Adjustment Factor Valuation with a Multiple Criteria Analysis Method and Sales Comparison Approach

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Application of Multiple Criteria Analysis methods on property valuation field in order to:

- provide valid information with small dataset
- easy handling qualitative information
- improve property valuation with Sales Comparison Methods

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Result overview

- robust method
- give a confidence value interval
- ease to implement basic economic a priori
- allow for the inference outside data set domain

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Sales Comparison Approach / Comparable method

A set of procedures in which a value indication is derived by comparing the property being appraised to similar properties that have been sold recently, applying appropriate units of comparison, and making adjustments to the sale prices of the comparables based on the elements of comparison. The sales comparison approach may be used to value improved properties, vacant land, or land being considered as thought vacant; it is the most common and preferred method of land valuation when comparable sales data are available.

The Dictionary of Real Estate Appraisal, Third Edition, Appraisal Institute

Steps in AGM

- Market research to collect information on recent transactions
- Select relevant "comparables" and develop a comparative analysis
- Compare the subject property with comparable sales
- Estimate adjustment factors
- Adjust the sale price of each comparable
- Reconcile the adjusted price in a single value or a range of values

Algebra in AGM

$$\mathbf{S} = \mathbf{P} + \mathbf{A}\left(\mathbf{ZI} - \mathbf{X}\right)$$
$$\mathbf{V} = \mathbf{WS}'$$
$$\mathbf{WI}' = \mathbf{1}$$

$$\begin{pmatrix} s_1 \\ s_2 \\ s_3 \end{pmatrix} = \begin{pmatrix} 120.000 \\ 100.000 \\ 115.000 \end{pmatrix} + \begin{pmatrix} a_1 & a_2 & a_3 \end{pmatrix} \begin{pmatrix} -10 & 10 & 0 \\ 5 & -5 & 1 \\ -5 & 5 & -1 \end{pmatrix}$$

Isakson, H. R. (2002). The Linear Algebra of the Sales Comparison Approach. JRER, 24 (2), 117-128

How to find adjustment factors?

- Direct valuation based on previous knowledge
- Cost
- Matched Paired Analysis

- Algebraic solution
- Total Grid
- Replication Method
- MLR

UTilité Additive

UTA method is a procedure able to asses a set of utility functions, consistent with the decision-maker's a priori preferences.
The set of utility functions is assessed using an ordinal regression method and linear programming.
Linear programming is used to optimally adjust additive non-linear utility functions.

Uta main references

- Jacquet-Lagreze, E. & Siskos, J. (1982). Assessing a set of additive utility functions for multicriteria decision-making, the UTA method. European Journal of Operational Research, 10, 151-164
- Coleman, J., & Larsen, J. (1991). Alternative estimation techniques for linear appraisal models. Appraisal Journal, 59, 151-164.
- Kettani, O., Oral, M. & Siskos, Y. (1998). A Multiple Criteria Analysis Model For Real Estate Evaluation. J. of Global Optimization, 12, 197-214
- Aouni, B. & Martel, J. (2004). Property assessment through an imprecise goal programming model. INFOR, 42, 189

Given a set of comparables $A = \{a_1, a_2, \ldots, a_m\}$
which is known price (P) and some characteristics (G)

$$P = \begin{cases} p_1 \\ p_2 \\ \vdots \\ p_n \end{cases} \qquad G = \begin{cases} g_{11} & g_{12} & \cdots & g_{1m} \\ g_{21} & g_{22} & \cdots & g_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ g_{n1} & g_{n2} & \cdots & g_{nm} \end{cases}$$

Example:

Price	*SQ*	*AGE*	*UQ*
120.000	110	25	2
100.000	95	40	1
115.000	105	30	3

Objective functions and constraints

Objective function:

$$Min \rightarrow \varepsilon$$

Subject to the following constraints:

