

THE USE OF CORRESPONDENCE ANALYSIS FOR DELPHI SURVEY RESULTS INTERPRETATION

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Abstract: In this paper the use of correspondence analysis for interpretation of the Delphi survey results was described. The analysis is based on the data obtained through the double-round Delphi survey carried out within the project 'Mazovia Economic Information Center'. Analyses were conducted on issues related to the economic growth of the Mazovia region. The results obtained within the study indicate a noticeable relationship between the location and size of the company headquarters and the assessment of the significance and likelihood of execution of the selected Delphi theses.

Keywords: correspondence analysis, foresight studies, Delphi method

THE USE OF DELPHI METHOD IN FORESIGHT STUDIES

Foresight, understood as a forward-looking study aims to inform policymakers and opinion leaders about the desired direction of long-term development or change [Nazarko 2013]. The results of foresight projects are used for arranging development scenarios and harmonization of the social partners activities (including economic, scientific and government institutions). At the same time, this process leads to the consolidation of various groups and stakeholders. A wide range of foresight objectives requires a variety of methods and research tools. The foresight research procedure is based on a number of methods derived from forecasting, futurology and the future studies, but also from management, economics and planning [Koniuk et al. 2008]. Due to the dynamic evolution of foresight the collection of methods mentioned above is extensive and is still open.

The Delphi method is relatively widely used in the foresight studies. It is estimated that it was used in nearly 80% of the Polish foresight initiatives (about

10% world wide) by the year 2012 [Nazarko 2013]. The Delphi method is a variation of the expert research technique, in which intuitive judgments of experts are treated as a final contribution to the formulation of the vision of the future. This method is particularly used when [Kowalewska et al. 2009]:

- there are no reliable data on the anticipated processes,
- the anticipated processes are mainly affected by external factors,
- there are no precise analytical techniques appropriate for forecasting the analysed phenomena.

The repeated surveys on the same group of experts using the Delphi questionnaire containing arguments and challenge questions are one of the stages of the Delphi method. The questionnaire, usually developed by an expert panel, includes a number of research questions related to the future description of the anticipated relations (Delphi theses). Challenge questions are used for getting information needed to achieve the aim of the study, such as the time and the likelihood the thesis realization, push factors, barriers or the expected effects of the thesis. At the first round experts are encouraged to present their judgments on the development of selected factors within the research area. In the next round they answer the same questions, knowing the overall results (distribution of answers) from the previous round of testing. It is also possible to present some comments (reviews) expressed by the respondents in the first round of testing. In order to preserve the anonymity of the study, the authors of individual opinion is not disclosed. Therefore, there is a remote, asynchronous communication between participants of the Delphi study [UNIDO, 2005]. It helps to avoid domination of strong personalities and leads to the better understanding of the shape of the future. Therefore, the accuracy of recruitment of the survey respondents and members of the expert panel are particularly important. There are two basic approaches for the selection of experts suggested by the literature: the selection of a homogeneous [Kotowska et al. 2005] or heterogeneous group [Steinert 2009, Schuckman 2012]. The heterogeneous selection increases the chance of obtaining a large number of different (extreme) opinions, to be agreed in the next rounds of the study. Such an approach seems to be particularly appropriate in the case of foresight studies that involve the participation of potential stakeholders.

CORRESPONDENCE ANALYSIS AS A METHOD OF QUALITATIVE DATA ANALYSIS

Correspondence analysis (CA) is a descriptive, exploratory technique allowing to define the nature and structure of the relationship between qualitative variables, measured in nominal and ordinal scales [Stanisz 2007]. CA belongs to the group of incomplete taxonomic methods [Górniak, 2000]. This technique, as well as multidimensional scaling, principal component analysis and factor analysis, on the cost of losing some of the information leads to an increase in the

transparency of data and simplifies their interpretation. The use of statistics and charts specific for that method allows the researcher for easy, intuitive reasoning on the relationships between the analyzed categories of variables [Panek 2009].

In general, the correspondence analysis could be considered as a method to decompose the overall chi-square statistics by defining a system with a small number of dimensions, in which the deviations from the expected values are presented. CA is a multi-step procedure, that starts from the summary of the data in the contingency table [Bendixen 2003]. CA technique includes the following steps [Gatnar et al. 2004]:

1. Determination of correspondence matrix, row and column profiles and masses¹;
2. Calculation of the distance between the rows (columns) using the chi-squared metric;
3. Presentation of row (column) profiles in the space generated by the columns (rows) correspondence matrix;
4. Determination of the average row and column profiles;
5. Reducing the dimension of space;
6. Plotting the correspondence map, as a common row and column profiles chart (bi-plot).

