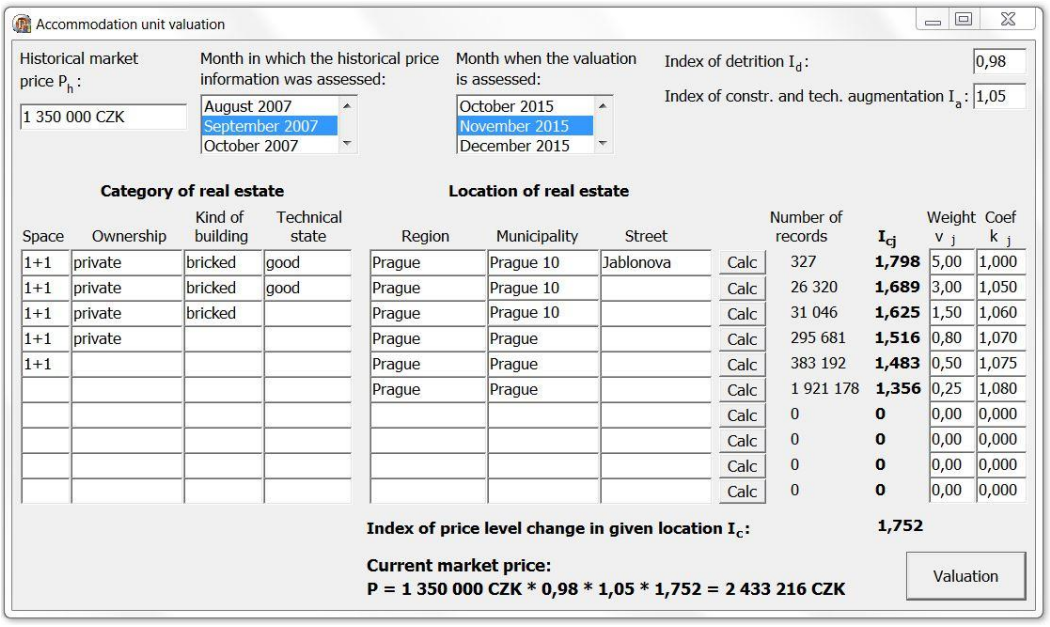

Figure 1 Valuation of a flat using historical market price method.

In the next step of the valuation, the user establishes several comparative bases which the user sets as appropriate for comparison with the valuated unit. For the sake of this demonstration, six comparative bases were chosen.

The first comparative basis usually represents the same category and location of real estate as the valuated unit. The example uses the exact same category and location (layout 1 room + 1 kitchen, private ownership, brick building, good condition, region Prague, municipality Prague 10, street Jablonova). EVAL database holds sufficient number of cases for comparison 327 advertisements. The highest value of comparative basis is considered (v_1 = 5,00), adjustment coefficient k_1 = 1,000.

Other comparative bases are chosen then, usually defined by a higher degree of aggregation, according to appraiser's expert opinion. These comparative bases contain a larger number of data generated from EVAL database (327 → 26 320 → 31 046 → 295 681 → 383 192 → 1 921 178). Higher degree of aggregation leads to less specific results, e.g. leaving out filters for specific street, municipality, kind of building, ownership, etc.

With higher aggregation, comparability of database output with valuated real estate diminishes. Therefore, it is suggested to lower the value of comparative basis v_j as well (5,00 → 3,00 → 1,50 → 0,80 → 0,50 → 0,25). At the same time, it is necessary to adjust coefficient k_j so that differences between compared real estates in various locations and categories are eliminated (1,000 → 1,050 → 1,060 → 1,070 → 1,075 → 1,080).

With this input, EVAL calculates the index of price change level in given location (I_c = 1,752) and then establishes current market price of real estate (P = 2 433 216 CZK).

4. Conclusion

Historical market price method is an innovative approach to valuation of real estate market prices. It is based on the comparative method of valuation combined with mathematic, statistical, and database algorithms. It can be used to establish market value of flats, houses, commercial real estate, and allotments. It can also be used for determining common rent for a flat, house, commercial real estate or allotment, and for establishing market value of real estate to a given date in the past.

The choice of different levels of aggregation and filtering of data makes it possible to use this innovative method even for valuation of atypical real estate or real estate in a location where there is insufficient number of price offers for comparison. Also it can be used where it is difficult to establish objective market price (e.g. small municipalities, borderline regions, allotments detached from commercial centers of regions).

The usefulness of this method is limited by the necessity of having trustworthy data concerning actual purchase prices from previous sale of valuated real estate. It has the advantage of speedy processing of input data about price level in a specific location by drawing directly from EVAL's offline database. The appraiser has more to rely on than his own research of real estate market.

Acknowledgements

This work was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS15/132/OHK1/2T/11.

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