Tom Kauko November 10, 2006

Report of the Seminar "Advances in mass appraisal methods"

In this seminar we explored the possibilities to develop mass appraisal methods, following two different arguments: one, that the performance and feasibility of appraisal methods may 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. This event took place at OTB Research Institute for Housing, Urban and Mobility Studies, Delft University of Technology, on Monday October 30, 2006. The number of invited participants was 27, representing ten different nationalities. Eight guest speakers (of eight different nationalities) contributed to the event. The rest of the participants represented various kinds of expertise in the field as well as researchers, for whom the event was meant as having educational purpose. Below the proceedings of the event are summarised speaker by speaker.

The event was opened by Tom Kauko (OTB Delft and Norwegian University of Science and Technology – NTNU), who provided an overview of the speakers and topics of the day. From the speakers he anticipated mind-boggling contributions, but also an openness, respect and modesty to allow fruitful debates among the group of participants. The topics would cover 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.)

Richard A. Borst (CLT Division of Tyler Technologies, Inc) opened the set of guest presentations by providing information about mass appraisal experiences in the US and UK. 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 not quantitatively demanding either. While his presentation mainly presented the results of a comparison between the accuracy performance of methods, he finally also noted the difference in country context too: compared to the generally data rich US in the UK problems arise due to poor data availability and indirect procedures of data management, which neatly build a bridge to the next presentation.

Nikolai Siniak (Belarusian State Technological University) then continued with a presentation 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. This presentation 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.

The first two presentations illustrated valuation problems and possibilities in completely different market circumstances and data availability situations: the Anglo-American, where regression based methods have been used successfully for about half a century, and the Eastern European emerging economy, where limitations have to be compensated by focusing on the modelling assumptions. Interestingly, in the latter case the resistance to state-of-the-art applications may be lower than in the former case.

After those two 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 proceedings provided us with five more presentations 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 argument (regarding contextual issues).

François Des Rosiers (Laval University) 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 modelling. 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, a discussion was devoted to the comparison of essentially economic and geographic methods, with the conclusion that the application of any one method indeed 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)?

Marco Aurélio Stumpf González (Universidade do Vale do Rio dos Sinos) 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. The position of this speaker thus seems diametrically opposite the preferences of the previous speaker. However, much in similar vein as in the presentation by Des Rosiers, the 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 data from a Brazilian urban property market context.

This presentation sparked off a lively debate about various issues related to feasibility and scientific quality of a certain valuation approach, and as to whether particular market circumstances matter. 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 (of the

kind used by Stumpf González) but not in the use of statistical modelling (of the kind used by Des Rosiers). 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.

Malgorzata Renigier (University of Warmia and Mazury) presented a *residuals analysis for correction of price differentials* in the context of 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. For example, a river is cleaned, or 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. 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 geo-statistical procedures applied in the modelling.

Marc K. Francke (Amsterdam Free University and OrtaX) 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.

Last of the individual presentations, but by no means least, was the presentation by Maurizio d'Amato (University Politecnico di Bari) on the use of *rough set theory (RST*) for this problem field. This technique was the most qualitative of the methods covered, and – because of the links made to bounded rationality the one that most severely questioned the analytical underpinnings of the hedonic approach. He went on to speculate with 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. The presentation by d'Amato was very illustrative and carefully thought involving plenty of metaphors. It succeeded in bringing 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.

The last module of the event was to evaluate the methods using common datasets and criteria (supplied in beforehand). At this point the original goal was to use common datasets (from Dutch and American circumstances) for the testing of methods and techniques, but such ambition turned to be too much to ask from the presenters, who already had to work hard to produce their individual presentations above. More generally, even if the idea seems good, it is possible that we cannot manage satisfactorily the strict comparison of our methods based on the same data sets due to people's lack of understanding of all local circumstances. The evaluation was in the end reduced to two shorter presentations by Kauko and Borst respectively, where an evaluation of valuation accuracy was carried out and compared using more formal criteria. At least most of Kauko's results with the Kohonen map technique were still to be considered below levels of acceptance. Borst then continued where he had left this morning by showing his 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.

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 participants can give feedback on other criteria. The discussion proceeded along the dimensions outlined by of broad methodological approach: namely, the contributions of Borst, 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 (who has applied a neural network aimed at pattern recognition as well as expert judgements), in turn can be considered *heretic.* 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.

As a last issue in the proceedings of the day, a condensed summary of findings were compiled by Kauko and d'Amato, with concluding comments presented by many of the participants. Like predicted by Kauko in the opening presentation, the level of all contributions as well as the discussion that followed was extraordinary high. All the presentations 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, were also considered relevant by the practitioners that were present. One particularly positive turn in the discussion emerged: one member of the audience, who was closely affiliated with the international valuation standards, was keen on bringing the set of issues forward to those who decide about the standardisation of mass appraisal methodology. Another comment emphasised the need to launch methodologies that are comprehended as trustworthy – not only for us professional experts – but also for the public eye.

At the outset, the seminar 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: (1) some very fruitful ideas were indeed aired during the 'roundtable discussion'; (2) while a full evaluation of the relative merits of each approach was not possible to do yet, a broader discussion was begun; (3) from the point of view of networking the situation now is promising: we intend to publish a book based on these presentations (RICS series is now proposed); as well as arrange follow up meetings, and to develop further the information put on the related web-page: www.IWGAVM.org.

Events such as this are important in order to widen the horizons of a given problem field. We were happy to note that, during the event, links where 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.