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ADVANCES IN MASS APPRAISAL METHODOLOGY – AN INTERNATIONAL PERSPECTIVE

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Topic W21: Tools to Facilitate Housing and Urban Processes

Advances in mass appraisal methodology – an international perspective

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Abstract

Mass appraisal may be defined as a systematic appraisal of groups of properties using standardized procedures. The accurate assessment of the value of a predefined set of properties, or one particular property, indirectly, using a model, for a given practical purpose, is the main target of these methodologies. Several contributions have addressed the importance of mass appraisal, exploring the relationship between the property value, the property characteristics and urban social and economic problems. Arguably, the standard multiple regression analysis (MRA) based hedonic price models are not suitable for capturing all the necessary information involved in the formation of value, and the literature on how to develop the value modelling tools further is evolving. Although the problems are highlighted, MRA remains at the moment the most important theoretical framework in mass appraisal.

The quantitative, MRA-based methodology may be referred to as the current advanced or orthodox approach to mass appraisal valuation. However, several other methodologies have been applied, which define a new approach to property mass appraisal valuation. In this work these methodologies may be dubbed as emerging or heretic because of their different theoretic basis from the MRA, the dominant approach to mass appraisal. Model-free estimation techniques such as neural networks and fuzzy logic have been introduced to bring some flexibility to the property value calculations, without neglecting the mathematical rigor. Pattern recognition is yet another relatively untried approach within this realm. Indeed a number of contributions here offer ingenious and pragmatic, if not totally transparent, modelling methodology.

This paper is intended as an academic project involving cross-disciplinary and cross-cultural aspects. It is also intended as a guideline for practitioners. We will approach the issue of methodological evaluation on the basis of technical and institutional criteria.

Keywords: mass appraisal methodology, cross-disciplinary, cross-cultural.

Introduction

It is widely recognised today that the development of urban areas requires sustainability. It is increasingly also being recognised that this concept is multidimensional involving ecological, environmental, economic, social and cultural aspects such as viability and QOL. With the help of mass appraisal methods it is possible to extract key dimensions of viability and QOL from a complex set of micro-level housing market data. This requires the use of high quality data cross-sections and a robust modelling tool. This could be characterised as an innovative socio-economic and geographic approach to the analysis of markets and price formation – the methodology is quantitative by definition, but because of the practical applicability aspect involved, it is not restricted to elegant formal modelling protocols. Currently, however, comprehensive mass appraisal systems – or even automated valuation methods (AVMs) – are limited to property tax applications in a few countries, notably the US and Denmark.

In this project we set out to explore the possibilities within this under-theorised problem area. The paper reports the main findings of a project funded by OTB Research Instute for Housing, Urban and Mobility Studies, and RICS, and carried out during 2006. The space available does not allow detailed descriptions of each method, but such information is available elsewhere: for a literature review, see Kauko (2004); for presentations of an event organised in October 30, 2006, see http://www.otb.tudelft.nl/live/pagina.jsp?id=ac23443b-6d94-4513-a9ea-d312362c0b8b&lang=en

Background

The systematic appraisal of groups of properties using standardized procedures is known as mass appraisal. The social-economic relevance of this topic cannot be over-stated if we consider that the main target of such methodology is an accurate assessment of the value of a predefined set of properties, or one particular property, indirectly, using a model, for a given practical purpose. The importance of mass appraisal may also be seen from the possibility to link the relationship between the property value, the property characteristics and urban social and economic problems. The literature on mass appraisal modelling tools (including AVMs) is rich and evolving. While the standard multiple regression analysis (MRA) based hedonic price models may not be the most suitable tools for capturing all the necessary information involved in the formation of value, MRA remains at the moment the most important theoretical framework in mass appraisal.

In this project we explored the possibilities to develop mass appraisal methods, following two different arguments: one, that the performance and feasibility of appraisal methods be compared and evaluated with regard to a set of *technical criteria*; and two, that differences in the suitability of methods also have to do with the *particular context* where application takes place. The topics covered three sorts of issues related to current mass appraisal practices and market analysis methods and their development possibilities: first, technical aspects concerning accuracy and other issues about model reliability and validity, second, institutional aspects, that is to say, the link to the specific country or regulative context, and, thirdly, speculative aspects about future changes in circumstances and an adaptation in the performance criteria that affects the valuation. (Thus the latter two aspects pertain to context.)

