

## IMPLEMENTATION OF THE DELPHI TECHNIQUE IN FINANCE

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### Abstract

In the rapidly developing world, forecasting is very important for numerous aspects of our lives, the finance realm not being an exception. Various qualitative and quantitative methods are used to predict what is ahead. One of them is the Delphi method, an anonymous, structured discussion among experts on the forecasted topic. Developed over 60 years ago, it is one of the most effective qualitative forecasting and decision-making techniques. That said, literature review suggests Delphi's advantages have not been sufficiently utilized in financial research. This paper is an introduction to Delphi with a focus on the method's application possibilities in finance and related disciplines. For this purpose, we performed a literature review and presented a step-by-step guide for implementing the Delphi technique, describing a structure of the Delphi process, major principles of Delphi, experts' selection, Delphi types, ways of establishing consensus, validity of the method among others. Finally, we focused on implementing Delphi in finance and offered example topics that could be studied with Delphi.

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## INTRODUCTION

Forecasting future events is crucial in the rapidly developing world. Such knowledge is hard to overestimate not only at a micro level (for enterprises), but also at a macro level (for entire economies). Forecasting methods are numerous; some based on quantitative data, while others on qualitative data. Employing historical data, quantitative methods are efficient only when these data are valid and the phenomena to be forecasted will follow a similar pattern as in the past. Unfortunately, experience suggests that economies are usually unstable and their behavior is difficult to predict; this is why financial crises are so difficult to foresee (e.g., Niemira & Saaty, 2004; Berg, Candelon & Urbain, 2008). Various econometric models have been applied, some less complicated (Bussiere & Fratzscher, 2006; Coudert & Gex, 2008; Tsai, 2014) while others very complex (Sexton, Sriram & Etheridge, 2003; Chen & Hsiao, 2008; Demyanyk & Hasan, 2010), but the truth is business cycles are very difficult to model and predict, and model selection can affect the final results (e.g., A'Hearn & Woitek, 2001).

Surowiecki (2004) discusses prediction methods that are not based upon historical data directly by constructing quantitative models, but instead are based upon so-called collective wisdom. Such methods make predictions based on the knowledge of the 'crowds', whose members do not have to be experts in the phenomenon of interest. Prediction markets (Wolfers & Zitzewitz, 2004) are one such example.

While collective wisdom assumes 'the many are smarter than the few' (Surowiecki, 2004) whether or not they are experts, several methods assume the same but under the additional assumption that the many include experts in the subject being considered. The interactive (discussion) group, nominal group, and the Delphi method use the group knowledge of experts (although sometimes Delphi followed the 'wisdom of crowds' scenario; e.g., McLaughlin & Bates, 2004; Gorghiu et al., 2013). These methods share the same philosophy: to collect knowledge of the experts and use it to make a decision (which can be a prediction or a strategy or the like). What makes them different is the level of connection and interaction among the experts (e.g., Van de Ven & Delbecq, 1974; Rowe & Wright, 1999; Sutton & Arnold, 2013). Although the subject literature is full of information and comparison of these methods, in what follows we shortly summarize the differences.

The interactive group is a conventional group meeting during which the group leader presents a problem to be discussed, which is followed by an unstructured discussion (Morgan, 1996). The final decision is taken, whether by the leader or based on voting or a consensus decision.

The nominal group is a structured discussion. Its structure can differ from meeting to meeting, but generally it can be summarized as follows: first, the problem is presented (like in the interactive group); the group members provide their individual views of the solution (often on paper to make them independent); the solutions are discussed; the members rank the solutions; and so on, till the final decision is made (Van de Ven & Delbecq, 1971). So, the nominal group technique assumes some level of individual work, for which there is no place in the interactive group. Nonetheless, the discussion itself in both techniques suffers from a lack of anonymity, which can lead to dominance of the discussion by particular members (Graefe & Armstrong, 2011); the efficiency of the discussion thus much depends on the personality of the group members.

