Multi-criteria Modeling of Postgraduate Students Bank Selection

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Abstract. *This paper presents the results of research conducted among postgraduate students to examine their criteria for bank selection. In the process of model development various research methods were applied: survey through which data from students was collected, descriptive statistics for data processing, clustering for grouping of data and factor analysis to reduce the data set and to define the criteria necessary for the model development. Finally, AHP model was developed and a sensitivity analysis was performed. Application of hybrid modeling resulted in the development of a complex model for decision making.*

Keywords. AHP, Factor analysis, Cluster analysis, Bank selection, Multi-criteria model, Marketing strategy

1 Introduction

Globalization brought huge changes in the economic environment, which is rapidly changing and consumers are becoming more demanding. The way of interaction with customers has changed because in the actual conditions stability is no longer guaranteed. The national economy is strongly dependent on business banks because they can create, together with central bank, conditions in which companies function and develop [5]. In such environment financial institutions need to identify factors that are relevant in the selection process of their clients and products [4]. Although this after-crisis time still has large impact on financial sector, banks have tried to upgrade their business and they approached the capital market through public offers and right issues to raise their capital base.

A huge variety of potential clients and investors are interested in banks business, from bank stakeholders and government to ordinary people. One of the interesting client populations for the banks are PhD students. These are students that have already been awarded with a graduate (bachelor) degree and they have successfully presented and defended their thesis and enrolled in one of postgraduate programs. Given the steady increase in the number of postgraduate students they may represent interesting market for banks.

Research presented in this paper analyzes the determinants of bank selection of postgraduate students. The study is based on data collected through online questionnaire among the students of postgraduate program *Information science* at the Faculty of Organization and Informatics in Varazdin. In this paper statistical methods of factor analysis and cluster analysis were applied along with multi criteria decision making method Analytic Hierarchy Process (AHP) to analyze the data collected from the students.

The paper is organized as follows. Next chapter gives an overview of previous research regarding financial sector and AHP method. Further, questionnaire and data collection are described. Following chapter briefly describes methods used in the research. The fifth chapter summarizes the results of the implementation of factor analysis and cluster analysis and provides AHP model results.

2 Review of related studies

Banking and the financial sector have been in research focus of various authors, especially in application of AHP method [1, 5, 7, 11].

Oyatoye et al. employed AHP as an evaluative tool for strategic reconsolidation of capital base by banks, using recent experience of six merger/acquisition banks [11]. The results confirmed that decisions taken by most of the groups of banks conformed to their result with the exception of only one bank confirming the appropriateness of the AHP approach in such decision-making scenario. Aznar Bellver et.al. proposed a scheme which combines the multiple criteria AHP method with the valuation ratio of the International Valuation Standards [1]. This new

methodology can be seen as a comparative method or market approach and it only requires a limited number of comparable companies, with their corresponding qualitative and quantitative variables. For this study this valuation method has been applied to the de facto mergers of savings banks. Due to the current situation of the industry, the valuation of financial institutions of this type is a task of great interest and this also serves to showcase the strengths of their methodology.

Major motivation for our work represents research of Hunjak & Jakovcevic [7], and Podrug, Rasic Bakaric and Slijepcevic [12]. Hunjak and Jakovcevic designed multicriteria model for bank performance evaluation using AHP. Their model enables the integration of the quantitative data (measured by selected financial ratios) and qualitative data by which the bank features and some internal and external environment factors are described [7]. Podrug, Rasic Bakaric and Slijepcevic identify criteria which students find most important in choosing the bank and to determine the global preferences of undergraduate students regarding existing Croatian banks [12].

3 Research results

The main purpose of this research is to investigate the main determinants of bank selection by postgraduate students.

In this research were included postgraduate students enrolled at the Faculty of Organization and Informatics in Varazdin, University of Zagreb. For acquiring the necessary information an online questionnaire was formed and distributed by e-mail to postgraduate students. After collection of completed surveys and cluster analysis, in order to reduce the number of variables, factor analysis was performed. Afterwards AHP method was implemented. Analysis has been performed with the help of statistical program SPSS 19.0 and Expert Choice 11. Methodology, sample and data analysis methods are explained below.

2.1 Profile of the respondents

Collection of data used in the study was conducted by the authors of this paper. Postgraduate students at the Faculty of Organization and Informatics, University of Zagreb were included in the sample.