That the perspective of the analysis is both cross-disciplinary and international gives an added value to the analysis. In the spirit of Nobelist Herbert Simon, Stephen Roulac, a respected real estate scholar, points out that one should avoid limited exposure to scientific ideas; according

to another important contributor to the real estate field, Graeme Newell, it pays of to engage in international research collaboration for the following reasons (see Manning et al. 2007): one, the topic of real estate is itself being *globalized*; two, even if the sub-topic happens to be *localized*, it is worth-wile to compare country-specific experiences of the phenomena in question, as well as different cultures of doing research of these phenomena. While all this is agreeable, one could here replace 'country-specific' with 'country-, region- or city-specific'. The case with mass appraisal definitely falls within the category (2): it is a highly localized activity, which is carried out differently in different contexts, and thereby provides and interesting objective also from an international point of view.

Objectives

We formulated three objectives for the project:

1. To understand the problem of advancing mass appraisal methods/expertise from both points of view: the scientific debate and the practical feasibility.
2. To evaluate a set of heretic and orthodox methods based on a set of specific criteria, partly technical/practical and partly institutional.
3. To establish an international platform for broader networking within this realm.

The project covers a variety of valuation issues, some of which are related to methodology and others to particular circumstances where the application takes place. This coverage includes the comparisons of performance using a wide range of approaches, from rather traditional to highly novel – and yet-to-test – ones: it is really about the cutting edge of valuation methodology. This project also provides an indication of new tendencies and directions in addressing valuation problems that may be common for different countries. Therefore, this project enables the systematic unification of problems – not only of methods – experienced in the mass appraisal of a set of different countries. In doing so, our project addresses both practitioners and academics. So far reviews have been written for either practitioners (e.g. Adair et al. 1996) or academics (e.g. Sirmans 1982) but not for both – in fact, to our knowledge, almost nothing comparable has been written recently.

The contents

	Participant	Contribution
Mass appraisal practice and recommendations	Richard A Borst (US), with William J. McCluskey (UK)	The comparable sales method as the basis for property tax valuation system in US and its relationship and comparison to geostatistical valuation models
	Nikolaj Siniak (Belarus)	Mass appraisal of real estate and fuzzy numbers in Belarus
	Dree Op't Veld with colleagues (The Netherlands)	Automated valuation in the Dutch housing market
	John Thompson (US)	Experience of building the AVM for England

	Participants	Contribution
Current advanced methods	François Des Rosiers with Marius Thériault (Canada)	Mass appraisal, hedonic price modelling and urban externalities
	Malgorzata Renigier (Poland)	Residual analysis for constructing "more real" property value
	Marc Francke (The Netherlands)	Hierarchical trend model

	Participants	Contribution
Emerging methods	Marco Aurelio Stumpf Gonzalez (Brazil)	Developing mass appraisal models with fuzzy systems
	Tom Kauko (Finland)	Unorthodox approach to mass appraisal based on patterns and judgements
	Maurizio d'Amato (Italy)	Rough set theory as automated valuation methodology

	Participants	Contribution
Comparison of tools using a set of specific criteria	Those who contributed to this module: Borst, Des Rosiers, Renigier, Stumpf Gonzalez and Kauko	Technical comparison of the methods including formal testing of accuracy and other modelling performance using own datasets and MRA
	d'Amato and Kauko	Property market classification, mass appraisal and institution

Below we go through the conceptual ideas and empirical evidence in relation to each value modelling approach, as described by each contributor. We begin with reporting practical considerations of mass appraisal modelling as highlighted by a set of country-specific cases. The next section then after that gives an overview of various techniques and methods, some of which are already in use and others which are being under development. The section after that then compares the methods with regard to performance, feasibility and other criteria. A summary and discussion of the findings is provided in the final section.

Practice and recommendations

The comparable sales method as the basis for property tax valuation system and its relationship and comparison to geostatistical valuation models

Richard A. Borst provided information about mass appraisal experiences in the US. He also provided us with a methodological overview, and his own recommendations as regard to which approach he favours himself, namely the *weighted residual error approach*, which among practitioners is in fact known as the *comparative sales approach*. Here the analysis is

based on a dissimilarity matrix, where more similar elements receive a larger and less similar ones lower weight in the computations. Borst showed how certain *geo-statistical methods*, namely the spatially lagged weight matrix model and geographically weighted regression (GWR) are loosely based on these same principles as the comparative sales method. Of course, in common use the comparative sales method is still meant as a very localised method and is not quantitatively demanding either.

