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Estimating the weights of location attributes with the Analytic Hierarchy Process in Donetsk, Ukraine

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Abstract *To specify a model for urban land assessment in Donetsk (Ukraine), when there is lack of market data, an expert opinion approach is used. The Analytic Hierarchy Process (AHP) and direct questionnaire are applied to estimate the weights of the most important location attributes influencing apartment prices. The weights of attributes obtained with these two methods are compared. The problematic aspects of scale, agency effect and nonlinearity are highlighted. The possibility of using the results in land assessment is discussed.*

Keywords *Urban Land Assessment, The AHP, Apartment prices, Location attributes, Donetsk*

1. Introduction

Due to underdeveloped land market, the assessed value of urban land in Ukraine is actually not based on market value. Instead, assessed value depends on weighted average of several location attributes[1]. When assessing land, the valuers, land managers and urban developers choose attributes and their weights on the basis of their subjective judgements.

To increase the degree of objectivity in land assessment, in Kryvobokov (2004a) it was proposed to extract a list of the most important location attributes influencing values in well-developed foreign real estate markets and use this list in Ukraine. The extraction was realized in Kryvobokov (2004b). According to Kryvobokov (2004a), the obtained attributes can be used in other valuation methods. One group of such methods is based on expert opinion, which allows estimating the weights of attributes.

[1] According to Ukraine's Pattern of technical documentation of monetary valuation of land.

Thus, the task of current research is to extract the weights of location attributes in a particular city. This paper deals with the Analytic Hierarchy Process (AHP), one of the expert opinion methods. An alternative direct method is also applied, which allows us to compare its results with the AHP findings.

The area of analysis is the city of Donetsk with a population of over one million people. Located in the eastern part of Ukraine, Donetsk is one of the biggest regional centres, currently in transition from planned to market economy.

The objective of the research is to improve the procedure of land assessment, making it more market-oriented. Initially, it was intended to apply the expert opinion methods to the land market directly. However, the state of land market is immature: the number of land sales is small, and the prices are really not market prices because many transactions take place between the City Council and the private sector. Therefore it was decided to analyse the apartment market in Donetsk, as this market is much better developed. The extracted information about the location components of apartment prices can be used in land assessment. Naturally, it can be applied in assessment of housing land. In Ukraine, however, the models for estimation of assessment values for land of different uses differ from one another only with the coefficient-multiplier for the type of land use.

To the knowledge of the author, only one regression model has been created for the Donetsk apartment market[2]. Therefore, the results of the AHP can help to specify a regression model for future research.

Section 2 considers the reasons for choosing the AHP among other expert opinion methods. Section 3 includes a method overview. Section 4 describes selection of value influencing attributes, questionnaire structure, selection of respondents, and process of interviews. Section 5 analyses obtained results, and Section 6 includes discussion.

2. Why the AHP?

In Kryvobokov (2004a), the following expert opinion methods are described: the contingent valuation, the contingent choice, the Delphi, and the AHP. In current research, the AHP is chosen due to the following reasons:

1. The AHP avoids directly asking the respondents how much money they are willing to pay for additional quantities of something, like the contingent valuation does (e.g. Hanemann, 1994). We see this avoidance as an advantage because in an unstable economy, prices are usually changing faster than preferences, and Ukraine's real estate market is rather volatile in respect of applying monetary values to one or another location attribute.

2. The AHP is a more sophisticated method than the contingent choice, which is usually based on simpler choices or tradeoffs (King and Mazzotta, 2002 include

[2] Ageev, A., and Sizova, N. from Donetsk National Technical University have not yet published the results. They used their own list of internal apartment characteristics, and the list of external location attributes, proposed by the author of this paper.

an overview of the contingent choice method and examples of its application).

3. The AHP is based on a pre-selected group of experts, like the Delphi method, but is less expensive than the Delphi, which requires iterations in questionnaire survey and feedback (for description and application of the Delphi, see e.g. Hemphill *et al*., 2002). Moreover, the Delphi also implies the "over-aggressive consensus" instead of exploring the areas of disagreement (Critcher and Gladstone, 1998).

In Kryvobokov (2004a), five criteria were proposed to evaluate a method: *clearness, measurability, relevance, market orientation,* and *simplicity rather than accuracy*, and it was concluded that the main problems of expert opinion methods existed with *clearness* and *relevance*. To reduce the problem of *clearness*, an additional effort should be made to the description of respondents' assignment and formulation of questions. Anyway, pair-wise comparisons can be seen as a clearer technique than direct statement of the utility function. One can say that the *relevance* of the result is unknown and it is not excluded that it can be doubtful. Therefore, the result should be checked by the comparison with the results of other methods, e.g. regression modelling, which is the subject of future research.

Ong and Chew (1996) highlight the clearness, elegance and relative simplicity of the AHP. Bender *et al*. (2000) consider the AHP as "a simple and effective methodology" and "a promising approach". According to Kauko (2002), the method is "technically sophisticated and fully transparent", the other important benefits are its ability to quantify qualitative judgements and incorporate behavioural aspect, namely non-rational preferences, perceptions and agency relationships. Another important advantage of the method is that a small number of pre-selected respondents is needed.

The AHP is quite widely applied in real estate research in different countries. Ball and Srinivasan (1994) propose to use the AHP in house selection process, illustrating the possibility on the example of Boston. In Ong and Chew (1996), the methodology is applied for the Singapore residential property market research. In Bender *et al*. (1997) and Bender *et al*. (2000), the AHP is used to analyse the preferences of homeowners in Swiss cities. Johnson (2001) proposes to use the method in housing mobility counseling in metropolitan Pittsburgh. Kauko (2002) analyses housing preferences in the Helsinki metropolitan area. Chan (2002) applies the AHP to estimate the stigma impacts in valuation of contaminated land in Australia. The example of the AHP application in Ukraine is Sivets (2003), who proposes to use the technique to reconcile the results of different methods of real estate valuation.

Describing the weakness of the AHP, Kauko (2002) mentions that the method is not robust, very sensitive, time consuming and not "scientific" in a classic sense. However, these are the drawbacks of many expert opinion methods (see e.g. Diamond and Hausman, 1994 in respect of the contingent valuation and King and Mazzotta, 2002 in respect of the contingent choice). More specific problem of the AHP is the scale that will be described below.

The fact that land market in Donetsk is immature justifies the use of the AHP and underlines its importance. The method may allow experts to enhance the quality of land assessment. Moreover, the result of the AHP can be used for initial specification of a regression model, especially when regression analysis is a new method for an area, like in the case of Donetsk. According to Kauko (2002), the weights obtained in the AHP, "may be understood as the regression coefficients".

Bender *et al*. (1997) and Bender *et al*. (1994), mentioned in Bender *et al*. (1997), give another example. In Bender *et al*. (1994), the regression is used in constructing housing indices in Geneva. Bender *et al*. (1997) apply the AHP in the greater Geneva to obtain better understanding of how property owners perceive numerous characteristics.

