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Continuous valuation model for work-in-progress investments with fuzzy logic method
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Abstract
Currently, banks and other financing institutions ask for detailed project documentation in order to finance major building projects. Among other requirements, continuous valuation reports are to be provided by investors under the term of building works to prove current Market Value of the project. There is no scientific model for work-in-progress valuation, so appraisers are forced to use subjective judgements. A credible and objective valuation method should help to minimise banking risk and, as a result, to increase lending activities. In the scientific literature, the fuzzy logic concept has been suggested to utilise for valuation purposes, but until now, it has not been not investigated for work-in-progress situations. Under the term of building, non-defined ("fuzzy") variables are usable and appropriate to predict the future. In this article, the author will describe and present a valuation model, which - in conjunction with automated project management tool - gives the best estimation of the actual Market Value of the project. The proposed model is based on Discounted Cash Flow (DCF) analysis. The article will also cover a case study to demonstrate the strengths of the model.

Keywords: fuzzy logic, Market Value, property, automated valuation model (AVM), work-in-progress, EVA.

1. Introduction, the reasons of research

Nowadays, after the great collapse of real estate market, financial institutions and other organisations dealing with real estate finance (including the providers of certain community sources) demand the submission of excessively detailed project documentations. The documentation has to contain the market appraisal being monthly or quarterly updated during the construction works. There are no standard, scientifically established models for the statements of Market Value\(^1\) of on-going projects; experts, while recording technical parameters, are enforced to evolve the Market Value by their own personal opinions. The technical literature of project management does not discuss the Market Value, however deals with the changes and monitoring of built-in technical contents. The latest method nevertheless does not follow the changes of the real estate market and the actual Market Value of the on-going development. The introduction of fuzzy logic into the practice of valuation still provides the possibility of keeping the subjective (soft) elements of the experts’ opinions however provides a well-organised calculation model for the hard facts being taken into account.

2. Valuation models and methods at a work-in-progress investment

The banking practice of great-volume commercial real estate projects before the crisis did not consider essential the market valuation of the development period. Investors considered it enough, in case the main indices, f.e. occupancy rate, and completion level, quality, followed the regulations of the loan agreements (Nádasdy et al, 2011).

The EVA-method (Earned Value Analysis) is a common and well-known project management tool, suitable to measure the financial and temporal performance of the project. Many technical articles discuss the suitability and enlargement of this method. A comprehensive analysis is published by Anbari (Anbari, 2003) for instance. The EVA approach investigates the project focusing only on financial and technical progression during the construction works, its assessment bases are the planned budget and the scheduled time. In this examination, the market evaluation of the project and the changes of market data and according to these, the changes of everyday Market Value are not enlisted; we would say that the examinations of EVA are suitable for the control of the suitability of the static, technical criteria. At the same time, the indices generated by the EVA are input information for the market valuation process. It is interesting that at the time of development of EVA

\(^1\) In present study I use the Market Value according to the definition of RICS as follows: „Market Value is the estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm’s length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion“
methodology, the utilisation of fuzzy language had been risen using soft descriptive variables instead of the usual discrete quantitative quantities (Noori et al, 2008).

3. Valuation based on fuzzy logic

The fuzzy logic was established in 1965 by Zadeh, when he described the so-called fuzzy set theory and defined the different operations (Zadeh, 1965). Many used his works in the past fifty years, and by today, fuzzy logic has become a general practical application in control system (Kovács, 1993). The basic idea is that one certain element might belong to an set at different levels; this theory maps the vague nature of human thinking and the grammaticals means of expression (Byrne, 1995). Different authors have examined the possibility of appliance of fuzzy logic in real estate appraisal. (F.e. Yalpir, 2011; Glumac, 2011, French, 2010, Zurada et al, 2006, Bagnoli, 1998 etc). All articles are common in that the authors consider the fuzzy method, the “soft” descriptions much more appropriate to real estate market forecasts, than valuations given by concrete data or ranges. For example for estimation of apartments’ prices in Turkey, Yalpir introduces a simple correlation that describes the market better than the usual hedonistic model (Yalpir, 2011). The method of fuzzy logic also suitable to provide information about the risks of the market for investors, as also in this case, it is to model the common effects of vague forecasts. (Hui et al, 2009). Authors have found the fuzzy logic also in the valuation process, and developed a method to measure the environmental output of the contractors for example (Yao et al 2007). Lee and his co-authors have worked out a complete mathematical real estate appraisal model, where the ranking of the variations were considered as experts’ exercises.