Mass appraisal of real estate and fuzzy numbers in Belarus

Nikolai Siniak then continued with a description of mass appraisal in Belarus, where *fuzzy numbers* have been applied to reduce the inaccuracies resulting from poor data availability. Such a method emphasises perceptions rather than measurements, and has its basis in a scientific philosophy outside the ideals of rational and equilibrium thinking. According to Siniak the Belarusian experience of land valuation is positive. Siniak not only taught us about a completely different country context but also justified the use of a completely different method than what normally is the case.

Automated Valuation in the Dutch housing market

Dree Op' t Veld showed an application of automated valuation from the Dutch housing market. In the Netherlands realtors play an important role: they are involved in the sales of about 90 % of all houses sold. Typically, the sales process starts with the invitation of a number of realtors to have a look at the house and give their opinion on the market value, the sales strategy, the asking price and the transaction price possible given the time available. From the invited realtors the seller selects the most convincing one, who subsequently is commissioned to sell the house, earning a negotiated percentage of the sales price. Clearly, the better the estimate of the market value, the better the chances of a successful and satisfying sales process. To assess the market value of any house in the Netherlands, the NVM – the Netherlands Organisation of Real Estate Agents – provides their members with "MarktPositie", a web-application for the automated valuation of any house giving its characteristics using a hedonic price model. Op't Veld provides a description of the web-application, the hedonic price model and the data available.

Experience of building an AVM for England

Compared to the generally data rich US in the UK problems arise due to poor data availability and indirect procedures of data management. John Thompson continued on UK experiences on the issues of setting up a countrywide model based on a set of models. The method is built in four steps of computing: first, the market adjustment of five selected comparable sales with regard to the comparability distance in terms of all input dimensions; second, the weighted average estimation of these observations (i.e. the sixth value); third, the MRA estimation of the subject property (i.e. the seventh value); and four, average of the middle two or three values. Subsequently, confidence measures for each estimate provides the justification for accepting, rejecting, or reviewing the valuation.

Interim conclusion 1

These descriptions illustrated valuation problems and possibilities in completely different market circumstances and data availability situations: first, the Anglo-American, where regression based methods have been used successfully for about half a century, then, the

Dutch, where data availability today is also good, but where automated valuation tools have been taken to use relatively recently, and lastly, the Eastern European emerging economy, where limitations have to be compensated by focusing on the modelling assumptions. Interestingly, in the last case the resistance to state-of-the-art applications may be lower than in the former cases.

After those presentations the richness of the discussion could already be seen on two levels: the kind of methodology preferred, and actual empirical context where the application takes place. The remainder of the paper provide us with six more descriptions on what academia has to offer in terms of sophisticated modelling approaches. These presentations deepened the first of the arguments above (regarding technical issues) with an indirect link to the second and third argument (regarding contextual issues).

Current and emerging methods

Mass appraisal, hedonic price modelling and urban externalities

François Des Rosiers presented a comparison of various methods that can be considered *spatial extensions of the hedonic regression approach*. He also provided a well-structured discussion of urban externalities and geographical accessibility with a house price modelling application from Quebec City, Canada. First Des Rosiers explained the relevance of including externality effects – exemplified by power line proximity and school districts – as well as modelling accessibility to urban services. After that, he compared the performance of two spatial methods: Casetti's spatial expansion method, and GWR. The former, while less accurate of the two, has the advantage of capturing also aspatial effects on property value. Finally, it may be concluded that, when comparing essentially economic and geographic methods, the application depends on the goals of the research. Is it about understanding the processes behind the phenomenon (as with the typical economist's strive for the ability to control), or is it about achieving accurate modelling results (as with the typical geographer's strive for depicting detail)?