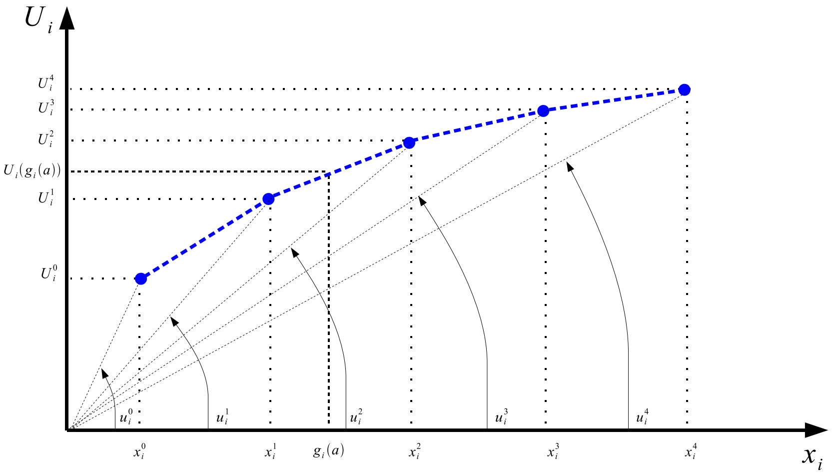
$$\begin{gathered} |p_1 - U(a_1)| \leq |\varepsilon| \\ \vdots \\ |p_m - U(a_m)| \leq |\varepsilon| \end{gathered}$$

Value function

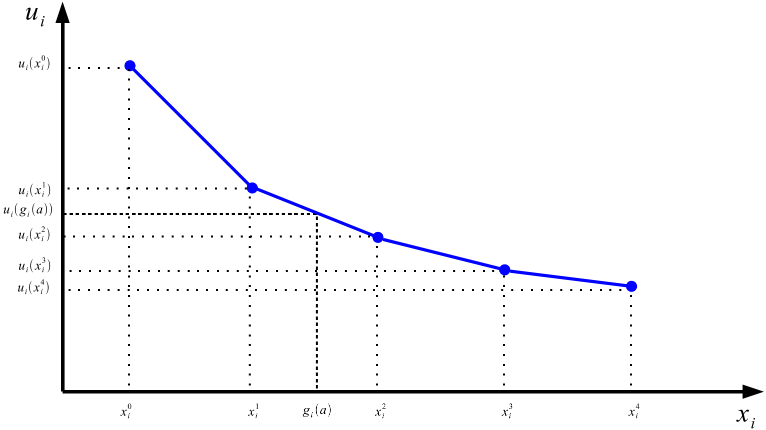
Value can be express using a piecewise additive value function:

$$U\left(a_j\right) = \sum_{i=1}^{n} u_i\left(g(a_j)\right) g(a_j)$$

Piecewise additive value function



Local evaluation function



Additional constraints

- Sign:

$$u_i\left(x_i^t\right) \geq 0 \text{ or } u_i\left(x_i^t\right) \leq 0$$

- Monotonous increasing or decreasing:

$$u_i\left(x_i^{t+1}\right) \geq u_i\left(x_i^t\right) \text{ or } u_i\left(x_i^t\right) \geq u_i\left(x_i^{t+1}\right)$$

- Declining marginal utility:

$$\frac{u_i\left(x_i^{t+2}\right) - u_i\left(x_i^{t+1}\right)}{x_i^{t+2} - x_i^{t+1}} \leq \frac{u_i\left(x_i^{t+1}\right) - u\left(x_i^t\right)}{x_i^{t+1} - x_i^t}$$

Confidence interval valuation and value function space

Objective function for confidence interval valuation:

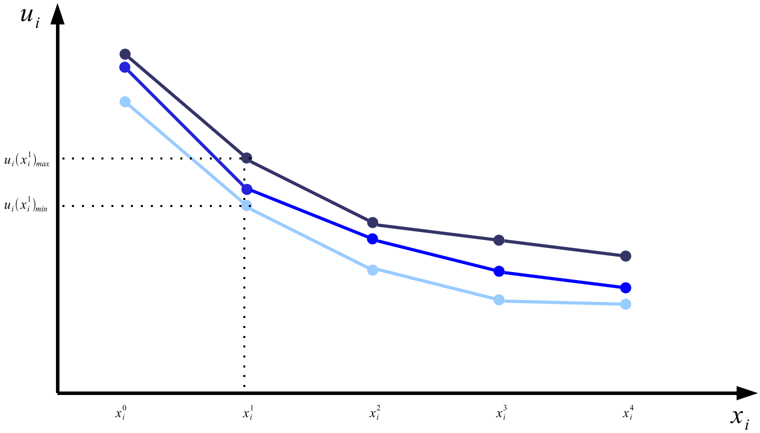
$$Min \rightarrow U_i \text{ or } Max \rightarrow U_i$$