A self – administrated online survey with items regarding preferred bank services was conducted. Online survey was made with the help of *google.docs* in September 2010. The link with the survey along with appropriate cover was sent to respondents. The questionnaire included questions about the socio-demographic characteristics of students, criteria for selection of banks and services that banks offer.

As a source of information about the students, official database of the Faculty was used. The size of population was 132 students. It included all four generations of students of doctoral study enrolled since the program started in 2006.

In the prepared questionnaire 11 variables were measured. To perform the factor analysis, the sample size needs to be at least four times bigger than the number of variables that are studied. For this research 11 variables concerning the time spent online were formed, and for that a sample size larger than 44 students was necessary.

Response rate was 36.66%, which means 48 fully completed surveys were received. Out of the 48 number of received response, 64% of them were answered by male students and 36% female students. This ratio corresponds to real situation because in the field of information science there are more male students. When analyzing student's age, results revealed that 60% of students are younger than 30 years. Most of the respondents are between 26 and 30 years old, whereas 13% of respondents are older than 40 years, and 9% of them have more than 46 years.

4 Methodology

This chapter provides a brief theoretical overview of the three methods used in the study. First, there is explanation of factor analysis, in the next subchapter cluster analysis and ultimately AHP is presented.

4.1 Factor analysis

Charles Spearman set up first empiric intelligence theory and he is assumed as a founder of factor analysis. The central aim of factor analysis is the 'orderly simplification' of several interrelated measures using mathematical procedures. Traditionally, factor analysis has been used to explore possible underlying structure in a set of interrelated variables without imposing any preconceived structure on the outcome [10]. Factor analysis is a multidimensional analysis and it is used to summarize a large number of correlated variables into a smaller number of variables called factors. These latent factors describe the original variables and explain their mutual relation. The need for reducing a large number of characteristics to a smaller number occurs because of the large number of statements about a problem sometimes overlap. The advantage of factor analysis is that it can identify some new dimensions which, at the beginning of the research, are not immediately noticed. Another advantage is that it eliminates the problem of correlated variables [9].

4.2. Cluster analysis

Cluster analysis divides data into groups or clusters that are relevant and useful. If goal of the analysis are significant groups, then clusters should incorporate natural data structure. In some cases, however, cluster analysis is only useful as a starting point. Cluster

analysis plays an important role for understanding and utility in many fields: psychology and other social sciences, biology, statistics, data mining, etc. The goal of cluster analysis is to achieve mutual similarity of objects within the group and the variety of objects from different groups [13]. The greater the similarity of objects within the group is, the larger is the difference between the group and therefore better clustering. There are three simple algorithms included in the cluster analysis: K-means clustering, hierarchical clustering and DBSCAN. First one will be used in this paper since it is commonly accepted and mostly used [8].

4.3. Analytic hierarchy process

AHP, since its invention, has been a tool at the hands of decision makers and researchers; and it is one of the most widely used multiple criteria decision-making model [5]. Many outstanding papers have been published based on AHP: they include applications of AHP in different fields such as planning, selecting best alternative, resource allocations, etc. Four basic steps involved in this methodology are [2]:

1. The hierarchy model of the decision problem is developed in such a way that the goal is positioned at the top, with criteria and sub-criteria on lower levels and finally alternatives at the bottom of the model.
2. After the hierarchy has been determined, the decision makers begin the procedure of prioritizing in order to determine the relative importance of elements on each level. On each hierarchy structure level, the pair-wise comparisons should be done by comparing all possible pairs of the elements of this level, starting with the top of the hierarchy and working this way to the lowest level. A pair-wise comparison in Expert Choice is process of comparing relative importance, preference or likelihood of two elements with respect to another element (goal) in the level above.
3. On the basis of the pair-wise comparisons, relative significance (weights) of elements of the hierarchy structure is calculated. The calculation of relative priorities for each decision making element through a number of numerical calculations are made. Finally, these results are eventually synthesized into an overall priority list of alternatives. Decision maker is allowed to change preferences and to test the results if the inconsistency level is considered high.
4. Results are priorities of alternatives in the form of priority list of alternatives and hierarchy tree with objectives relative significance. The sensitivity analysis is also carried out. Sensitivity analysis is used to determine the sensitivity of the alternatives.