Residual analysis for constructing "more real" property value

Malgorzata Renigier presented a *residuals analysis for correction of price differentials* in the context of Olsztyn, a Polish city. In her approach the causative sources of price dynamics are split into a predictable, deterministic component, and into an unpredictable, stochastic component, the spatial distribution of which is conveniently illustrated by plotting it as a residual value component. The value of this approach is to recognise and measure investment niches. In this treatment, it may be that unidentified, and spatially unevenly distributed externalities caused by technical and political changes need to be corrected for in order to guarantee the sustainability of future valuations. While the method was by and largely received as an innovative addition to our arsenal, potential flaws and inconveniences were noted related to the specific geostatistical procedures applied in the modelling.

Hierarchical trend model

Marc K. Francke showed his results using *hierarchical trend modelling* – a combination of time-series and segmented hedonic modelling. Robustness is another problem for space and time dependent modelling, and with Francke's approach this drawback is possible to overcome in a general modelling framework that is still within the orthodoxy of parametric

estimation method (state-space modelling). Such a method is estimated with the Kalman filter. In his application he constructed one model for the whole of Amsterdam, and found how different neighbourhoods and house types have different effects on the price trend. The deviations from the general price trends were using this approach essentially treated within hedonic modelling and parametric statistics. Francke finally underlined the level of difficulty required to perform the analysis. On the other hand it was noted that the use of a priori determined segments poses a rigidity on the analysis that is present in many other methods too.

Developing mass appraisal models with fuzzy systems

Marco Aurélio Stumpf González argued that artificial intelligence based methods are easier to apply than the spatially extended hedonic regression based methods in the sense that the latter require much more specialized training about statistics. However, much in similar vein as Des Rosiers, his aim was to compare and combine two or more specific approaches or modelling techniques. The key to building the application in these highly computational modelling exercises was to trace the effects produced by submarkets. *The genetic algorithm* is based on the metaphor of survival of the fittest, and *the neural network* on the imitation of the brain functions. In both cases the aim was to apply the fittest results to determine rules for fuzzy systems of mass appraisal. The use of fuzzy rules based on genetic algorithms or neural networks produce efficient artificial intelligence and model-free *hybridizations* (i.e. combinations of elements from two or more techniques) that Stumpf González applies on house price data from Porto Alegre, a Brazilian city.

Unorthodox approach to mass appraisal based on patterns and judgements

Kauko dealt with two modelling techniques that he has been using for housing market research and real estate prices for more than a decade now: *the self-organising map* (SOM, also known as the Kohonen Map) and *the analytic hierarchy process* (AHP, also known as the Saaty method of elicitation). The SOM is a neural network technique that allows recognition of patterns in complex data sets. The AHP is a decision making tool that allows the quantification of nearly immeasurable attributes of the property value. While being fundamentally different from each other the two methods potentially complement more conventional methods of data analysis as well as each other. Regardless of the exact modelling approach, the requirements are always high for the quality of the data and the suitability of the method. Thus in that sense these two rather unconventional techniques are not different from MRA. (See Kauko, 2002, for housing market applications using the SOM and the AHP.)

Rough set theory as automated valuation methodology: the whole story

The description by Maurizio d'Amato on the use of *rough set theory (RST*) for this problem field was the most qualitative of the methods covered. Furthermore, because of the links made to bounded rationality this was the subproject that most severely questioned the analytical underpinnings of the hedonic approach. Using data from the Italian town of Bari he underlined the need to find solutions commonly not optimal but ‘satisficing’. Lastly d’Amato left some recommendations about the need for someone who applies such models to be familiar with the hedonic type of methodology as well. He furthermore speculated how AVM processes would not be able to replace the human analyst. d’Amato’s illustrative and carefully thought argumentation brings completely new issues into the discussion; without being aware

of the whole gamut one is likely to only reproduce the past methodological assumptions, even in situations that require thinking outside the box. The question is however how to standardise the use of RST into a feasible enough sequence of procedures.

Interim conclusion 2

The discussion proceeded along the dimensions outlined by of broad methodological approach: namely, the contributions of Borst, Op't Velt, Thompson, Des Rosiers, Renigier and Francke can be considered *orthodo*x in the sense that the basis for the method is still the hedonic model and the parametric statistical approach; and the favourite methodologies of by Siniak, Stumpf González, d'Amato and Kauko, in turn can be considered *heretic.*

One of the main issues raised concerned the need to validate the results with independent samples, which is common practice in the use of mathematical tools (i.e. of the more heretic kind) but not in the use of statistical modelling (i.e. of the more orthodox kind). The principal difference between the two empirical quantitative modelling paradigms is that, whereas the statistical models rely on probability theory, the mathematical modelling tools require an independent sub-sample (or even better, with two sub-samples). This is because no assumptions are made about whether a given sub-sample is representative of the total population, or about the distribution of this population. Another intriguing issues brought up was the value of different metaphors that are used for simplification of the complexities involved: 'simulation of human mind functions' in neural network modelling, and 'the rational actor and efficient market' in hedonic regression modelling.