The aim of the correspondence map construction is to reduce the number of analysed space dimensions by choosing such a low-dimensional subspace in which the chi-square distances between points are shown with the best accuracy [Greenacre et al. 1987]. In this process, the SVD (singular value decomposition) algorithm of decomposition of the matrix with respect to specific values is used [Press et al. 2007]. Interpretation of the correspondence map allows the researcher to find the diversity within the analyzed variables profiles, as well as their co-occurrence of different categories.

In this paper the results of the classical and multiple correspondence analysis of the selected Delphi survey results are presented. The survey was carried out in 2013 in the framework of the “Mazovia Economic Information Center”² (MEIC), conducted by the Association of Employers of Warsaw and Mazovia. The calculation procedure was carried out using the STATISTICA PL package³.

RESEARCH PROCEDURE AND RESULTS

The one of the research topics carried out within the MEIC project, was a pilot foresight study covering the following areas: the innovation of Mazoviabusinesses, local development and economic growth. The main aim of the

¹ The ‘mass’ term in CA is used to determine the size of records in the table of relative frequencies. Since the sum of all the values in relative frequency equals 1, the table shows the relative frequencies as one ‘mass’ unit is distributed in the cells of the table.

² Detailed information about the project are available on the official website <http://mcig.pl/>

³ StatSoft, Inc. (2011). STATISTICA (data analysis software system), version 10. www.statsoft.com.

study was to develop a model and methodology of foresight studies used for projection of alternative scenarios for the region, as well as to test the model by a pilot experiment. In the first phase, a number of expert analyses were made. The studies were based on such methods and techniques as desk research, expert panels, in-depth STEEPVL and SWOT, structural analysis and scenario method. The result of the first stage was the initial presentation of the proposed scenarios for the Mazowieckie region until the year 2025 [Nazarko 2013].

The Delphi method was used in the second stage of the study. The essential objective of this phase was to confront the obtained results with the opinion of entrepreneurs, as the main group of the project's stakeholders. Delphi theses, as well as challenge questions, were developed by expert panels in relation to the scenario-axes factors, trends and unprecedented events. The prototype on-line questionnaire was then made and a double-step verification procedure for its correctness, formulation of questions and user-friendliness was conducted. The verification was carried out in a group of 30 experts, who participated in the mini-Delphi survey. The revised questionnaire was used in a double-round Delphi survey conducted using CAWI method on 120 representatives of companies established in the Mazowiecki region.

More than 70% of the respondents were the representatives of micro-enterprises (employing less than 10 people). The next largest group were representatives of small enterprises (employing 10 to 49 people), with 14% share of all the surveyed firms. The share of medium and large companies was 7% and 5% respectively. 47% of respondents accounted for the enterprises located in Warsaw. Warsaw East and West subregions were represented by 28% of respondents. The share of companies located in other subregions amounted for a total of 25% [Dębkowska 2013].

In this paper the interpretation of selected results of the Delphi study conducted in the area of economic growth of Mazovia region are presented. There were six following Delphi theses developed for that area [Dębkowska 2013]:

1. The education system forming an innovative and entrepreneurial approach will be a stimulating factor for the economic growth.
2. Improving the legal system will be one of the most important drivers of economic growth.
3. Development-oriented use of public funds will strengthen the long-term growth.
4. The development of diversified transport infrastructure will improve the accessibility of the region and its internal consistency.
5. Increasing public participation will improve the conditions for economic growth.
6. Deep interference in the international political system will cause an economic crisis in Mazovia region.

The first two theses related directly to the key factors identified as axes of growth scenarios of Mazowieckie region. The next three theses referred to the

trends affecting growth. The last thesis represented an unprecedented event, or an event that disrupts trends and occurs for the first time.

For each of the theses above there was the same set of five challenge questions as follows:

1. How do you assess the significance of the thesis for the area of economic growth of Mazoviaregion?
2. When and with what probability, in your opinion, the thesis will be completed or when the processes or phenomena described in the thesis will occur?
3. To what extent the following factors or activities are conducive to the realization of an argument?
4. To what extent the following factors or barriers hinder the execution of the thesis?
5. To what extent it is necessary to take the following actions to implement the thesis?

For questions 3-5, as a result of the work of the expert panel, a set of predefined factors, barriers and the necessary actions required to meet the assessed thesis were developed. In addition, the surveyed entrepreneurs were asked to justify their answers on questions 1 and 2. The respondents in the second round of Delphi study were given the opportunity to view the distribution of responses in the first round as well as the selected justifications.