The Delphi technique aims to overcome this problem. Although fully anonymous (the members do not know who the other members are), it enables the knowledge of all the group members, irrespective of their status in the group, to be distributed among all the other members. In this way, the entire knowledge of the group is used. Shortly – because in the next section the method is described in detail – the discussion among group members takes place without their personal meeting, but by regular post or e-mail (as in the Conventional Delphi method) or on-line (in the so-called Real-Time Delphi). Delphi has established its place as a reliable qualitative method used in situations of uncertainty in many disciplines, including medicine, economics, technology, and social science; it has been used not only as a scientific research method, but also by the private sector to make predictions or take decisions important for companies.

This paper aims to present basic assumptions of the Delphi technique as well as its applications in finance and related disciplines. It is organized as follows. First, the Delphi method is presented along with its principles of application. Then, a number of literature examples of application of Delphi in finance is presented. The paper ends with conclusions.

## METHOD OVERVIEW

Delphi is a method for structuring a group communication process so that the interaction among group members is effective in allowing a group of individuals, as a whole, to deal with a complex problem (Linstone & Turoff, 1975). The technique is based on the knowledge, opinion and experience of the experts, and thus does not aim to be representative of a population (Okoli & Pawlowski, 2004). Because even experts in a particular topic can be mistaken (Kahneman, 2011), Delphi attempts to decrease chances of such mistakes by allowing the experts' knowledge to be freely distributed among all the experts in the group. Delphi is widely used for forecasting, gaining information for the decision-making process, or obtaining views on possible strategies. Created by RAND corporation in the 1950s, it was originally used to estimate the U.S. industrial targets from the viewpoint of a Soviet strategic planner during the Cold War (Dalkey & Helmer, 1963). Later, Delphi gained popularity in non-military applications, grounding its position in forecasting of technology, economics, education, transportation, social sciences, national foresight programs and many others (Landeta, 2006).

### ■ *Structure of the Delphi process*

A conventional Delphi study contains 2-4 rounds. In the first round, experts, chosen by the manager of the study, fill in a primary questionnaire containing questions on the researched subject. The questionnaire is produced by the manager of the study based on literature review, analysis of the industry or discipline, etc. Sometimes experts (hereafter also called "participants") themselves help create the questionnaire to be used in the first round by beforehand presenting issues that deserve consideration in the particular topic. It is either done before the first round or in some studies it is the first round. The experts' responses after the first round are presented to all the group members by a so-called statistical group response, which is based upon summary statistics such as median, mean, interquartile range, histograms and other. The information collected during this round is fed back to the participants before they reply to the next round of questions (Gordon & Helmer, 1964). Also, the experts can comment on their responses, entering or provoking discussion.

Such a design allows an expert to change his or her initial response based on views of the other experts, in case the expert learns something new from the discussion or considers the others' views convincing. Usually, the participants are asked to rank solutions concerned with the problem being researched, less frequently to answer open-ended questions, estimate time line, or the like. As with any questionnaire study (Boynton & Greenhalgh, 2004; Fan & Yan, 2010), the structure of the Delphi questionnaire and of each question is of crucial importance (Lang, 1995). For Delphi it also is important to obtain feedback that is easy to manage in subsequent rounds.

### ■ *Paper-and-pencil vs. Web-based Delphi*

Delphi can differ depending on the mode of communication between experts and the manager of the study. A conventional Delphi study is conducted with help of printed questionnaires sent to the experts by post. It is a so-called paper-and-pencil Delphi. With the increasing popularity of Internet, a new type of Delphi appeared, called web-based Delphi. It has the same principles as the conventional Delphi, but all the communication is on Internet (through e-mail services, a special webpage, CAWI software or the like). This type of Delphi is much less time-consuming and more comfortable for the managers and participants of the study. A further development of the method led to Real-Time Delphi, a web-based technique in which experts can enter and fill in the questionnaire any time and change their opinion without strictly established rounds. Feedback to the other participants is provided immediately after an expert answers all the questions (Gnatzy et al., 2011).