5 Research results

This chapter describes the implementation of previously explained methods on the collected data. First, factor analysis was performed with the aim to determine factors which students recognize as significant in the bank selection process. Later, cluster analysis is conducted in order to group students regarding similarities in age, gender, usage of Internet banking and other services.

The largest cluster of students evaluated four different banks considering four criteria and nine sub-criteria. Thus the most important criteria for bank selection are recognized by this particular group of students.

5.1. Cluster analysis

Clustering was performed in order to group the students with similar characteristics. Using k-means clustering algorithm similarities in our sample are found using this set of variables: gender, age group, use of internet banking (whether the respondent uses the internet banking or not) and usage of wide range of services (whether large or small number of services respondents use in the bank). Cluster analysis encompasses a number of methods to determine the natural clustering of multivariate data.

The purpose of the cluster analysis was to answer the question:

- How to classify data set into clusters so that data in one cluster are as similar as possible and different from the data in other clusters?

To answer the question it is necessary to define the objectives of the classification. The aim of this classification is data compression. The idea is to focus on the certain group of users (the largest group identified by cluster analysis) of banking services and establish most important criteria for selecting the bank for that particular group. Thus, AHP model is applied on the reduced data set and only one segment of postgraduate students' have evaluated banks regarding to criteria and sub-criteria. This way, results may be used by the banks so that they can focus on one segment of postgraduate students in marketing. The first step in the process of classification is to calculate the distance between objects or observations. In this case, we tested different numbers of clusters and finally selected four clusters to group students in. Table 1 shows the distances between the clusters, and table 2 arithmetic means of the variables in the clusters. They provide explanation of characteristics of the students in each cluster.

Table 1. Cluster distances of the sample

Cluster	Distance
1	1,3687
2	1,9317
3	1,5843
4	0,6623

The first cluster consists of women (1) who are between 26 and 30 years old, using internet banking, but apart from these service, do not use a wide range of other services. The second cluster consists of males (2) that have more than 30 years and less than 35 years and use internet banking and many other services that the bank is offering. In the third cluster are women who are 21-25 years old and do not use internet banking. The fourth group consists of males aged 41-45 years which do not use internet banking, and the range of other services they use is extremely small.

Table 2. Arithmetic means of clusters

Cluster	Gender	Age	Internet banking	Used services
1	1	2	1	0,5
2	2	3	1	1,5
3	1	1,5	2	1
4	2	5	2	0

AHP is performed on group of students situated in the first cluster since it is the largest group.

5.2. Factor analysis

Factor analysis was performed following steps suggested by DeCoster [6]:

1. Collect measurements.
2. Obtain the correlation matrix
3. Select the number of factors for inclusion
4. Extract the initial set of factors
5. Rotate factors to a final solution.
6. Interpret the factor structure

Postgraduate students in the field of social sciences have answered the questionnaire and after the cluster analysis the goal was to extract factors which have the highest impact on the bank selection. Correlations between received data were calculated for each pair of variables and analyzed.

Selection of number of the factors is arbitrary decision. However, there are some guidelines which yield the best results. Those guidelines are used here to select optimal number of factors. The first criterion suggests selection of the factors with eigenvalues greater than 1. This is like saying unless a factor extracts at least as much as the equivalent of one original variable, we drop it. This criterion, which is widely used, was proposed by Kaiser [6]. Following this criterion we would retain 5 factors. The second guideline, suggested by Catell, uses graphical method, scree test, for determining the number of factors. We can plot the eigenvalues shown in a simple line plot. Cattell suggests finding the place where the smooth decrease of eigenvalues appears to level off to the right of the plot [6]. To the right of this point, presumably, one finds only "factorial scree" - "scree" is the geological term referring to the debris which collects on the lower part of a rocky slope [10]. According to this criterion, we would retain 4 factors (see Fig. 1). Using Kaiser Criterion we retained more factors, while scree test retains fewer factors. Both solutions were examined and 4 factors were extracted and used in further analysis since it makes the most sense.