3. The Method

The AHP, developed in the US by Saaty (1977), is based on the concept of "exploding tree"[3], which allows splitting a goal into sub-criteria. It is assumed that the relevant importance of one attribute influencing a goal over other attributes can be determined via a pair-wise comparison. These comparisons are executed between all attributes in all combinations, avoiding repetitions. The tree may consist of several levels, where a goal for the lower level at the same time can be a sub-criterion for the upper level.

The pair-wise comparisons among all attributes on one level generate the symmetric matrix A as follows:

$$A = \begin{bmatrix} w_1 / w_1 & w_1 / w_2 & \cdots & w_1 / w_n \\ w_2 / w_1 & w_2 / w_2 & \cdots & w_2 / w_n \\ \ldots & \ldots & \cdots & \ldots \\ w_n / w_1 & w_n / w_2 & \cdots & w_n / w_n \end{bmatrix},$$

where

w_i – weight of attribute i;

n – number of attributes.

To obtain the matrix A, the number of comparisons needed is $n(n–1)/2$. The task is to estimate the weights having their ratios. We can describe the vector of weights as W:

[3] This concept is also referred to as a value tree (e.g. Kauko, 2002).

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix},$$

$$\sum_{i=1}^{n} w_i = 1.$$

The most common technique to obtain the weights is the eigenvalue-method from matrix algebra. The matrix equation for an ideal case, i.e. when all the weight ratios are fully consistent, is as follows:

$$AW = nW .$$

Nevertheless, in reality the pair-wise comparisons are inconsistent, and the largest eigenvalue $\lambda_{\max}$ of the matrix A is used instead of n:
More detailed mathematical description can be found in Saaty (1977), Saaty (1990), Ball and Srinivasan (1994), Bender et al. (1997), and Labib et al. (1998).

$$AW = \lambda_{\max} W .$$

Saaty (1990) has shown that $\lambda_{\max}$ is always greater than or equal to n, and the closer it is to n, the more consistent are the values of A. The consistency index CI and consistencv ratio CR are calculated:

$$CI = (\lambda_{\max} - n)/(n-1);$$

$$CR = CI / ACI ,$$

where ACI – index of randomly generated weights.

It is supposed that CR should be very small. Usually a cut-off rule of 0.10 is applied for the comparison matrix to be consistent enough.

4. The questionnaires, the respondents, and the interviews

4.1. Selection of the attributes

The list of the most important groups of location attributes, obtained in Kryvobokov (2004b), is as follows[4]:

[4] The "amalgamated" list of attributes from Kryvobokov (2004b) is used.

- Central business district (CBD) accessibility;
- Commercial objects accessibility and characteristics;
- Income level of the population and prestige;
- Demographic characteristics (including home-ownership characteristics);
- Water (ocean, sea, river, lake) accessibility;
- Road accessibility and characteristics;
- Green area (including golf course) accessibility;
- Crime level;
- Nuisance proximity;
- Planning and urban development characteristics;
- Educational level of the population;
- Racial composition;
- Inner public transport accessibility;
- Air and train accessibility;
- Educational objects accessibility and characteristics;
- General level of neighbourhood quality;
- Secondary centre accessibility.

We have to adopt this list to the conditions of the Ukraine's city Donetsk. Undoubtedly, the attributes of the CBD accessibility and commercial objects accessibility should be used. As the number of large trade complexes is still relatively small, it seems better to consider food shops of any size as the most frequently used commercial objects. We cannot ignore the secondary centre accessibility due to the big size of Donetsk and the importance of secondary centres in the city economy. It is worth to test the degree of crime level influence. The most popular green areas in the city are often located close to water: the river and ponds; that is why it is logical to aggregate green area accessibility and water accessibility. Because of usually high correlation between road accessibility and inner public transport accessibility we can select one of these characteristics. In Donetsk there are more users of public transport than owners of cars; so we choose the attribute of inner public transport accessibility, which is easy to measure as a distance to the nearest stop. Considering the diversity of the objects of nuisance, it is better to split them into two groups: traffic noise (caused by motor transport, railway, and airport), and other nuisance (landfill, contaminated factory, etc.). Due to relatively modest economic activity and low income level of the population, the airport does not play an important role in everyday life, as opposed to the much more "popular" railway. We ignore the racial composition, because the population is racially homogeneous and consists mainly of mixed Russians and Ukrainians. Such peculiarity of a former socialist city as the heterogeneous social composition of the population within dwelling areas is still observed in Donetsk. Therefore, we can skip educational level of the population as well as demographic characteristics (including home-ownership characteristics). For the same reason, in many cases it is difficult to operate with the income level of the population; moreover, there is

a lack of statistical data about the spatial distribution of incomes. It seems easier to use prestige, because a small number of prestigious areas has been formed. To simplify and shorten the interview, which otherwise would have been too long, we can ignore the complex group of planning and urban development characteristics, and such rather fuzzy group as general level of neighbourhood quality. Finally, it is also possible to skip the educational objects accessibility and characteristics due to the location of all the main institutions of higher education in the city centre.

There are two alternatives: either to use the characteristics without specifying the units of measurement (e.g. "the CBD accessibility", "crime level"), or to specify the units of measurement explicitly (e.g. "the CBD accessibility, km", "crime rate, crimes/1,000 residents"). It is better to select the second way: firstly, for a respondent it is easier to make a comparison, and, secondly, in the prospective it would be possible to compare the results of questionnaire with regression results.

Specifying the distance attributes, we can distinguish between more general and more local, measuring the former in kilometres, and the latter in hundreds of metres. The reason is a better perception by a respondent, e.g. it is easier to think about distance to the CBD measuring it in kilometres, and about distance to the nearest stop measuring it in hundreds of metres.

The nearness of the CBD, secondary centres, and river are usually considered as having positive effect on property value. For residential property in Donetsk, we can presuppose that the vicinity of commercial objects, public transport and railway station should also positively influence a value. The empirical examination shall demonstrate if these suppositions are correct.

For the reason of better comparability all the attributes are specified in a positive way, i.e. the negative attributes are transformed into positive like this: "Absence of traffic noise", "1 km farther from nuisance", etc., whereas the attributes, which seem to be positive, are specified in the following way: "1 km closer to the CBD", "100 m closer to stop", etc.[5].

The attributes used in the questionnaire are as follows:

A. 1 km closer to the CBD;
B. 1 km closer to the nearest secondary centre;
C. 100 m closer to the nearest shop;
D. 100 m closer to the nearest stop;
E. 1 km closer to the railway station;
F. 100 m closer to the river (lake, green area);
G. 1 km farther from nuisance;
H. Absence of traffic noise (dummy);
I. Decrease in crime rate (crimes/1,000 residents) by 10 %;
J. Prestige (dummy for location in a prestigious area).

[5] It is supposed that we are situated within more than 1 km from the CBD, more than 100 m from stop etc.

The proposed delineation of the CBD, preliminarily discussed with specialists from Donetsk City Administration on Urban Development and Architecture, and the examples of secondary centres are given in the questionnaire. Detailed descriptions of other attributes are introduced in the questionnaire as well.