Comparison

Technical comparison of the methods including formal testing of accuracy and other modelling performance using own datasets and MRA

The next module of the project was an evaluation of valuation accuracy using common datasets and more formal criteria (see Kauko 2004).

Borst provided results with various methods on the same data sets of three American counties. In his presentation comparative sales based results were compared with those using MRA, Kriging and GWR methods on the same data set. In fact, all these methods can be understood as related in the sense that they all include a residuals analysis. According to these results the comparative sales methods outperforms the other methods in term of accuracy (see table 1). In a strictest sense Borst compared the baseline OLS, segmented OLS and comparative sales method using three different datasets. For the accuracy criteria all three methods are sufficient. However, the comparable sales method wins in all three different datasets and using all three criteria: COD, percentage accuracy (Thibodeau 2003, see table 2) and spatial autocorrelation. Moreover, the comparable sales method provided a crucial reduction in spatial autocorrelation, which adds to the evidence of this method being 'best practice'.

Table 1. Comparison of COD among all tested methods

	Number of Sales in Model	Best Global Model	Best Segmented Model	Best Binary Model	MBV as Independent Variable in Global Model	MBV and Best Segmented Model	GWR Global	Comps Method
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Catawba	7,107	11.05%	10.21%	11.00%	11.08%	10.55%	9.97%	9.75%
Fairfax	19,983	8.94%	6.95%	7.22%	7.05%	6.88%	7.30%	6.52%
Sarasota	24,616	18.99%	14.36%	15.68%	16.09%	14.09%	13.15%	12.92%

Table 2. Accuracy comparison

	Catawba			Fairfax			Sarasota		
Accuracy Range	Baseline	Segmented	Comps	Baseline	Segmented	Comps	Baseline	Segmented	Comps
95-105%	32.01%	35.22%	38.19%	37.40%	47.52%	51.26%	18.38%	26.73%	30.54%
90-110%	58.60%	61.83%	65.19%	65.05%	77.29%	80.87%	35.42%	49.51%	55.39%
85-115%	75.97%	78.47%	79.81%	82.36%	90.44%	92.24%	50.51%	66.25%	71.44%
50-150%	98.68%	99.20%	99.27%	99.75%	99.89%	99.90%	93.13%	96.73%	97.25%

The GWR method was due to its computational intensity substantially slower than traditional OLS techniques. As for the mixed regressive spatially autoregressive model, user friendly software was not even currently unavailable. However, these problems are expected to be overcome with technological development.

Des Rosiers compared the performance of seven models on one dataset. While all models have sufficient percentage accuracies, the best accuracy was obtained with GWR (see table 3). On the other hand, the expanded OLS method was best from an explanatory point of view.

Table 3. Accuracy comparison of the models

Model type	(Mean % error)	% of cases with errors within 5%	% of cases with errors within 10%	% of cases with errors within 15%	% of cases with errors in excess of 50%
OLS basic prop. specifics, vegetation, centrality (B)	0.0963	0.32	0.60	0.80	0
OLS B + Household Data (H)	0.0914	0.34	0.63	0.82	0
OLS B + Census (C) + H	0.0865	0.36	0.65	0.83	0
OLS-Expanded B + C + H + interactions	0.0815	0.37	0.68	0.87	0
GWR B	0.0782	0.39	0.69	0.88	0
GWR B + H	**0.0780**	**0.39**	**0.71**	0.88	0
GWR B + C + H	0.0819	0.38	0.66	0.86	0

Renigier compared linear models with more advanced models on one dataset, and found that geostatistical models outperform linear regression models; multifunctional models outperform linear, exponential and squared regression models; and that trend models outperform additive models. On the other hand, the better the model fits the data, the more credible and effective is the analysis of the spatial model of residuals. In the analysis carried out by Renigier, both the geostatistical model and the linear regression model were improved. As a result, the geostatistical model obtained the better fit to the market data (see table 4). Furthermore, the same procedure of model improvement is also applicable to linear regression analysis of more homogeneous and informatively effective markets. On the other hand, the procedure of constructing geostatistical models is more time-consuming and labour-intensive than constructing linear models.