Objective function for value function space valuation:

$$Min \rightarrow u_i^t \quad Max \rightarrow u_i^t$$

Additional constraint:

$$\varepsilon \leq \bar{\varepsilon}$$


u_i
$u_i(x_i^1)_{max}$
$u_i(x_i^1)_{min}$
x_i^0
x_i^1
x_i^2
x_i^3
x_i^4
x_i

Innovation with respect to previous application

- MIN (Max ε) approach
- Declining marginal utility constraint
- Confidence interval by U_{max} and U_{min} valuation
- Space of all possible value function by $u_{i\ max}$ and $u_{i\ min}$valuation

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Case study

- Adjustment factors valuation
- Few comparables (17 data)
- Quantitative (Surface) and qualitative judgment (Finishing, Parking, Noisy, Brightness)

Surface	Finishing	Parking	Noise	Lightness	Price
97	1	0	3	3	140.000
87	3	0	2	3	138.000
75	3	0	2	2	135.000
86	2	0	3	1	130.000
83	2	1	1	3	130.000
94	3	0	2	2	129.000

Surface	Finishing	Parking	Noise	Lightness	Price
112	2	0	1	3	128.000
112	3	0	2	2	125.000
97	2	0	2	3	125.000
67	2	0	3	2	122.000
106	3	1	1	2	120.000
73	3	0	1	2	120.000
75	3	0	1	2	120.000
76	1	0	2	3	115.000
98	2	0	1	2	110.000
74	2	0	2	3	110.000
82	3	0	1	2	106.000

Distribution

Qualitative variable

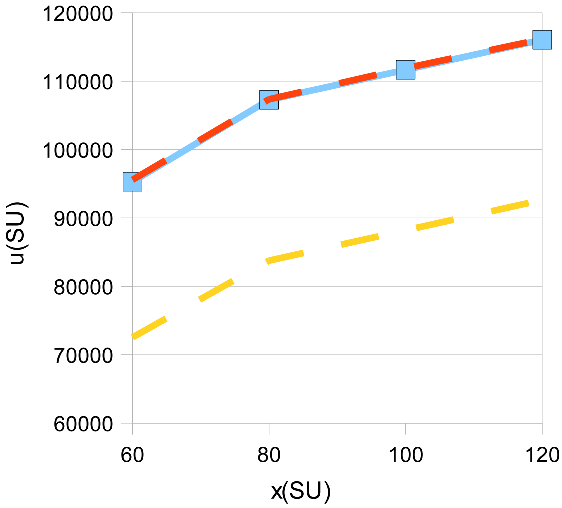
	Code	N	%
Lightness	1	1	6%
	2	9	53%
	3	7	44%
Parking	0	15	88%
	1	2	12%
Finishing	1	2	12%
	2	7	41%
	3	8	53%
Noise	1	6	35%
	2	7	41%
	3	4	35%