Undoubtedly, some attributes are overlapping, like the accessibility to the CBD and prestige, nevertheless, as Kauko (2002) states, "in value tree analysis some overlap is unavoidable".

In current research we apply a one-level value tree, i.e. the weights of the attributes determine the location value, which is assumed to be a land value. Ideally, we intend to obtain a market value. Nevertheless, the list of attributes is not yet approbated in this particular area, and data used is from the real estate market, therefore, we would rather name this land value as "a priori semi-market value ", like in Kryvobokov (2004b).

4.2. Questions and scale

Two questionnaires are used. The first (Appendix 1) includes an assignment for pair-wise comparisons (the AHP). In pair-wise comparisons, a simple linear scale of 1 to 10 is applied[6], i.e. the answers are used to estimate attributes' weights without exponential transformation. Though the exponential model is used in literature (e.g. Bender et al., 1997; Bender *et al*., 2000), the question, whether this model is better than the linear one remains open (Kauko, 2002). The second questionnaire (Appendix 2) includes the assignment to state directly the percentages of attributes' influence. Thus, the first questionnaire focuses on choices, whereas the second on prices. However, the second questionnaire deals with relative prices, which reflect the relative degrees of attractiveness, and therefore the results of both questionnaires are comparable.

4.3. Selection of the respondents

A pre-selected group of respondents is an important feature of the AHP. In Kauko (2002), it is stated that "the most important issue is that the set of respondents should be selected from the relevant groups of experts meaningfully, and not randomly", and they must have "deep local knowledge of the housing market segments and quality differences between neighbourhoods gained by professional experience". When respondents are selected with care, the necessary covering can be obtained with around 20 respondents at the most (Kauko, 2002).

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[6] Saaty (1977) proposed the nine-point scale as the most reliable of the scales that were examined: five-point, seven-point, nine-point, fifteen-point, twenty-point, and ninety-point. In literature devoted to the AHP, the nine-point scale is applied. In current research, however, a ten-point scale is used as more traditional in general and therefore suitable for respondents.

[7] The reason for the relatively small number of realtors is connected with professional belonging of the author, who has good relations with valuers, land managers and urban planners, but almost no links with realtors.

[8] In Ukraine, land valuation and real estate valuation specializations are certified separately.

In current research, we used 20 respondents divided in four groups: 7 valuers, 3 realtors, 4 urban planners, and 6 land managers. We intended to select the best experts. Realtors compose a group of practitioners from real estate agencies with deep knowledge of the housing market[7]. The group of valuers includes the leading experts in land valuation and real estate valuation[8] from different institutions, mainly more experienced in land. Urban planners are the representatives of Donetsk City Administration on Urban Development and Architecture. The group of land managers consists of practitioners from Donetsk Regional Centre of State Land Cadastre and researchers from the Department of Geoinformatics and Geodesy at Donetsk National Technical University. This group is engaged, because the target of the research is a land value. The group of land managers as an exception includes not only leading experts, but also the specialists with short experience in the local land market, 3 representatives have only theoretical knowledge in the subject.

Of these groups, realtors and valuers are the professionals who work with clients in the real estate market; therefore they have the best understanding of buyer attitude to location attributes. Urban planners represent the supply side in the housing market; it is worth to check if their view differs from the opinion of realtors and valuers. Land managers compose a specific group having good knowledge of location attributes and prices for land, thus the bias towards land market instead of housing market is expected.

Neither private actors nor developers were among the respondents. In Donetsk there were no private housing corporations, which purchased houses. Developers were not included in the set of respondents because of their small number and scale and very modest construction activity at the time of the interviews[9].

4.4. The interviews

The interviews were conducted in January-February 2004. In most cases, they were done during the visits to respondents. In some cases, due to the wish of respondents, the questionnaires were left with a promise to fill in. Unfortunately, three respondents, a valuer, an urban planner, and a land manager, did not respond. Therefore, the number of answers decreased to 17.

The most common verbal comments concerning the questions were as follows:

- difficulty in evaluation of distances, e.g. 1 km closer to the CBD from the CBD vicinity and from the city edge is not the same (the usual inconvenience of linear model);
- difficulty in comparison of quantitative and qualitative characteristics (it was a problem for less experienced respondents).

[9] The situation is in change: many construction companies, including big firms from Kiev and Moscow, have started activity in Donetsk in 2004-2005.

One comment from a realtor stated that it is incorrect to compare the decrease in crime rate and prestige, because some exclusively safe prestigious areas do not have crimes at all. The counterargument was that these areas are rather small islands surrounded by less safe territories.

Another important comment from realtors was that the nearness to the railway station is a negative attribute. Nevertheless, the negative side of influence of the station can be explained, at least to some extent, by traffic noise[10] and criminal rate. It seems interesting that valuers and other respondents considered the accessibility to the railway station as a positive attribute, i.e. to their opinion the positive effect of railway transport nearness overweighs the negative influence.

5. Results

5.1. The AHP results

The weights and consistency ratios CR for the AHP results are presented in Appendix 3. The figures supplementing the experts are just counts, which are not connected with the skills. Of 17 respondents, we obtain only 4 results with $CR \leq 0.10$. In 3 cases $CR > 0.10$.

The AHP literature involves a debate as to whether consistency ratio of more than 0.10 should be allowed. The 0.10 cut-off rule has been applied e.g. in Ong and Chew (1996), where if the consistency ratio exceeded 0.10, the expert double-checked his judgement inputs. On the other hand, according to Nevalainen (Kauko, 2002), the cut-off rule is meaningless in practice, since the AHP tolerates "obscure preferences". This rule has not been applied in Bender *et al*. (2000). Bender *et al*. (1997), and Kauko (2002) analysed both result: with and without the cut-off. In the latter case, when the author applied the 0.10 cut-off rule, the number of results for two submarkets shrank from 22 to 3 and 4 only.

In current study when the 0.10 cut-off rule is applied the number of consistent answers is only 4 of 17. These are the answers by two valuers, one realtor, and one land manager. Description statistics for these 4 results is introduces in Table 1. Means, medians, and Perth-formula estimations are shown. The latter is calculated as one-sixth of a sum of the smallest value, the largest value and four times median (Kauko, 2002). The question is what measure of statistical aggregation of the AHP results is appropriate. Ball and Srinivasan (1994) propose to use the trimming procedure. Because of small sample in our case the one-trimmed means are exactly the same as medians. Kauko (2002) applies the Perth -formula. For our sample it gives practically the same results as means. Medians are considered below as a measure of aggregation. Adjusted medians are calculated to obtain the sum of weights equal to unity. These weights are shown in Figure 1. The highest

[10] According to Strand and Vågnes (2001), the potential negative influence of a railway proximity is also caused by vibrations, barriers created by the railway track itself (hindered mobility, hazards for children), and negative aesthetic effects.

weights, 0.19 and 0.18, belong to the attributes *A* (1 km closer to the CBD) and *J* (prestige) respectively. The attribute *E* (1 km closer to the railway station) has the lowest weight, 0.03. Standard deviations are presented in Table 1, the lowest are for *C* (100 m closer to the nearest shop), *G* (1 km farther from nuisance), *I* (decrease in crime rate), and *J*, and the highest is for *A*.