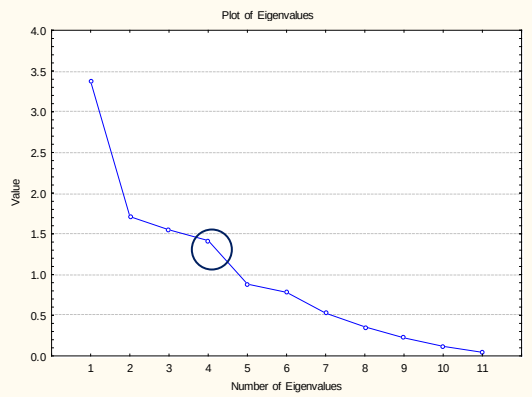

Figure 1. Plot of eigenvalues

There are different models of factor analysis which are used to extract the initial set of factors, such as maximum likelihood, principal component and principal axis extraction. In this research principal component method was used. This method is performed on unreduced correlation matrix which ensures equal treatment of variables. Varimax rotation method was used, which maximizes variance of unformed factor loadings on columns [10]. Every variable is linearly related to factors. Strength of the relation is shown by factor loading.

Variables are classified into the factor according to the highest factor loading. Table 3 presents total variance of results gained by factor analysis of the reduced model. Second column indicates absolute values of eigenvalues of correlation matrix, whereas third column expresses percentage of each eigenvalues. Fourth column indicates cumulative of eigenvalues and fifth column gives their percentage. Four factors account for 57.01973% of the variance among the intercorrelations of the 11 variables, where the first factor accounts for 19.55728% of the variance. The sum of eigenvalues equals the sum of the initial communality. In natural sciences, the secretion of factors should not stop until extracted factors do not explain at least 95% of the total variance. In contrast, in social sciences, where information is often less accurate, researchers appease for a solution that explains 60% of the total variance, and very often less. The fifth column of the table 3 contains the cumulative variance extracted. The variances extracted by the factors are equivalent to eigenvalues. The limit for factor loadings, if variables to be included in the factor, was set up on 0.70 since under this condition factors can be interpreted in the meaningful way (see table 4). Although factor loading of variable *High interest rates on savings* is higher than 0.70 this variable was excluded from the model

because of low Cronbach's' alpha when reliability analysis was performed.

As presented in table 4, first factor is determined by variables *Professional and friendly staff* and *The image of the bank* since those variables have the highest correlation with factor one. *Appearance and tidiness of branch offices* has also high loading to factor one (0.73). Considering the variables that are situated in it, first factor is named *Attractiveness to clients*. Second factor is named *Influence of people* since highest correlation with factor two have variables *Recommendation of friends* (0.86) and *Request of the employer or student service* (0.85), which reefer to external influences on the choice of bank. Both variables in this factor have high factor loading which indicates high relation between factor and variables. Third factor consists of variables *Vicinity of automatic teller machine (ATM*) (0.79) and *Fast service* (0.70). Those variables represent options which bank offers to students in order to facilitate the service. This factor is called *Availability of the services*. Both variables in the fourth factor have high factor loading, higher than 0.7.

6 Multi-criteria model for decision making

The Analytic Hierarchy Process (AHP) is powerful and flexible decision making process which is helpful in setting priorities and making the best decision when both qualitative and quantitative aspects of a decision need to be considered [2]. AHP method is implemented in program tool Expert Choice, in versions for group decision making. The method is performed following four steps suggested by Begicevic [3] and explained in the chapter 3 of this paper.

The hierarchy model of the decision problem is presented in the Fig 2. At the top is goal, bank selection. There are four criteria (*Attractiveness to clients, Influence of people, Quality of the service, Availability of services*) and nine sub-criteria. The alternatives are four banks which are mostly used from postgraduate students in our sample: *Zagrebačka banka, Privredna banka Zagreb, Hypo-Alpe-Adria-Bank* and *Raiffeisenbank Austria*. In the second step, group of the students from cluster 1 compared criteria in relation to how much is criteria important for selection of banks in relation to other and how much one alternative has advantages of another regarding those criteria.

For making these estimates Saaty scale was used. It is a scale that has nine degrees of intensity (where 1 stands for equally important and 9 extreme importance). Fig. 2 contains values of weighting criteria, derived from group of students, based on which we rank the banks.

Criteria *quality of the s*ervice has the highest priority for the postgraduate female students younger than 30 years old. *Influence of the people is ranked* second, whereas *attractiveness to clients* is least important criterion. Within the criterion *quality of the service*, sub-criterion *vicinity of ATM* is recognized as most important for bank selection.