Table 4. Comparison of the degree of fit of the geostatical model and the linear regression model.

Measures of the model adjustment	**SSe**	**R^2**	**A**	**SSq**
Linear regression model	1.369.591	0,38	87	42
The geostatistical model	**421.397**	**0,76**	**29**	**22**

Stumpf González compared four models on one dataset (see table 5): (1) traditional regression, (2) neuro-fuzzy, (3) generic-fuzzy based on house size, and (4) generic-fuzzy based on location. The model 4 wins the comparisons but the differences are small. In all cases the accuracy is sufficient. Here two more general conclusions could also be made: one, when using these methods pre-processing the data is important in order to avoid over-fitting; two, fuzzy rules are convenient for mass appraisal purposes.

Table 5. General comparison among the models (N=5,315)

Model	MAPE	RMSE	COD	$r_{SP.SP}$[h]	E<5%	E<10%	e>50%
Traditional regression model	14.23	2,308	13.91	0.9898	1,244 (23%)	2,392 (45%)	95 (1.8%)
Neuro-fuzzy model	14.57	2,398	14.67	0.9892	1,207 (23%)	2,351 (44%)	98 (1.8%)
Genetic-fuzzy model, based on GBA	14.14	2,322	14.04	0.9894	1,234 (23%)	2,385 (45%)	86 (1.6%)
Genetic-fuzzy model, based on location	13.38	2,355	13.85	0.9898	1,286 (24%)	2,416 (45%)	87 (1.6%)

Kauko compared the performance of MRA and SOM on several data sets, some of which also were used in the contributions above (see table 6). While most of Kauko's results (with either method) were to be considered below levels of acceptance, two of them were useful for

making conclusions about the relative merits of each method. In one comparison, the SOM outperformed the MRA and the criteria of sufficient accuracy was also fulfilled. In another comparison both methods reached sufficient accuracy, but the accuracy of the SOM was lagging behind that of the linear MRA. As it happened, these two datasets were of different nature: with a more heterogeneous house type included (Heerlen, the Netherlands) the SOM performed better than the MRA, whereas with a more homogeneous house type (Fairfax, US) MRA performed better than the SOM. While this, at last, could be interpreted as a small victory for the credibility of the SOM, one must remain cautions, because, besides the accuracy criteria, considerations regarding research ethics and feasibility do not suggest the use of SOM is problem-free.

Table 6.. Comparison of modelling accuracy between SOM and MRA on various datasets (the 'sufficient' results emphasised)

MODELLING TECHNIQUE	1. MEAN ACCURACY OF ERROR (N=100)	2. PROPORTION OF ERRORS WITHIN 5-%:	3. PROPORTION OF ERRORS WITHIN 10-%:	4. PROPORTION OF ERRORS WITHIN 10-%:	5. PROPORTION OF ERRORS OF MORE THAN 50%
OLSZTYN, POLAND: 14 VARIABLES, N=720					
SOM	40.8%	11%	24%	28%	19 %
MRA LINEAR	46.3%	9%	17%	29%	56%
HEERLEN, THE NETHERLANDS: 15 VARIABLES, N=2558					
SOM	**14.7%**	27%	**50%**	70%	1%
MRA LINEAR	21.8%	22%	37%	59%	8%
MRA, LOGARITHMIC	25.6%	14%	18%	29%	8%
CATAWBA, FLORIDA, US: 18 VARIABLES, N=7007					
SOM	27.5%	14%	34%	43%	12%
MRA LINEAR	25.0%	19%	29%	48%	5%
MRA, LOGARITHMIC	24.3%	18%	30%	46%	10%
FAIRFAX, VIRGINIA, US: 19 VARIABLES, N=14718					
SOM	**16.6%**	26%	44%	55%	2%
MRA LINEAR	**12.4%**	20%	**52%**	66%	**NONE**