Table 1. *Description statistics for weights obtained with the AHP after the 0.10 cut-off*

Statistics	Attributes										Sum
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	
Mean	0.18	0.11	0.06	0.06	0.03	0.07	0.12	0.10	0.09	0.18	1.00
Perth	0.18	0.11	0.06	0.06	0.03	0.07	0.12	0.10	0.10	0.18	1.01
Median	0.19	0.11	0.06	0.06	0.03	0.06	0.12	0.10	0.11	0.19	1.03
Adj. median	0.19	0.11	0.06	0.05	0.03	0.06	0.12	0.09	0.11	0.18	1.00
St. dev.	0.06	0.03	0.01	0.02	0.03	0.04	0.01	0.01	0.05	0.01	-

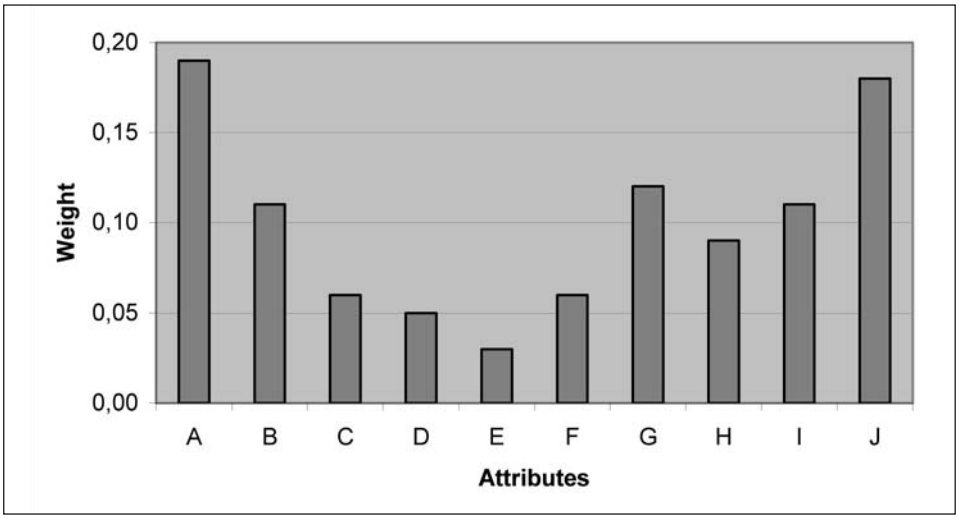

Figure 1. *Adjusted median weights obtained with the AHP after the 0.10 cut-off*

Due to the insignificant number of consistent answers we will analyse all the results (Appendix 3) without applying the 0.10 cut-off rule. Fluctuations exist between the groups of respondents, as well as within the groups. Table 2 represents means, Perth-formula estimations, medians, adjusted medians, and standard deviations for the attributes. One-trimmed means and two-trimmed means have negligible differences from means. Perth-formula estimations have more similarity with

means than adjusted medians have. We will focus on adjusted medians. Like in Table 1, the attributes *A* and *J* have the highest weights, 0.14 and 0.19 respectively, though now the "leader" is *J*, and the difference between them is bigger. At the same time *J* has the highest standard deviation, which demonstrates that prestige is "the most complicated" attribute for respondents. The attribute *G* has the third highest weight, 0.13, which is very close to the second. The least important attribute is *E* with the weight of 0.02. The smallest standard deviations belong to *B* (1 km closer to the nearest secondary centre) and *H* (absence of traffic noise).

Table 2. *Description statistics for weights obtained with the AHP for all respondents*

Statistics	Attributes										Sum
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	
Mean	0.14	0.09	0.06	0.07	0.04	0.08	0.15	0.08	0.13	0.16	1.00
Perth	0.15	0.09	0.07	0.08	0.04	0.07	0.15	0.09	0.12	0.17	1.03
Median	0.13	0.09	0.06	0.07	0.02	0.06	0.12	0.09	0.11	0.18	0.93
Adj. median	0.14	0.10	0.06	0.08	0.02	0.06	0.13	0.10	0.12	0.19	1.00
St. dev.	0.08	0.03	0.04	0.04	0.04	0.04	0.08	0.03	0.06	0.09	-

In Kauko (2002), a formal heuristically chosen testing of agency relationships was undertaken using one tenth of the difference between maximum and minimum elicitations across the results as an indicator of agency effect. This is an idea by Kaufman and Escuin (2000). Thus, a difference in weights of this magnitude between any two groups was considered enough for an agency effect to be verified. In current research, the threshold for the AHP equals to 0.035. To find the agency effect we have to calculate the differences between adjusted medians of the groups. The effect exists between all groups for the majority of attributes. The attribute *J* has the highest measure of agency effect. For the attributes *C* and *E*, the agency effect is not observed. The highest agency effect (0.22) exists between land managers and urban planners. The lowest effect (0.06) is observed between valuers and realtors.

Standard deviations can be calculated within each of four groups of respondents separately. The most homogenous group is realtors, for them the interval of standard deviations for different attributes is of 0.00 to 0.05. Valuers compose the least homogenous group having the standard deviations of 0.02 to 0.11. Within the groups of urban planners and land managers, the intervals of standard deviations are of 0.02 to 0.10 both.

Adjusted median weighs for different groups is shown in Figure 2. The highest similarity in weights between all groups is observed for the attribute

C (100 m closer to the nearest shop); the fluctuations in the weights of other attributes between groups are quite considerable. Nevertheless, the most similar groups of valuers and realtors demonstrate less difference. Some similarity exists also between these two groups and land managers. The weights of urban planners demonstrate the least similarity with other groups, being significant extremes for *G, I*, and *J*. If focusing on the adjusted medians for valuers, realtors, and land managers, the dominant attributes are *J* and *A*, the least important is *E*.