In the third step, overall priority list of alternatives is calculated. Banks were compared according to criteria *attractiveness to clients and Privredna banka Zagreb* has the highest priority. Next, banks are compared by the criterion *influence of p*eople. Evaluating by this criterion *Privredna banka Zagreb* also has the highest priority and *Zagrebacka banka* slightly smaller. Comparison of alternatives by the *criterion quality of the service* placed *Zagrebacka banka* on the top (priority 0.36), followed by *Raiffeisenbank Austria* (0.252) and *Hypo Alpe-Adria-Bank* (0.223). Evaluation of the banks due to *the availability of the services* shown that Zagrebacka banka has the highest priority, whereas *Privredna banka* Zagreb and *Hypo Alpe-Adria-Bank* have the smallest. When taking into account all four criteria and their weights *Zagrebacka ban*ka turned to be the alternative with the highest priority, followed by *Privredna banka Zagreb* and *Raiffeisenbank Austria*. The lowest priority has *Hypo Alpe-Adria-Bank.*

6.1 Sensitivity analysis

In the previously described model the input data based on which we calculated the priorities were the estimates of the relative importance of criteria and evaluation of priorities of banks. It can be assumed that these estimates may vary and that these changes are still consistent with the preferences of decision makers. For this reason, we will conduct a sensitivity analysis to determine the extent to which changes in input data reflect the overall priorities of alternatives. Here, the sensitivity analysis is carried out with the help of Expert Choice.

Figure 3 shows a sensitivity analysis using the *Gradient option*, which demonstrates how priorities of alternatives are sensitive to changes in weight of each criterion. Since for the criteria shown in the fig. 3, *attractiveness to clients*, alternatives cross, increase or decrease of the priority will have an effect. This means that an alternative *Privredna banka Zagreb* would gain an advantage over alternative *Zagrebacka banka* when there would be a change in weighting. Figure 4 provides overview of sensitivity analysis by using option *Dynamic*. This option shows change of the priorities of the alternatives by dynamically changing the weight of individual criteria. With this option we get answers to questions such as: how much weight should be the for criteria *attractiveness to clients* that alternative *Privredna banka Zagreb* would gain an advantage over alternative Z*agrebacka banka.* Specifically, if the weight criterion *attractiveness* increases to 44% then alternative *Privredna banka Zagreb* would obtain an advantage over alternative *Zagrebacka banka*. Figure 5 shows the sensitivity analysis by using option *Head to Head.*

Figure gives nice overview where it is clearly seen comparison of the two leading alternatives (*Zagrebacka banka* and *Privredna banka Zagreb*) for each criteria. It is to be noticed that alternative *Privredna banka Zagreb* has an advantage over alternative *Zagrebacka banka* within the criteria *attractiveness to clients* and *influence of the people*, while *Zagrebacka banka* has the advantage by the criteria *availability* and *quality of the service.*

7 Conclusion

This paper presents the results of survey conducted among students of doctoral programs at the Faculty of Organization and Informatics about their preferences when choosing a bank. Factor analysis identified four criteria and five sub-criteria by which students make decisions about choosing the bank.

The AHP method gave the rank of criteria according to importance and banks are ranked with respect to the performance of each individual criterion and overall. We believe that the AHP model presented in this paper may help banks to identify their strengths and weaknesses in relation to competition and in accordance with the results they can improve their services. Results showed that postgraduate students give great significance to the nearness of bank – to the availability of bank's ATM and fast service by employees. Furthermore, as essential criteria students highlight the recommendation of family members and friends. Students give an advantage to *Privredna banka Zagreb* by the criteria of attractiveness and influence of the people, while *Zagrebacka banka* has an advantage by the criteria of accessibility and responsiveness. Overall, *Zagrebacka banka* is the most common choice for students of doctoral study at the Faculty of Organization and Informatics.