Property market classification, mass appraisal and institution

At the micro-level of the property market, disequilibrium and inefficiency are reality, and involve considerations that extend beyond issues of information and data availability. D' Amato and Kauko stress the importance of classifying the particular property market and considering the institutional environment of the valuation. When looking for a general

framework for the application of mass appraisal methodologies one also needs to focus on the relationship between the property market and mass appraisal methodology, and not limit the attention to the latter. Starting from an institutional point of view (D'Arcy and Keogh 1999), the definition of 'market efficiency' may be revised, in order to classify property markets across the world based on their specific properties with regard to information, maturity and institutions. It can be argued that the selection of mass appraisal method may not be a simple problem of technical and statistical affordability of the tool. It could be influenced by the availability and quality of the data, and it may be correlated to the features of the market in which the method is applied instead of applying only methodological criteria for the evaluation (see Fig. 1.).

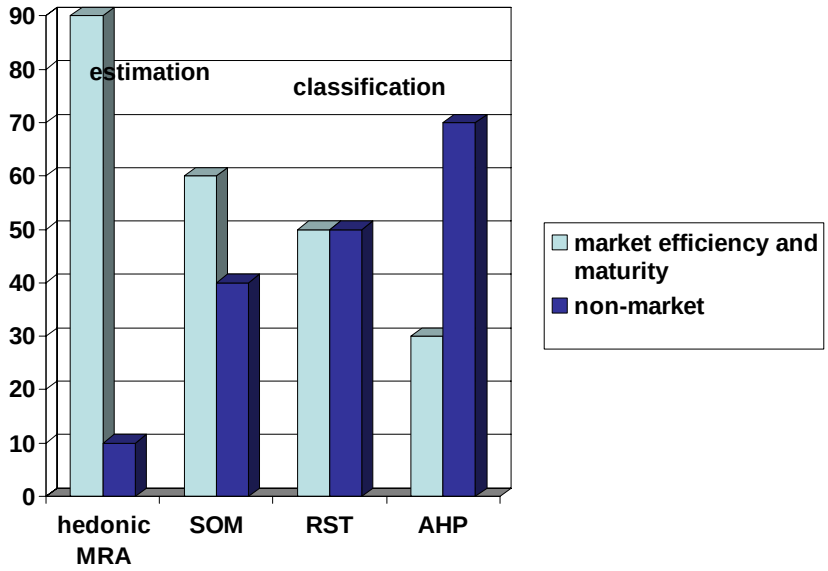

Figure 1. Examples of methods in relation to context.

The third issue outlined at the outset still remains. Below we elaborate on *the need to relate models to changes in the environment itself*, and *the need to relate models to changes in criteria/perceptions of individuals in order to evaluate the environment.*

Future changes in context

The main novelty of using residual modelling and geostatistics for mass appraisal is the capability of price correction due to externality effects. If we now build a simple valuation model that misses relevant new externalities – either negative or positive – that occur because of technical of political influence, we have a problem. For instance, a wind-farm is built or a local tax is levied and the actual market prices are reduced because of that, but the value estimated by the old model remains higher. Or, similarly, a river is cleaned, with a subsequent lift in the real attractiveness value of the location, but which remains unexplained by the old model. Or a new rock drilling technology allows digging a tunnel through a mountain, with anticipations of improved accessibility in travel time and subsequently higher price expectations for the areas affected. Now, the approach were residuals are reduced or added to the modelling estimates can mitigate much of such problems.

For some of the specific externality effects on property values it is too difficult to arrive at a clear conclusion about what the value influence might be using a simple model. The logical argument leads us to believe there is an effect, but then the actual empirical evidence does not

lend much support unless using interviews. However, the geostatistical residuals modelling approach brings a more powerful method for this than the basic hedonic approach. Thus on a more general level it can be argued that some yet unidentified and spatially unevenly distributed externality effects may indeed exist; these are detrimental effects or bonus effects sticking to a certain location, and not necessarily captured by a basic model well as they are or might be captured by the more sophisticated model based on residuals and geostatistical modelling. (Cf. Chica-Olmo 2007)

How then to construct indicators of sustainability in relation to market value when such indicators are not recorded in datasets? Positive or negative price corrections have to be added in such a situation as there are *a priori* no supply or demand proxies for all possible indicators that have an impact on value.