Quantitative variable

	mean	sd	min	max
Price	123.706	9.796	106.000	140.000
Surface	88	14	67	112

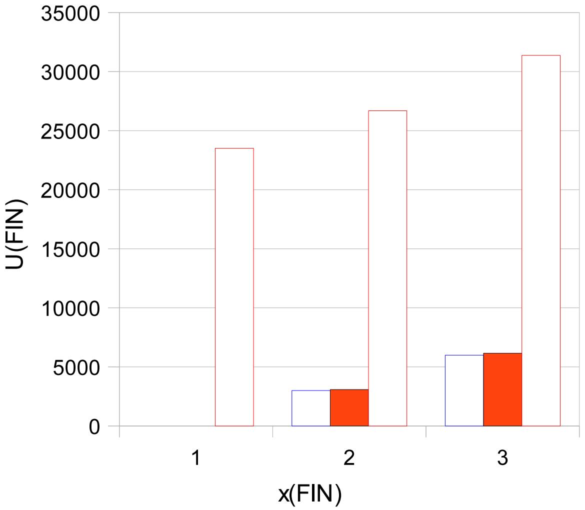
Results - Surface factor

x(SU)	u(SU)
60	1.577
80	1.346
100	1.120
120	969



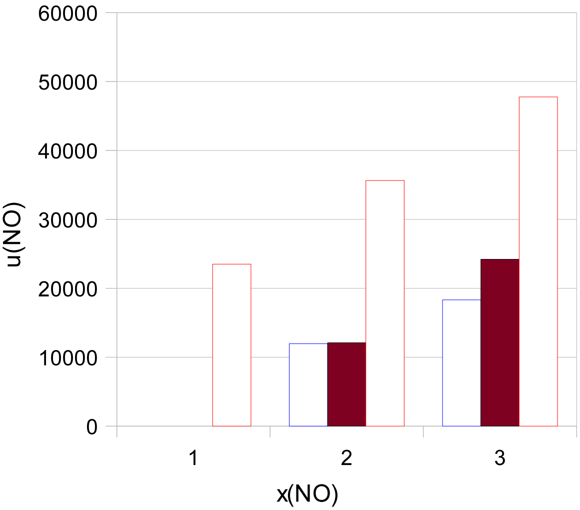
Results - Finishing factor

x(FIN)	u(FIN)
1	0
2	1.540
3	2.053



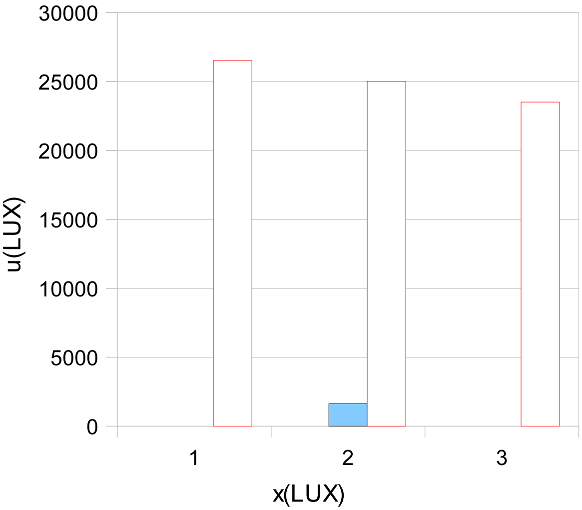
Results - Noise factor

x(NO)	U(NO)
1	0
2	6.052
3	8.069



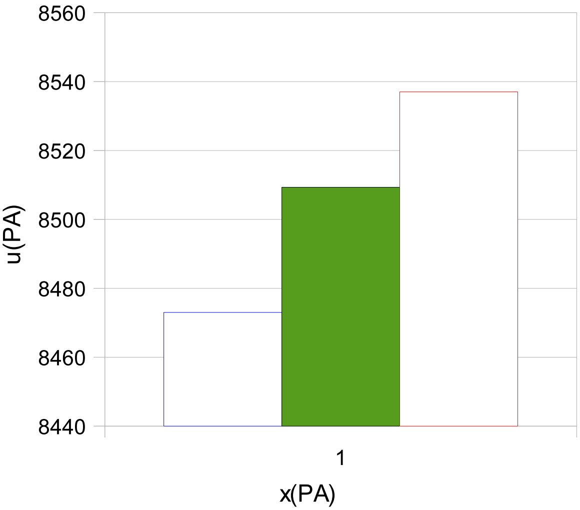
Results - Lightness factor

x(LUX)	U(LUX)
1	0
2	812
3	0



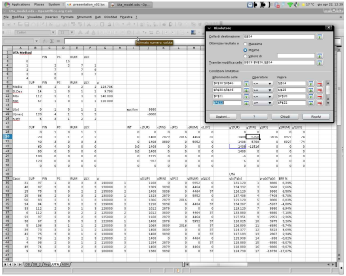
Results - Parking factor

x(PS)	U(PS)
1	8.509



Conclusion

- The procedure presented seems to be suitable for valuation problem on small data set
- Easy to implement using spreadsheet software and included linear solver package



Future developments

- Implementation with UTA refinements as $UTA^{GMS}/GRIP$
- Exploring other objective function
- Software implementation