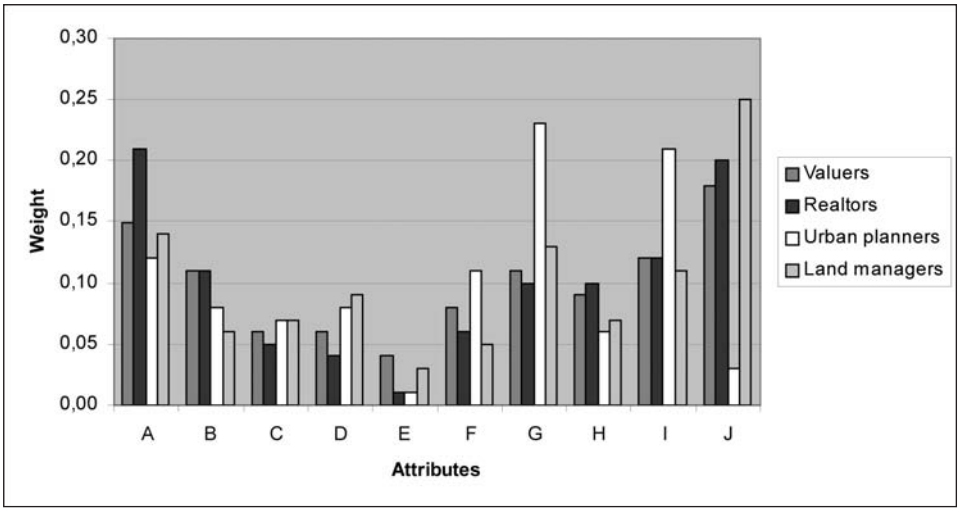

Figure 2. *Adjusted median weights in groups obtained with the AHP for all respondents*

5.2. The direct questionnaire results

For direct questionnaire results, we do not use the cut-off rule, therefore the opinions of all respondents (Appendix 4) are analysed. Description statistics is introduced in Table 3. In general, the statistics are similar to the AHP results. Perth-formula estimations are close to the means. The adjusted medians are calculated and used below as weights. The highest weight (0.26) belongs to the attribute *J*, the second highest (0.17) to the attribute *A*. The attribute *E* has the lowest weight (0.02). The attribute *J* has the highest standard deviation; *C* has the lowest one.

Table 3. *Description statistics for weights obtained with the direct questionnaire*

Statistics	Attributes										Sum
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	
Mean	0.15	0.10	0.04	0.04	0.03	0.07	0.11	0.09	0.12	0.25	1.00
Perth	0.15	0.10	0.04	0.05	0.04	0.07	0.09	0.09	0.12	0.24	0.99
Median	0.15	0.09	0.04	0.04	0.02	0.06	0.07	0.08	0.11	0.23	0.89
Adj. median	0.17	0,10	0.05	0.04	0.02	0.07	0.08	0.09	0.12	0.26	1.00
St. dev.	0.07	0.04	0.02	0.03	0.03	0.04	0.07	0.05	0.06	0.12	-

The agency threshold for these data is of 0.048. The testing of agency relationships indicates that the effect exists between all groups for the majority of attributes. Like for the AHP results, the attribute *J* has the highest measure of agency effect. For the attributes *C* and *D*, the agency effect is not observed. The highest agency effect (0.30) exists between realtors and urban planners. The lowest effect (0.05) is observed between valuers and land managers.

We can calculate standard deviations within each of four groups separately. The most homogenous group is realtors having the interval of standard deviations for different attributes of 0.00 to 0.04. For valuers, it is of 0.01 to 0.08. The least homogenous group are urban planners and land managers with the intervals of standard deviations of 0.01 to 0.16 and of 0.03 to 0.16 respectively.

Adjusted median weights for different groups are shown in Figure 3. Fluctuations in the weights between groups are considerable. The least difference is observed between valuers and land managers. Some similarity exists also between these two groups and realtors. Like in the AHP case, weights of urban planners demonstrate the least similarity with other groups; the most significant extreme is observed for *J*. If focusing on the adjusted medians for valuers, realtors, and land managers, the dominant attributes are *J* and *A*, the least important is *E*.

6. Discussion

Comparing the adjusted medians in the results of the AHP (for all respondents) and the direct questionnaire (Figure 4), it is worth noting that maximum and minimum weights are obtained for the attributes of prestige and 1 km closer to the railway station respectively. The attribute of 1 km closer to the CBD has the second highest weights for both methods. These findings are similar with the results of the AHP after the 0.10 cut-off (Figure 1), though in that case the attribute of 1 km closer to the CBD has the highest weight.

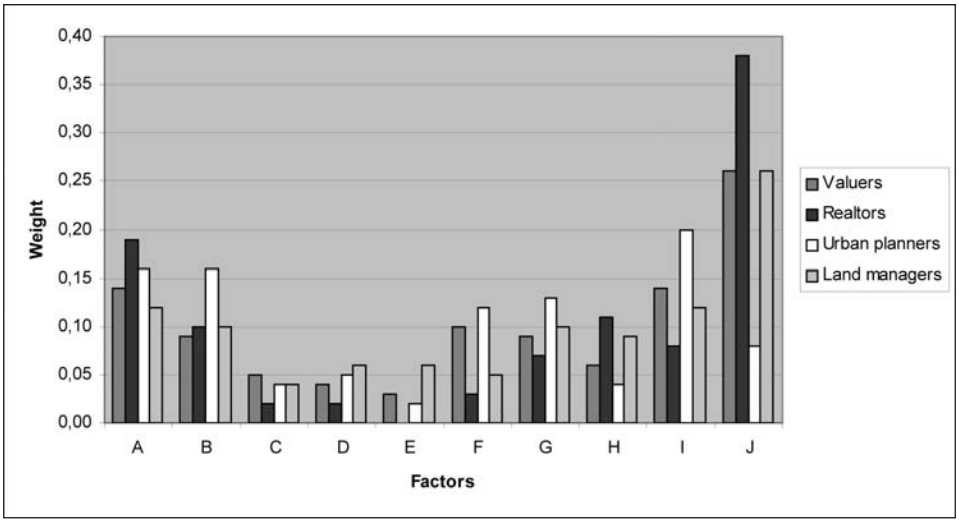

Figure 3. *Adjusted median weights in groups obtained with the direct questionnaire*

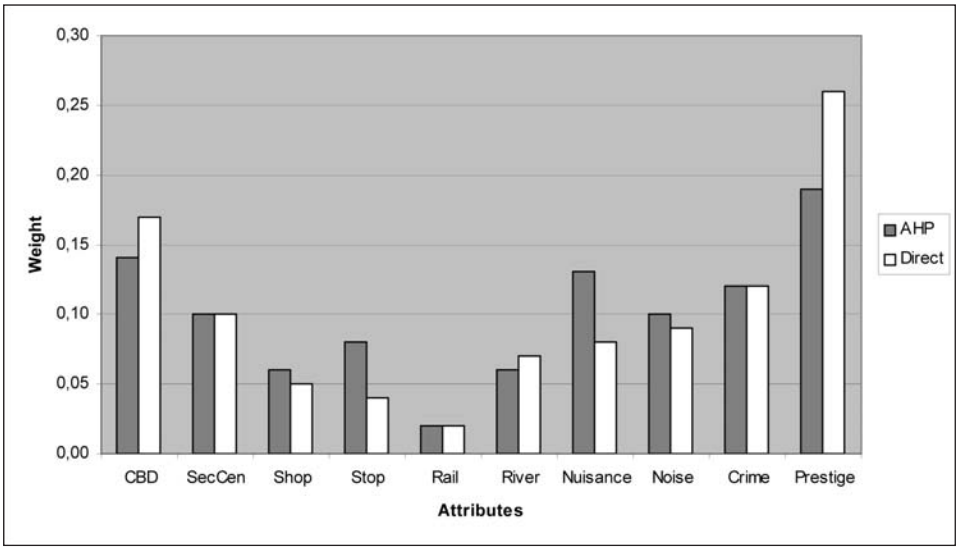

Figure 4. *Adjusted medians of the AHP and the direct questionnaire*

Though the results of the AHP and direct questionnaire are rather similar in general, the maximum weight for the latter is significantly higher than for the former (Figure 4). Realtors' highest weight (0.38) belongs to prestige, which is the maximum in the direct questionnaire (Figure 3). In the AHP, realtors define prestige as the second important attribute, with the weight of only 0.20 (Figure 2). The maximum weight in the AHP (0.25) has the attribute of prestige, according to the opinion of land managers. The other example illustrating the difference

between the methods is the attribute of 1 km closer to the railway station (Figures 2 and 3). For this attribute, valuers specify less value in the direct questionnaire than in the AHP. The same is for realtors; moreover, they specify zero weight in the direct questionnaire.