Initial results of the research

The first question of the questionnaire concerned the significance of each thesis for the area of economic growth of Mazoviaregion. All the theses were highly evaluated in terms of their relevance to the research area and indicated as "very important" or "important" in both the first and in the second round of the Delphi survey. It should be also noted that the percentage of responses indicating theses as important and very important for economic growth of Mazovia region increased in the second round, and simultaneously response rates defining the theses as insignificant or rather insignificant for the area decreased. In the second round the percentage of experts who had no opinion in evaluating the significance of the thesis for the area also declined [Dębowska 2013].

The following question of the Delphi survey aimed to determine the most probable period of the execution of each thesis in the future. It was possible to identify three time periods: up to the end of 2013, from 2014 to 2025 or after 2025. In assessing the probability an expert could also choose the "never" option.

For the first five theses more than a half of the respondents indicated that the most likely period of their implementation is 2014-2025, and about 30% indicated the year 2025 and after. The nearest future (the end of 2013) was indicated by about 10% of the respondents. In the case of the last thesis, relating to an unprecedented event, in the first round more than 40% of respondents believed that such an event

will never happen. In the second round, the percentage of such answers has dropped to 30%.

The obtained results have shown the existence of discrepancies in the assessments formulated by the respondents in both the assessment of the significance and probable duration of the theses. That led the authors to use correspondence analysis for in-depth interpretation of the research results. Analyses were performed with respect to the results obtained in the second round of the Delphi survey.

In-depth analysis of the research results

Correspondence analysis was chosen as a research technique regarding the assumption that the size of the company and its location affects the assessment of the significance of theses and alters the projections relating to the probable period of their implementation. The hypothesis above was supported by a pre-review of selected comments made by respondents on survey questions. The entrepreneurs' comments have confirmed the differences in their opinions with respect to the issues such as i.a. the expected support for the financing of development projects and prospects, in which companies are willing to plan their business activities.

Regarding the observations above the size of the company, measured by the level of employment was additionally taken into account for all analyses. As a result, contingency tables and the correspondence matrices for such couples of variables were created: (1) the size of the company – assessment of the significance of the thesis, (2) the size of the company – the duration of the thesis. Subsequently the standard procedure of the classical correspondence analysis was made.

Table 1. Percentage of inertia reproduced in two-dimensional space for various combinations of the analysed variables

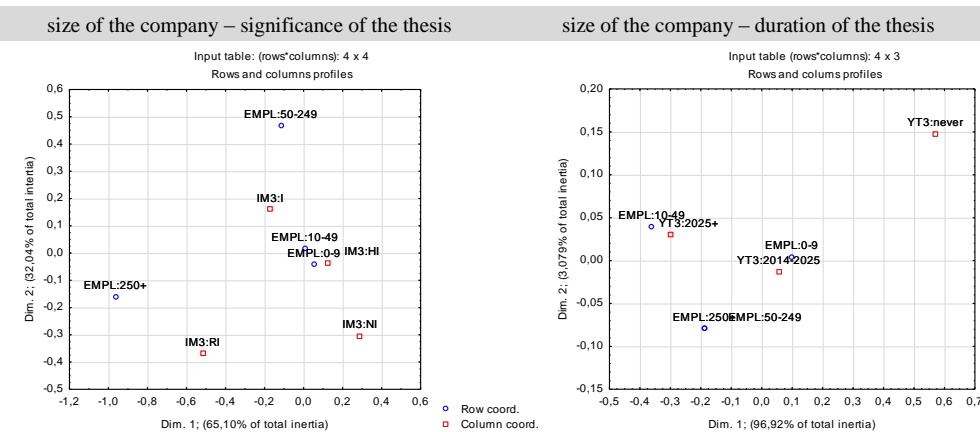
Thesis	Combination of variables			
	(1) size of the company – significance of the thesis		(2) size of the company – duration of the thesis	
	Dimensions		Dimensions	
	1	2	1	2
Thesis 1	85,15	96,48	74,84	100,00
Thesis 2	96,89	100,00	91,07	100,00
Thesis 3	65,10	97,14	96,92	100,00
Thesis 4	93,83	98,91	73,13	100,00
Thesis 5	53,00	91,76	92,44	100,00
Thesis 6	71,72	93,59	64,31	95,41

Source: own calculations

It occurred, that projection of row and column profiles in a two-dimensional space allowed us for a very good representation of the original relationship between the variables (Table 1). In all analyzed cases, the percentage of inertia

reproduced in two-dimensional space exceeded 90%. An example of the interpretation of the results obtained in regard to the thesis 3: development-oriented use of public funds will strengthen the long-term growth is presented below. In case of that thesis, the vast majority of respondents indicated the important role that public finance management by the authorities play in stimulating development of the region.