- ⇨ Do we opt for a residuals approach (Renigier, Borst, see above)?
- ⇨ Do we opt for a multi-criteria/judgement approach (fuzzy or rough sets, AHP)?

The market situation and individual action together with externalities caused by political or technological change determine sign and magnitude of price correction: discount for unsustainable property, premium for sustainable property. In other words, a new environment requires new criteria of appraisal. When databases improve and such info (health, environment, social issues) is recorded, then the valuations become sustainable, and subsequent investments become sustainable in the long run.

Daly et al. (2003) carried out an excellent piece of research in the context of *single-property valuation.* The practical valuation problem concerns how lender pressure influences the residential valuer to overvaluation: the bid price is higher than the transaction price, and often unsustainable in the light of anticipated market behaviour. As a consequence, today's mortgage valuation is problematic. (In Australia the results were slightly better than in the UK or in Ireland, but in Germany, for example, a truly sustainable value concept is applied.) What is interesting here is the propagation of the 'behavioural paradigm' in residential valuation, which puts more emphasis on the demand or consumer-driven factors related to preferences and intangible quality components, and evaluates the performance of a given method regarding these aspects. Indeed, there are often problems with listed price data (scarcity, unreliability and low quality), which means that conventional methods do not apply. Including such elements of *consumer behaviour* and *quality* to the mass appraisal method would improve its conceptual soundness; that is, why multi-criteria decision-making analysis is the most conceptually sound approach to valuation as it explicitly deals with such elements.

Interim conclusion 3

In most cases, the more advanced methods outperform linear regression, and furthermore, all methods tested reached sufficient percentage accuracy and fulfilled other technical performance. Here we should be aware that it may not be possible to satisfactorily carry out a strict comparison of our methods based on the same data sets due to the analyst's lack of understanding of all local circumstances. Further to the stricter principles of comparison of mass appraisal approaches, the evaluation was continued on a level of more informal criteria and explorative results. The idea was that, if not enough 'formal testing' based on same datasets is possible, then the evaluation is carried out based on other criteria. The following issues were raised:

- scientific aspect: conceptual soundness, robustness and so forth;

- practical feasibility: mainly, how long it takes to run the analysis with ones PC;
- contextual criteria: for example, the Dutch data comprised detached, semi-detached and row housing; the American data comprised only detached housing.

Summary and discussion

All the contributions picked up at least one particular aspect of the topic, with the focus either on mass appraisal applications and country-specific circumstances, or on the relative merits of specific state-of-the-art methods and techniques. The contributions, while being of high academic quality, are also considered relevant for practitioners, bringing the set of issues forward to those who decide about the standardisation of mass appraisal methodology. There is also a need to launch methodologies that are comprehended as trustworthy – not only for us professional experts, but also for the public eye.

The paper has noted several challenges for building a valuation methodology. Accuracy and robustness across space and time are the clearest problem for modelling. Moreover, the methodological evolution in value modelling pose problems as it is not happening in a vacuum, and therefore the need to relate mass appraisal techniques and approaches into the particular geographical-institutional context is evident. In doing so, different questions need to be asked:
- Are the markets transparent enough (perhaps not in Italy and the Netherlands)?
- What is the availability of data (rather poor in England and Wales until very recently)?
- What is the possibility to gain foothold amidst established tools (difficult in Finland and the Netherlands)
- What kind of inertia is prevailing in general (*pro* or *con* AVM)?

At the outset, the project had three goals: (1) to understand the problem of advancing mass-appraisal methods/expertise from both points of view: the scientific debate and the practical feasibility; (2) to evaluate a set of *heretic* and *orthodox* methods based on a set of specific criteria, partly technical/practical and partly institutional; and (3) to establish an international platform for broader networking within this realm. All these goals were met at least partially: Projects such as this are important in order to widen the horizons of a given problem field. Links may be established between researchers and practitioners with a variety of professional affiliations and disciplinary upbringings. The common denominator is the applying of AVM, or having ideas of possibly applying AVM in the future. It can be argued that with improved preconditions for reciprocal flow of information and co-operation across vastly different academic communities on one hand, and between the academia and practitioners (i.e. the industry and the government interests) on the other hand, the likelihood for innovation discovery and synergy benefits increases. The avenue of research on AVMs, empirical modelling of property value, and systems for property market analysis is now marked.

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