Thus, the study illustrates that the AHP is characterised by a smoothing effect, i.e. it generates lower maximum weights and higher minimum weights in comparison with the direct questionnaire. Having the scale of 1 to 10 for pair-wise comparisons it is impossible to obtain zero weight. Thus, this effect does not allow realtors to specify zero weight for the attribute of 1 km closer to the railway station, though they give the minimum to this attribute in all pair-wise comparisons. Lower weights of prestige in the AHP to compare with the direct method can also be caused by a smoothing effect.

The important reason of differences between the groups of respondents (Figures 2 and 3) is the agency effect. The most interesting attribute in this respect is prestige. The difference in the results for prestige can be interpreted from the positions of demand and supply sides. The closest to supply side group of urban planners undervalues prestige, when the group of realtors with the best knowledge of consumer demand put several times higher weight to this attribute. With the attributes of 1 km farther from nuisance and decrease in crime rate by 10%, the result is opposite. The importance of prestige is recognised by valuers and land managers as well, the latter group state the highest weight in the AHP for this attribute. Another illustration of the agency effect is urban planners' equal weights for the attributes of 1 km closer to the CBD and 1 km closer to the nearest secondary centre (Figure 3) in contrast with the opinion of other three groups, who states higher weights to the CBD accessibility in all cases. It seems that urban planners are not "switched on" to consumer preferences, if to cite Daly *et al*. (2003), who advocate the importance to consider demand in residential valuation.

According to standard deviations, the most homogenous groups are realtors and, in less degree, valuers. This is not surprising, because these two groups are the active participants of the real estate market, having deep local knowledge about the preferences. Other groups, urban planners and land managers, look at the assignment from their professional points of view rather than from the position of general preferences. For urban planners, it is demonstrated by very high weight of the attribute of 1 km farther from nuisance in the AHP and lower weights of prestige in both questionnaires. For land managers, it is illustrated by relatively high weights of the attribute of 1 km closer to the railway station.

The important finding is that valuers' weights of the railway station accessibility are also relatively high, as opposed to the realtors' opinion. The next paragraph includes some findings from the literature highlighting the complexity and contradiction of a railway station influence.

Nelson and McCleskey (1992), mentioned in Bowes and Ihlanfeldt (2001), find a weak confirmation that proximity to railway station increases property values within the Atlanta region. Nelson (1992), cited in Bowes and Ihlanfeldt

(2001), studies the same region and argues that railway station access is more important to low-income residents, while for high-income residents nuisance effects dominate. Bowes and Ihlanfeldt (2001) analyse the influence of railway transit stations on the neighbourhoods in the Atlanta region. Large positive effects are found in high-income neighbourhoods farther from the CBD. Negative direct effects are generally restricted to low-income neighbourhoods. Negative crime effects are found mainly closer to downtown. McDonald and McMillan (2000) found that proximity to commuter railway station has no effect on residential development in Suburban Chicago. Strand and Vågnes (2001) study the influence of railway proximity on residential property prices in Oslo through regression analysis and real estate agents' opinion investigation; in both cases, the negative effect of proximity to railway line is observed only at distances less then 100 meters from the line.

In the case of Donetsk, realtors do not consider accessibility to the railway station as an attribute, which increases apartment values; according to their comments, this attribute is negative. According to urban planners, its influence is slightly positive. At the same time, the specialists more experienced in land questions (valuers and land managers) give higher weights to the railway station proximity, which reflects the situation in the land market and is connected with potential highest and best use. This fact highlights the conflict between apartment prices and land prices.

The potential problem with application of findings of this research is connected with the nonlinearity of distance influence. Thus, both the AHP and direct questionnaire have allowed us to estimate the weights of several distance attributes with two units of measurement: 1 km and 100 m. The nonlinearity of distance influence on apartment prices in Donetsk is illustrated by the same scale of weights obtained for these two units of measurement (see e.g. Figure 4).

In the future, specifying the model for land assessment in Donetsk, we can be supported by the following findings. Firstly, according to expert opinion, nine of ten attributes examined in this research have significant influence (not less than 5%) on apartment prices. Secondly, the problematic attribute of the railway station accessibility needs additional investigation and can be excluded at the initial stage of model specification as the least important attribute. Finally, the application of a linear model for assessment value estimation may be problematic due to nonlinearity of distance influence.

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References

Ball, J., and Srinivasan, V. C. (1994), "Using the Analytic Hierarchy Process in House Selection", Journal of Real Estate Finance and Economics, Vol. 9, No 1, pp. 69-85.

Bender, A. R., Gagem, B., and Hoesli, M. (1994), "Construction d' indices immobiliers selon l' approche hédoniste", Finanzmarkt und Portfolio Management, 8, pp. 522-434.

Bender, A., Din, A., Favarger, P., Hoesli, M, and Laakso, J. (1997), "An Analysis of Perceptions Concerning the Environmental Quality of Housing in Geneva", Ubran Studies, Vol. 34, No 3, pp. 503-513.

Bender, A., Din, A., Hoesli, M., and Brocher, S. (2000), "Environmental preferences of homeowners: Further evidence using the AHP method", Journal of Property Investment and Finance, Vol. 18. No 4, pp. 445-455.

Bowes, D. R., and Ihlanfeldt, K. R. (2001), "Identifying the impacts of rail transit stations on residential property values", Journal of Urban Economics, Vol. 50, No 1, pp. 1-25.

Chan, N. (2002), "Stigma Assessment: A Multi-Criteria Decision-Making Approach", Pacific Rim Property Research Journal, Vol. 8, No 1, pp. 29-47.

Critcher, C, and Gladstone, B. (1998), "Utilising the Delphi Technique in policy discussion: A case study of a privatised utility in Britain", Public Administration, Vol. 76, No 3, pp. 431-449.

Daly, J., Gronow, S., Jenkins, D., and Plimmer, F. (2003). "Consumer behaviour in the valuation of residential property: A comparative study in the UK, Ireland and Australia", Property Management, Vol. 21, No 5, pp. 295-314.

Diamond, P. A. and Hausman, J. A. (1994), "Contingent Valuation: Is Some Number Better than No Number?", Journal of Economic Perspectives, Vol. 8, No. 4, pp. 45-64.