Figure 1. Selected correspondence maps for the 3rd thesis in “economic growth” area



EMPL – employment (0-9; 10-49; 50-249, 250+)

IM n – significance of the n thesis (HI – very important, I – important, RI – rather important, NI – not important)

YT n – duration of the n thesis (2013; 2014-2025; 2025+; never)

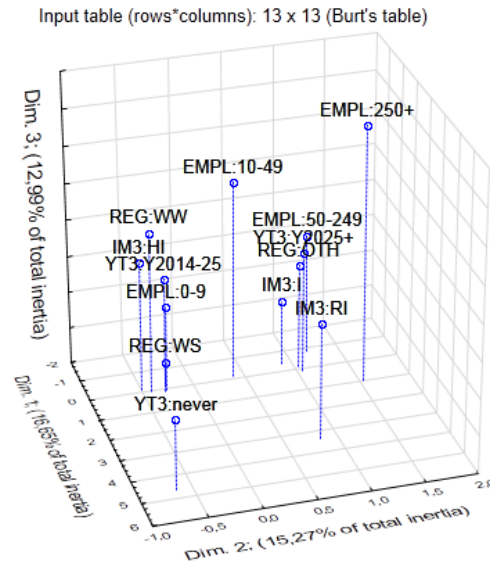
Source: own calculations

The analysis of two-dimensional correspondence maps relating to the 3rd thesis leads to the conclusion that it was assessed as important or very important for the process of Mazovia region economic growth mainly by micro and small enterprises (employing up to 49 people). The largest enterprises, employing more than 250 employees, were significantly standing out. To some extent it might be explained by the past experience of entrepreneurs concerning the use of EU funds, support business activities, the beneficiaries of which were mostly small and medium enterprises. With regard to the period in which the phenomenon described in the thesis can be most likely expected companies with no more than 9 employees forecasted earlier scenario exercise (indicating years 2014-2025), while the companies employing 10-49 people indicated a longer-term perspective (after 2025). Definitely distant answer was – in regard to the third thesis – “never” option, which did not identify any of the groups of entrepreneurs.

In order to extend the scope of this interpretation a common analysis including such variables as (1) the size of the company, (2) its location, (3) the assessment of the significance of the thesis and (4) the expected duration of its implementation was made. The projection of variables was performed using

a three-dimensional map of correspondence (Fig. 2). For the variables being analysed, it allowed mapping of 44.9% of the total inertia.

Figure 2. Three-dimensional correspondence map for the 3rd thesis in “economic growth” area



EMPL – employment (0-9; 10-49; 50-249, 250+)

REG – subregion (WW – Warsaw, WS – surroundings of Warsaw, OTH – other)

IM n – significance of the n thesis (HI – very important; I – important; RI – rather important; NI – not important)

YT n – duration of the n thesis (2013; 2014-2025; 2025+; never)

Source: own calculations

It can be observed, that there are two distinct clusters of points on the obtained map (Fig. 2). The first cluster contains representatives of small enterprises (EMPL: 0-9), indicating that the most probable duration of the thesis is 2014-25 period, assessing the 3rd thesis as very important (IM3: HI), located in Warsaw or its immediate vicinity (REG: WW; REG: WS). The second group are larger companies (EMPL: 50-249), located on the outskirts of the region (REG: OTH) evaluating the 3rd thesis as important (IM3: I), indicating that the most probable duration of the thesis is the year 2025 or later (YT3:2025+). The analysis of the relative positions of points on the graph confirms previous findings. It justifies the assumption of a different interpretation of the thesis by the representatives of firms located in Warsaw and its closest neighbourhood and the companies located in the outskirts of the region. It seems that the first group of enterprises, that usually are a kind of natural leaders and located in the area that mostly determines the rate of economic growth of the whole region, expect earlier implementation of the phenomena presented in the thesis.

SUMMARY

Correspondence analysis presented in this paper is a technique that allows for a relatively rapid, cross-sectional analysis of various qualitative data. Graphical presentation of the initial results of the survey allows to find the relationship between the analyzed variables, which is a good starting point for an in-depth interpretation of the results. This technique significantly simplifies the interpretation of the results of Delphi survey, where a vast majority of the obtained data is described by qualitative variables.

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