Everyday professional practice as well as the different international methods in real estate appraisal (RICS, TEGOVA, IVS) prescribe to define and authenticate an exact amount as Market Value. Following the crisis in real estate industry, the professional dispute has started how to comment on the possibilities of surety and domain along the provided discrete value. While a value-range or a triplet of an optimistic/realistic/pessimistic value might provide more information for the users about the uncertainty of expected values, it is also possible that users misunderstand and use in a wrong way. French in his article suggested to interpret the appraised values in a graph of density function to visualise the punctuality of valuations. (French, 2011). Theoretically, certain valuation variables might be regarded as random variables to set up an evaluation model; however, its closed mathematical solution can only be accomplished following making significant simplifications (Hajnal, 1994). The uncertainty of variables usually replicated with different simulation models (the Monte Carlo method, for example), while such solutions calculate with discrete values and assigned probabilities. It is important to note that the operations with the random variables (f.e. the Monte Carlo analysis) are formally similar to the fuzzy approach however its contents are purely different, as it utilises the inner rules of a non-linear world to establish the final conclusions (Bagnoli, 1998). In recent years, the methods of real estate appraisal have been fortunately growing (Pagourtzi, 2003; Kauko, 2009). Many “non-traditional” valuation methods have appeared in scientific publications, out of some are already introduced in everyday practice. The “non-traditional” methods are the different regressive, hedonic models, the artificial neurotic nets, the process of requesting experts’ opinions as well as fuzzy logic. In many of his studies, Kauko examines the fuzzy logic – based mathematics applicable at mass-like valuations. (f.e. Kauko 2003). He explicates by a detailed mathematical justification, that fuzzy logic, in highly uncertain valuation cases and markets, gives a better appraisal than either traditional valuation methods or the hedonic valuation model utilising the multi-regressive theory (Kauko, 2009). Van Kooten suggests the appraisal based on the fuzzy logic on the estimation of defining value of natural resources invaluable with comparative methods (van Kooten, 2000). This proposal might be normative in our studied case as on-going investments are usually not subjects of transactions, therefore cannot be evaluated by comparisons.

4. Advantages of fuzzy approach, specialities of the problem from the point of view of the appraisal

The all-time Market Value of the real estate is excessively interesting information both in the point of view of the bankers and the investors; presently used techniques however do not provide solutions for the estimation of Market Value while the construction works are in progress. Its’ reason is that investment activity had been extremely high before the real estate crisis, and preliminary expectations usually achieved or even exceeded the forecasted market value of the completed project. Along with the entry of the new market paradigm, it has been clear that the value of real estate can also increase or decrease either in short and long term. At the same time, investors have been heavily controlled by creditors’ control, since the financiers wish to decrease the number of bad or falling projects. Because of all these, the appraisals have faced the requirements of the demand to provide well-based Market Value estimations also during the construction phases of projects.
In the period of the construction works, the uncertainty of the appraisal is the highest (vide Figure No. 1). Therefore, there are no similar buildings in transactions to those ones that are under construction, within this period, it is not possible to apply the comparison-based method. In case of commercial real estates, the cost-based approach is not convenient for investment and loan providing purposes either, hence only the yield-based approach and its model, the DCF (Discounted Cash Flow) can be contemplated. The general formula of the DCF model is as follows:

\[ V = \sum_{t=0}^{n} \frac{F_t}{(1+i)^t} \]

where

\( n \): number of investigated periods,
\( i \): applicable market yield, and
\( F_t \): net revenue realised in \( t \) period.

However, as the uncertainty in the period of construction is very high concerning the variables of the cash flow while forecasts are plastic, they are “soft”.

5. General description of the suggested model

The model suggested by the author integrates the advantages of DCF method and fuzzy approach and makes it possible in the different phases of construction for the appraiser by the consistent process to put up estimations to the actual Market Value of the project. First thing is to examine what type of information are available about a project under construction, secondly, that these information have impacts to which DCF appraisal variables. The financing partner usually receives information from four sources relating to the projects. These are the technical area (by the technical supervisor appointed by the financier), the sales area, the legal area and finally the bunch of general market information. Some of these information are quantified such as the expected costs of additional work at the technical field. Some are verbal ‘fuzzy’ information such as the setting of the real estate investment market. The following Table No. 1. shows the specific data of an institutional real estate development that are influencing the Market Value.