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Appendix

Table 3. Variance

	Eigenvalue	% of total variane	Cumulative of eigenvalues	% of cumulative
F1	2,151301	19,55728	2,151301	19,55728
F2	1,647336	14,97579	3,798637	34,53306
F3	1,266406	11,51279	5,065044	46,04585
F4	1,207127	10,97388	6,272171	57,01973

Table 4. Factor loadings

	Factor 1 (Attractiveness to clients)	Factor 2 (Influence of people)	Factor 3 (Quality of the service)	Factor 4 (Availability of the services)
Wide range of services	0,22	0,23	0,04	**0,83**
Fast service	0,28	0,22	**0,70**	0,28
Professional and friendly staff	**0,88**	0,01	0,05	0,06
Appearance and tidiness of branch offices	**0,73**	0,01	0,26	0,18
The image of the bank	**0,78**	0,11	0,18	0,11
Vicinity of ATM	0,13	0,27	**0,79**	0,29
Vicinity of branch offices	0,04	0,15	0,02	**0,73**
Low interest rate on loans	0,43	0,00	0,35	0,38
High interest rates on savings	0,86	0,07	0,15	0,05
Recommendation of friends	0,14	**0,86**	0,38	0,02
Request of the employer or student service	0,06	**0,85**	0,31	0,07