### ■ *Four major principles of Delphi*

What makes Delphi different from and in some cases more useful (Graefe & Armstrong, 2011) than the other group communication methods is the combination of controlled feedback, anonymity, structured questioning, and iteration (Lang, 1995). The results of the previous round are analyzed and fed back to the participants, to give them the possibility to change their mind after revising the group responses. Anonymity allows experts to change their opinion without discomfort of doing so in public; it also reduces the effect of personal characteristics that make participants too shy, fearful of speaking in front of the other members, or to dominate

the discussion (whether because of their willingness to dominate the discussion or by a naturally loud and overwhelming voice). Dominating the group's performance during a discussion by the quantity or quality of individual's personality is called the "bandwagon effect" (Linstone & Turoff, 1975). The main purpose of the structured questioning is to help the moderator keep focus of the experts on the study and control the decision-making process (Lang, 1995). Unlike the other techniques, conventional Delphi is not prone to digressions; Real-Time Delphi can be, but still to a much lower extent than any (even structured) meeting. Iteration in Delphi gives the experts a possibility to reenter the questionnaire multiple times, thanks to which they can use information obtained from the other experts. In conventional Delphi the number of rounds is usually decided at the outset. In Real-Time Delphi the experts themselves decide how many times they will visit the study platform and answer a particular question, but within the time-line established by the manager of the study (Gordon, 2009b).

#### ■ **Conditions for implementation of Delphi**

According to Linstone and Turoff (1975), Delphi should be applied especially when:

- 1) no relevant quantitative data are available,
- 2) available information on the topic is insufficient to solve the problem,
- 3) geographical location of the experts does not allow face-to-face communication,
- 4) a possibility exists that the strong personality of some of the experts would affect the direct discussion (the bandwagon effect), not allowing the others to fully contribute to it,
- 5) anonymity of participants (e.g., when the topic of the study is considered to be strongly influenced by social and economic factors) is an advantage.

#### ■ **Selection of Delphi experts**

The Delphi study is based on the opinions and expertise of participants, which is why they are a key to success (Gordon, 2009a). Their number can vary from a few to thousands, depending on the research questions, possibilities of managers of the study, and the number of reachable experts in the given topic. The very first Delphi study, conducted by RAND, had only seven experts

(Dalkey & Helmer, 1963), while a recent study in the National Foresight Program "Poland 2020" as many as 2,883 (Kowalewska & Głuszyński, 2009). Gordon (2009a) states that most studies use 15-35 experts. Depending on the researched question, a group of participants can be homogeneous (which means they represent the same field) or heterogeneous (which means they have diverse backgrounds and specializations). An example of the former is a study by Henson (1997), in which 42 experts in food-borne Salmonella infection were asked to estimate the number of incidents involving food-borne Salmonella and evaluate the effectiveness of infection control measures. An example of the latter is a study by Czinkota and Ronkainen (2005), in which 25 experts represented by policy makers, business leaders, and academic participants were to forecast development of globalization, international business and trade. Depending on the purpose of the research and the profile of the experts, they can be divided into panels (e.g., academics, business, government officials and other) or work in one group (Okoli & Pawlowski, 2004). Criteria of expert selection usually include publications on the researched problem, years of experience in the field, experts' self-evaluation of their experience and knowledge on the topic, and recommendations from the relevant institutions (Gordon, 2009a).

Okoli and Pawlowski (2004) presented a procedure called Knowledge Resource Nomination Worksheet (KRNW) for selecting experts. The procedure consists of five steps. In the first step relevant disciplines and organizations in which experts pertinent for the study can work are identified. The second step is to identify individuals from these selected disciplines and organizations. In the third step the selected experts are contacted; if an expert is not willing to take part in the study, he or she is asked to recommend other experts. In step four the experts are ranked based on their qualifications. Finally, the most relevant experts are selected based on the ranking and are invited to participate in the study. This method is useful when the topic of the research suggests that experts representing various disciplines with a diverse set of skills are needed.