Hanemann, W. M. (1994). "Valuing the Environment Through Contingent Valuation", Journal of Economic Perspectives, Vol. 8, No 4, pp. 19-43.

Hemphill, L., McGreal, S., and Berry, J. (2002), "An aggregated weighting system for evaluating sustainable urban regeneration", Journal of Property Research, Vol. 19, No. 4, pp. 353-373.

Johnson, M. P. (2001), "Decision Support for Family Relocation Decisions under the Section 8 Housing Assistance Program Using Geographic Information Systems and the Analytic Hierarchy Process", Journal of Housing Research, Vol. 12, No 2, pp. 277-306.

Kaufman, J. L., and Escuin, M. (2000), "Thinking Alike: Similarities in Attribute of Dutch, Spanish, and American Planners", Journal of the American Planning Association, Vol. 66, No 1, pp. 1-12.

Kauko, T. J. (2002), Modelling the locational determinants of house prices: neural network and value tree approaches, PhD thesis, Utrecht: Utrecht University, 252 p.

King, D. M., and Mazzotta, M. (2002)
The Contingent Choice Method (visited May 18, 2004)
http://cbl.umces.edu/~dkingweb/contingent_choice.htm

Kryvobokov, M. (2004a), "Urban land zoning for taxation purposes in Ukraine: Possible methods under an immature land market", Property Management, Vol. 22, No 3, pp. 214-229.

Kryvobokov, M. (2004b), "What location attributes are the most important for market value? Extraction of attributes from regression models", working paper, 34 p.

Labib, A. W., O'Connor, R.F., and Williams, G.B. (1998), "An effective maintenance system using the analytic hierarchy process", Integrated Manufacturing Systems, Vol. 9, No 2, pp. 87-98.

McDonald, J. F., and McMillan, D. P. (2000), "Employment Subcenters and Subsequent Real Estate Development in Suburban Chicago", Journal of Urban Economics, Vol. 48, No 1, pp. 135-157.

Nelson, A. C., and McCleskey, S. (1992), "Improving the effects of elevated transit stations on neighborhoods", in Transportation Research Record 1266, Transportation Research Board, National Research Council, National Academy Press, Washington, DC.

Nelson, A. C. (1992), "Effects of elevated heavy-rail transit stations on house prices with respect to neighborhood income", in Transportation Research Record 1359, Planning and Administration: Economics, Finance, and Administration, Transportation Research Board, National Research Council, National Academy Press, Washington, DC.

Ong, S. E., and Chew, T. I. (1996), "Singapore residential market: An expert judgemental forecast incorporating the analytical hierarchy process", Journal of Property Valuation and Investment, Vol. 14, No 1, pp. 50-66.

Pattern of technical documentation of monetary valuation of land of Brovary, Kyiv Oblast (1998) (Ukraine).

Saaty, T. L. (1977), "A Scaling Method for Priorities in Hierarchical Structures", Journal of Mathematical Psychology, Vol. 15, No 3, pp. 234-281.

Saaty, T. L. (1990), "How to make a decision: The Analytic Hierarchy Process", European Journal of Operational Research, Vol. 48, No 1, pp. 9-26.

Sivets, S. A. (2003), "How to pass 'the exam of conscience', or About the problem of reconciliation of valuation results", Paper presented at the International Conference "Actual Questions in Valuation of Business and Property Rights", Alushta, Ukraine, 25-27 September, 14 p. (in Russian).

Strand, J, and Vågnes, M. (2001), "The relationship between property values and railroad proximity: a study based on hedonic prices and real estate brokers' appraisals", Transportation, 28, pp. 137-156.

Appendix 1

Questionnaire 1

The purpose of this questionnaire is to study your opinion concerning the location attributes influencing residential property values in the city of Donetsk. Please, answer the questions *from the position of a buyer of an apartment.* State your own view about general preferences.

All the attributes are external: the subject is not the residential object itself, but its place within the city and the neighbourhood. Here are the examples of explicit description of the attributes in respect to the city of Donetsk:

- The CBD – area between Artyoma St., Universitetskaya St., Donetsk City Bank and Mira Pr.;
- The examples of secondary centres – the crossroad of Illicha Pr. and M. Ulyanovoy St.; Regional Central Clinical Hospital in Leninskiy Pr.; Trade Centre Textilshik; etc.;
- Stop – stop of public transport (bus, trolleybus, tram, service route);
- Shop – food shop or department store with food sections;
- The railway station – Railway Station "Donetsk";
- River, lake, green area – attractive (not contaminated) areas;
- Common nuisance – landfill, contaminating factory, etc.;
- Traffic noise – noise caused by motor transport, railway, and airport;
- Crime rate – number of crimes / 1,000 residents;
- Prestige – location in a prestigious area (areas where high income residents want to move to).

The equivalences of the ranks are:

1 – equal importance;
2 – insignificant importance;
3 – insignificant to moderate importance;
4 – moderate importance;
5 – moderate to strong importance;
6 – strong importance;
7 – strong to very strong importance;
8 – very strong importance;
9 – very strong to extreme importance
10 – extreme importance.

To each pair of the attributes give two numbers (1 to 10) reflecting their relative importance, e.g. 1 / 1 – equal importance; 1 / 10 – extreme relative importance of the second; 6 / 1 – strong relative importance of the first. Be careful with the units of measurement!

1)	1 km closer to the CBD / 1 km closer to the nearest secondary centre:	__/__
2)	1 km closer to the CBD / 100 m closer to the nearest shop:	__/__
3)	1 km closer to the CBD / 100 m closer to the nearest stop:	__/__
4)	1 km closer to the CBD / 1 km closer to the railway station:	__/__
5)	1 km closer to the CBD / 100 m closer to the river (lake, green area):	__/__
6)	1 km closer to the CBD / 1 km farther from nuisance:	__/__
7)	1 km closer to the CBD / Absence of traffic noise:	__/__
8)	1 km closer to the CBD / Decrease in crime rate by 10 %:	__/__
9)	1 km closer to the CBD / Prestige:	__/__
10)	1 km closer to the nearest secondary centre / 100 m closer to the nearest shop:	__/__
11)	1 km closer to the nearest secondary centre / 100 m closer to the nearest stop:	__/__
12)	1 km closer to the nearest secondary centre / 1 km closer to the railway station:	__/__
13)	1 km closer to the nearest secondary centre / 100 m closer to the river (lake, green area):	__/__
14)	1 km closer to the nearest secondary centre / 1 km farther from nuisance:	__/__
15)	1 km closer to the nearest secondary centre / Absence of traffic noise:	__/__
16)	1 km closer to the nearest secondary centre / Decrease in crime rate by 10 %:	__/__
17)	1 km closer to the nearest secondary centre / Prestige:	__/__
18)	100 m closer to the nearest shop / 100 m closer to the nearest stop:	__/__
19)	100 m closer to the nearest shop / 1 km closer to the railway station:	__/__