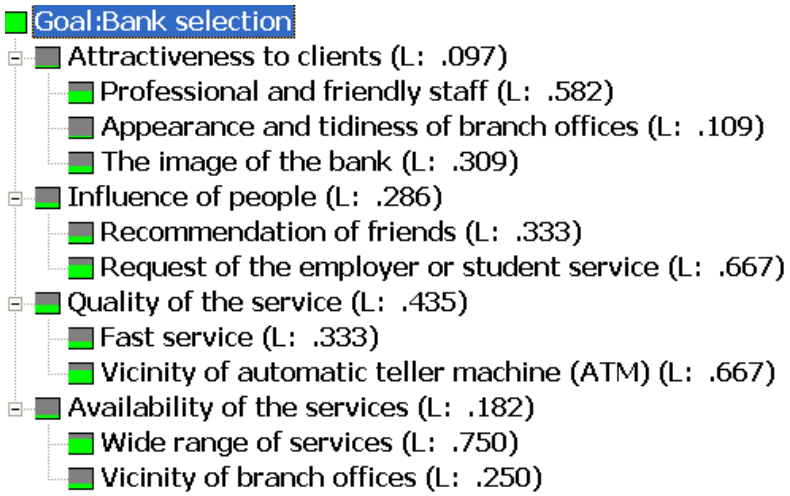

Figure 2. Weights of criteria in decision making model

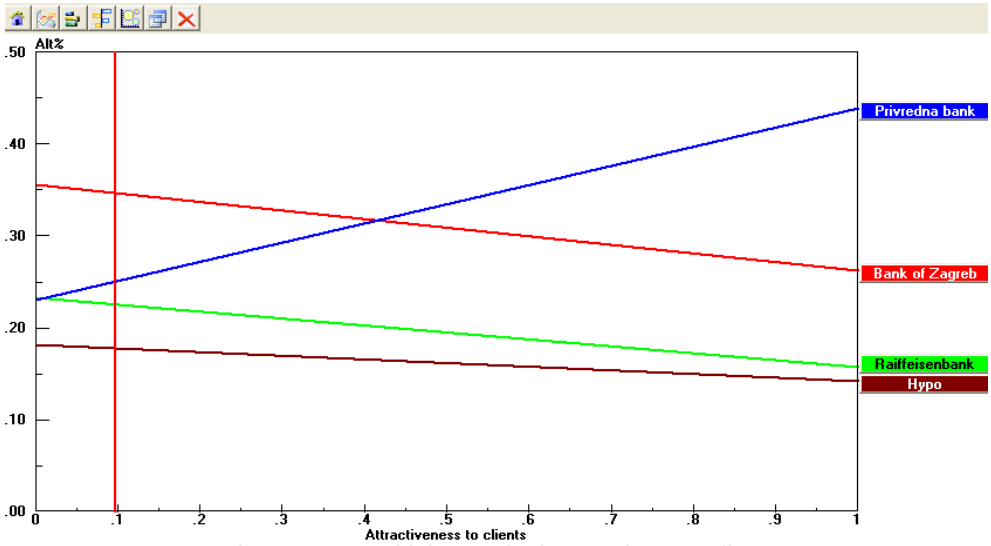

Figure 3. Sensitivity analysis – option Gradient

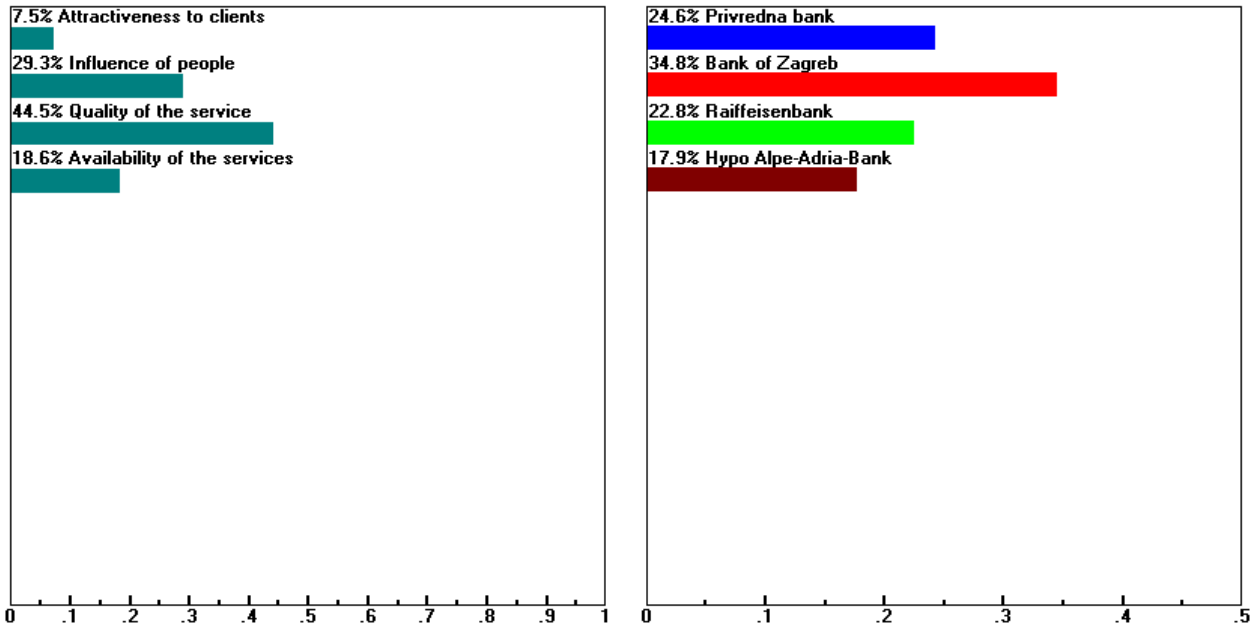

Figure 4. Sensitivity analysis–option Dynamic

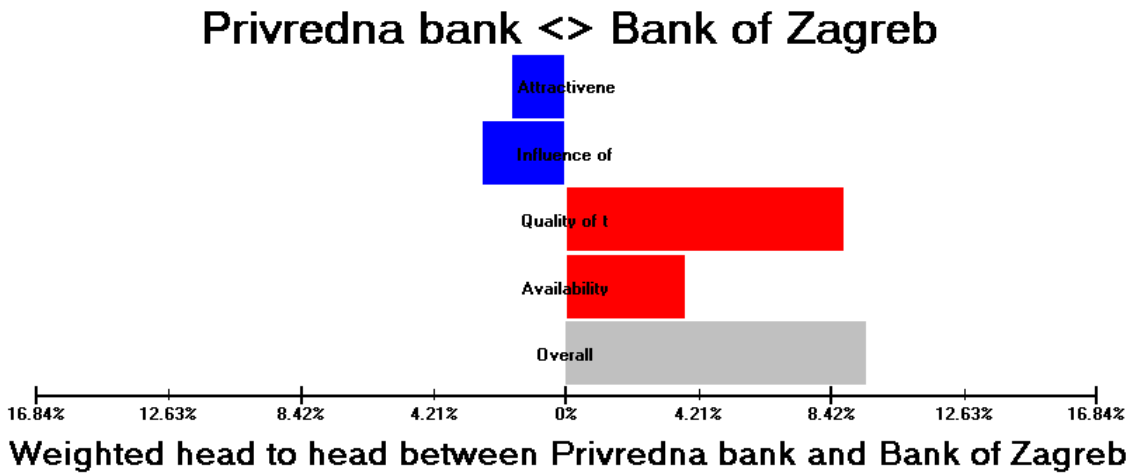

Figure 5. Sensitivity analysis – option Head to head