#### ■ **Motivation for participation**

Sometimes the experts are offered no incentives for participation in the study. Other times, though, there are,

either monetary or other. In some cases, experts take part in Delphi studies with no remuneration because they are interested in the method itself, or because they feel honored to be selected and involved. Willingness to learn the results of a study themselves can sometimes be a sufficient motivation (Kowalewska & Głuszyński, 2009).

### ■ *Delphi types*

Three main types of Delphi can be distinguished based on the aim of a study. The best known and most frequently used is Classical Delphi, whose main goal is forecasting of future events and developments (Nielsen & Thangadurai, 2007). Forecasting of technological developments is the most popular implementation. An example is the TechCast Project (Halal, 2013), which gathers opinions of experts on the future of technology. Another type is Policy Delphi or dissensus Delphi, formulated by Turoff in 1970 (Linstone & Turoff, 1975). It seeks to generate a range of alternative views on the potential resolutions of a major policy issue. Here, not always is a consensus itself the goal of the study: instead of providing a decision (see below the description of Decision Delphi), the main purpose can be to analyze policy options. A group of experts should thus represent a wide range of opinions for and against the policy issue (Rayens & Hahn, 2000). The best example of Policy Delphi is a series of “State of the Future” reports conducted by Gordon and Glenn for the American Council for the United Nations University. For more than a decade, every year experts from different disciplines attempted to identify 15 global challenges and to generate strategic alternatives to meet them (Nielsen & Thangadurai, 2007).

Decision Delphi aims to help make a joint decision by a diverse group of experts with different views on the topic of a study (Lang, 1995). Unlike in Policy Delphi, here a study should be ended with the consensus. An example of Decision Delphi is the study conducted by Herkert and Nielsen (1998) for the Institute of Electrical and Electronics Engineers (IEEE). It aimed to study social, organizational and economic impacts of a shift toward electronic media on communication, sharing of information and publication of technical research (Nielsen & Thangadurai, 2007). The experts presented recommendations concerned with overcoming organizational, technical and personal barriers to the shift.

### ■ *Consensus in Delphi technique*

An important decision to make is when a Delphi study should stop. Many authors say that the best way is to set the number of rounds at the beginning of the study (e.g., Cantrill, Sibbald & Buetow, 1998; Fan & Cheng, 2006). Others (e.g. Rayens & Hahn, 2000; Sharma, Nair & Balasubramanian, 2003) recommend using descriptive statistics to establish whether a consensus has been reached. Gracht (2012), however, argues that the consensus itself should not be used alone to decide when to finish the research.

Dalkey and Helmer (1963) claim that the goal of Delphi is to reach a consensus based on views of experts. However, Linstone and Turoff (2011) argue that consensus is not the main purpose of the Delphi, but the stability of experts’ answers in consequent rounds. So, when participants do not want to change their opinion or forecast, why should the manager continue the study? If there are no extremes in experts’ answers between two subsequent rounds, the study can be ended. If the experts still do not agree, the study is nonetheless ended. The whole idea of Delphi is to base a decision on the experts’ knowledge and opinion, so the results have a mainly qualitative character. One should thus not base a decision only upon quantitative measures when making such an important decision as when to end the study (Gracht, 2012).

### ■ *Validity of Delphi studies*

The validity of a Delphi study depends on the number and qualifications of the experts and the task itself. Czinkota and Ronkainen (2005) evaluated accuracy of the Delphi technique by checking the results of studies on forecasting in the international business arena that they conducted in 1986, 1992 and 1997 (Czinkota, 1986; Czinkota & Ronkainen, 1992, 1997). Five years after each study they compared predicted results with the actual occurrences, and reported average predictive accuracy of 76% (82% for 1986, 80% for 1992 and 65% for 1997) for the Delphi technique.

Gupta and Clarke (1996) and later Landeta (2006) analyzed publications concerned with the Delphi technique, indexed in several main databases of scientific publications, namely, ScienceDirect, ABI Inform, Psycho and Medline. An increasing number of articles on the Delphi itself and articles describing implementation of Delphi was observed between 1975 and 2004.