<table>
<thead>
<tr>
<th>Technical information</th>
<th>S&amp;C budget</th>
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<tbody>
<tr>
<td></td>
<td>Additional Budget</td>
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<td></td>
<td>Fit-out Budget</td>
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<tr>
<td></td>
<td>Shell&amp;Core completion</td>
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<tr>
<td></td>
<td>Fit-out completion</td>
</tr>
<tr>
<td></td>
<td>On-going disputes</td>
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<tr>
<td>Letting information</td>
<td>Vacancy</td>
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</tbody>
</table>
During the construction works, the DCF model in some of its elements (for example in conditions of finance) is already fixed, some elements are however influenced by the information above. The involved variables of the DCF model are: Hand-Over Date; Total Budget; Rental Income; Rental Term; Vacancy; Absorption; Interest Rate and Exit Rate. The ‘Vacancy’ for example can be equally modified by the rental negotiations, the tenancy legal and market circumstances. The point of the suggested model is, that the information arrived at a certain time – following their ‘fuzzification’ – is converted into DCF variables according to a planned logical scheme by utilising fuzzy rules and prepare the DCF analysis with these. Simpler and more difficult computer solutions are available for the operations on fuzzy sets, for example an easy internet application\(^1\). The process of the fuzzy model calculating the variables is shown on the following picture (Figure No. 2).

![Figure 2. Process of the set of variables](http://cld.mst.uni-hannover.de/cldtools/faces/fuzzyCalc.jsp)

6. Case study by applying the model

The aim of our case study is to introduce the effectiveness of the method. The subject of the case study is an office building for lease being constructed in the years of the market depreciation, meaning within a continuously changing market relations. Regarding that the building had been constructed by re-building and expansion of an earlier monument of a school building, the implementations required complex technical works. All the real estate appraisals are available for us prepared by the appointed appraisers, moreover, we are in the possession of the monthly reports indicating the actual prospects of the certain fields verbally. By analyzing the reports it has become possible, the (post-factum) preparation of the systematic, fuzzy logic based valuations and their comparison with the official appraisals. In our case study, we have examined the two key variables of the project, namely the date of occupancy permit and the exit rate, and we have created the above system of rules for these latters. With regard to the generally unfavourable market expectations of the years 2008 and 2009, the input variables could apply the following fuzzy values:

\(^1\) [http://cld.mst.uni-hannover.de/cldtools/faces/fuzzyCalc.jsp](http://cld.mst.uni-hannover.de/cldtools/faces/fuzzyCalc.jsp)
Considering the handover date Finishing date of Shell&Core As planned Small time-lag Great time-lag
Finishing date of tenants’ fit out As planned Small time-lag Great time-lag
Disputes nil Manageable Significant
Starting date of Tenancy As planned Small time-lag Great time-lag
Issuance of Building permission As planned Small time-lag Great time-lag
Issuance of permission As planned Small time-lag Great time-lag

Considering the EXIT rate Legal circumstances - EXIT Stagnant Bad Very bad
Change of market Stagnant Weak Very weak

The possible values of the two examined output fuzzy variables:

<table>
<thead>
<tr>
<th>Issuance of permission</th>
<th>As planned</th>
<th>Small time-lag</th>
<th>Great time-lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXIT rate</td>
<td>As expected</td>
<td>Unfavourable</td>
<td>Highly unfavourable</td>
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</table>

The system of fuzzy rules have been set up between the input and output variables. The system rules have altogether 729+9 rules. We introduce sample rules each for the two output variables as follows:

- **IF** the ‘Shell&Core finishing date’ are As Planned and the ‘Finishing date of tenants’ building out’ is in Small time-lag and the ‘Disputes’ are Manageable and the ‘Starting date of Tenancy’ is in a Small time-lag and the ‘Issuance of Building permission’ is As planned **THEN** the ‘Issuance of permission’ is in a Small time-lag.

- **IF** the ‘Legal circumstances considering EXIT sales’ is Bad and the ‘Change of Market’ is Weak **THEN** the ‘EXIT Rate’ is Highly unfavourable.

In the interest of ‘defuzzification’ of calculation results as fuzzy variables, we created customized rules based on our practical experiences. With these variables, we used the DCF model for the certain valuation periods. We compared the original Market Values with the re-valued results with fuzzy method on Figure No. 3.

![Figure 3. Comparison of Market Values](image)

7. **Summary and conclusion**

The study case presents well how to make the estimation of Market Value more reliable by systematic construction of variables. The fuzzy language is a great assistance in this procedure as many of the variables are non-quantitative while other variables, even if they are given numerically, these discrete numbers still contain significant uncertainty. Preparing such a fuzzy knowledge base and a decision-making motor for general cases might be the subject of further research works. The model described above could be linked to an automatic project management toolbar or platform that might have further possibilities to define everyday value of the project automatically and reliably for the financiers.
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