20) 100 m closer to the nearest shop / 100 m closer to the river (lake, green area): __/__

21) 100 m closer to the nearest shop / 1 km farther from nuisance: __/__

22) 100 m closer to the nearest shop / Absence of traffic noise: __/__

23) 100 m closer to the nearest shop / Decrease in crime rate by 10 %: __/__

24) 100 m closer to the nearest shop / Prestige: __/__

25) 100 m closer to the nearest stop / 1 km closer to the railway station: __/__

26) 100 m closer to the nearest stop / 100 m closer to the river (lake, green area): __/__

27) 100 m closer to the nearest stop / 1 km farther from nuisance: __/__

28) 100 m closer to the nearest stop / Absence of traffic noise: __/__

29) 100 m closer to the nearest stop / Decrease in crime rate by 10 %: __/__

30) 100 m closer to the nearest stop / Prestige: __/__

31) 1 km closer to the railway station / 100 m closer to the river (lake, green area): __/__

32) 1 km closer to the railway station / 1 km farther from nuisance: __/__

33) 1 km closer to the railway station / Absence of traffic noise: __/__

34) 1 km closer to the railway station / Decrease in crime rate by 10 %: __/__

35) 1 km closer to the railway station / Prestige: __/__

36) 100 m closer to the river (lake, green area) / 1 km farther from nuisance: __/__

37) 100 m closer to the river (lake, green area) / Absence of traffic noise: __/__

38) 100 m closer to the river (lake, green area) / Decrease in crime rate by 10 %: __/__

39) 100 m closer to the river (lake, green area) / Prestige: __/__

40) 1 km farther from nuisance / Absence of traffic noise: __/__

41) 1 km farther from nuisance / Decrease in crime rate by 10 %: __/__

42) 1 km farther from nuisance / Prestige: __/__

43) Absence of traffic noise / Decrease in crime rate by 10 %: __/__

44) Absence of traffic noise / Prestige: __/__

45) Decrease in crime rate by 10 % / Prestige: __/__

Appendix 2

Questionnaire 2
Imagine two identical typical apartments. The first of them has better location than the second one. To what percentage the value of the first apartment is higher to compare with the second one, if only one of the following differences exists? Be careful with the units of measurement!

- 1 km closer to the CBD: ____%
- 1 km closer to the nearest secondary centre: ____%
- 100 m closer to the nearest shop: ____%
- 100 m closer to the nearest stop: ____%
- 1 km closer to the railway station: ____%
- 100 m closer to the river (lake, green area): ____%
- 1 km farther from nuisance: ____%
- Absence of traffic noise: ____%
- Decrease in crime rate by 10 %: ____%
- Location in a prestigious area: ____%

Appendix 3

Weights obtained with the AHP, and consistency ratios

Expert	Attributes										***CR***
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	
Valuer 1	0.10	0.09	0.07	0.07	0.05	0.13	0.12	0.09	0.11	0.17	0.05
Valuer 2	0.36	0.06	0.05	0.04	0.05	0.05	0.08	0.09	0.13	0.09	0.16
Valuer 3	0.07	0.07	0.15	0.13	0.08	0.15	0.10	0.08	0.08	0.09	0.16
Valuer 4	0.23	0.11	0.05	0.04	0.01	0.06	0.11	0.09	0.12	0.18	0.10
Valuer 5	0.16	0.11	0.09	0.03	0.02	0.09	0.08	0.02	0.11	0.29	1.41
Valuer 6	0.13	0.12	0.02	0.09	0.03	0.03	0.17	0.05	0.11	0.25	1.30
Realtor 1	0.17	0.09	0.05	0.06	0.01	0.13	0.10	0.16	0.07	0.16	0.18
Realtor 2	0.20	0.10	0.03	0.03	0.01	0.04	0.10	0.09	0.15	0.25	0.22
Realtor 3	0.22	0.10	0.05	0.04	0.01	0.06	0.12	0.10	0.11	0.19	0.10
Urban planner 1	0.12	0.08	0.12	0.14	0.01	0.03	0.24	0.06	0.13	0.07	0.40
Urban planner 2	0.17	0.09	0.07	0.08	0.07	0.11	0.12	0.06	0.22	0.01	1.14
Urban planner 3	0.04	0.05	0.02	0.02	0.01	0.17	0.31	0.11	0.24	0.03	0.45
Land manager 1	0.16	0.15	0.07	0.09	0.06	0.04	0.12	0.10	0.02	0.19	0.08
Land manager 2	0.04	0.02	0.10	0.18	0.02	0.10	0.11	0.10	0.10	0.23	0.37
Land manager 3	0.13	0.06	0.02	0.06	0.01	0.04	0.21	0.02	0.21	0.24	0.39
Land manager 4	0.13	0.14	0.10	0.08	0.03	0.05	0.08	0.07	0.09	0.23	0.16
Land manager 5	0.02	0.04	0.06	0.07	0.15	0.06	0.33	0.05	0.21	0.01	0.23

Appendix 4

Weights obtained with the direct questionnaire

Expert	Attributes									
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Valuer 1	0.27	0.14	0.04	0.04	0.01	0.12	0.08	0.04	0.04	0.22
Valuer 2	0.10	0.05	0.03	0.03	0.05	0.10	0.19	0.05	0.20	0.20
Valuer 3	0.11	0.06	0.06	0.06	0.02	0.06	0.06	0.11	0.23	0.23
Valuer 4	0.14	0.07	0.02	0.02	0.00	0.03	0.07	0.18	0.11	0.36
Valuer 5	0.15	0.08	0.04	0.04	0.03	0.08	0.23	0.04	0.08	0.23
Valuer 6	0.11	0.11	0.06	0.05	0.05	0.17	0.03	0.06	0.14	0.22
Realtor 1	0.19	0.13	0.02	0.01	0.00	0.03	0.07	0.16	0.07	0.32
Realtor 2	0.21	0.07	0.02	0.02	0.01	0.03	0.07	0.10	0.09	0.38
Realtor 3	0.17	0.10	0.02	0.02	0.00	0.04	0.06	0.11	0.08	0.40
Urban planner 1	0.25	0.16	0.05	0.04	0.02	0.02	0.07	0.02	0.04	0.33
Urban planner 2	0.16	0.07	0.04	0.08	0.02	0.12	0.24	0.04	0.20	0.03
Urban planner 3	0.01	0.18	0.03	0.05	0.01	0.13	0.13	0.19	0.19	0.08
Land manager 1	0.18	0.14	0.07	0.11	0.05	0.04	0.09	0.08	0.02	0.22
Land manager 2	0.11	0.05	0.00	0.00	0.05	0.11	0.23	0.11	0.11	0.23
Land manager 3	0.17	0.10	0.02	0.02	0.02	0.04	0.06	0.13	0.15	0.29
Land manager 4	0.09	0.09	0.04	0.05	0.02	0.05	0.05	0.04	0.09	0.48
Land manager 5	0.04	0.07	0.07	0.11	0.14	0.07	0.21	0.07	0.18	0.04