Landeta (2006) also reported an increasing number of dissertations and theses in which Delphi was used.

According to Rowe and Wright (1999), accuracy tends to increase over Delphi rounds and Delphi panels tend to be more accurate than unstructured interacting groups. However, they also stated that technique-comparing studies are not definitive due to a variety of technique formats (different types of feedback, selected experts and the like) that influence the methods' validity (Rowe & Wright, 1999). The authors also stated that the studies on evaluation of Delphi mostly included usage of short-range forecasting and almanac questions, based on which the Delphi study can be easily validated in the near future. Studies involving long-range forecasting and policy issues are rarely used in evaluative studies due to problems with validation of the results (Rowe & Wright, 1999).

When evaluating the Delphi method, one has to remember that each study is unique and many various factors can affect its validity. Thus it is not reasonable to state that Delphi has a high level of accuracy only because in one or several studies such a high level of accuracy was achieved (Rowe & Wright, 1999).

#### ■ **Challenges of Delphi implementation**

Delphi is widely used for research in many disciplines, but it is not free of problems. The main challenges – which does not mean the only challenges – are complexity of the study, selection of experts, the time needed to conduct the study, a high attrition rate (which means that the number of experts drops off in the subsequent rounds), establishment of consensus, and implementation of the results of study into real life. Some of the problems can be overcome thanks to the use of new technologies. For instance, use of Internet greatly reduced the time needed to conduct a Delphi study and made it more comfortable for experts, thereby decreasing the attrition rate. Statistics and visualization (graphical presentation of feedback, interactive charts and the like) – especially in Real-Time Delphi – support experts in their discussions.

### **EXAMPLES OF IMPLEMENTATION OF DELPHI IN FINANCE AND RELATED DISCIPLINES**

This section offers five examples of the use of Delphi in finance. Some of them have a purely research-based

character, while others show how big companies can use Delphi for their internal decision-making process.

#### ■ ***Incorporating judgments in sales forecasting at American Hoist and Derrick (Basu & Schroeder, 1977)***

Top managers of the American Hoist and Derrick manufacturing company incorporated Delphi to develop sales forecast for the next 5 years, “to prepare production schedule, cash flow projections and work force plan” (Basu & Schroeder, 1977). According to the authors, the historical data used alone were insufficient for determination of the rate of production capacity development, as they reflected former production constraints. So, the managers of the company used Delphi, enhancing the knowledge gained from the historical data with the knowledge obtained from learned experts. Twenty-three inside experts (knowledgeable personnel from the diverse functional areas of the corporation) took part in the three-round Delphi study. In each round they were asked to estimate (i) Gross National Product; (ii) construction equipment industry shipments; (iii) American Hoist and Derrick construction equipment group shipments and (iv) American Hoist and Derrick corporate value of shipments; the estimates were to be made in current dollars for each of the following five years. Another forecasting method used was regression analysis with exponential smoothing. Five years later the accuracy of both these methods was compared by relating their estimates to the actual levels of sales. Delphi (with forecasting error smaller than 4%) was more accurate than regression analysis (with forecasting error around 10-15%).

#### ■ ***Forecasting financial markets (Kauko and Palmroos, 2014)***

Although Kauko and Palmroos's (2014) study was not actually an application of Delphi, but rather a methodological study on Delphi, we decided to present it here because it strictly refers to finance. The authors compared face-to-face meetings and Delphi in the context of forecasting financial markets. Twenty experts from the Bank of Finland and the Financial Supervisory Authority of Finland were divided into two independent groups, one for Delphi and another for the face-to-face meeting. They were then asked (according to the procedures of the two methods) to forecast developments in domestic financial markets.

Questions were related to stock market turnover, the Bank of Finland claims on credit institutions, interest in corporate loans, net interest income of small banks, and many others. The results of both methods were comparable, but clearly outperformed simple trend explorations based on historical data and an assumption of stable growth rates in the future (Kauko & Palmroos, 2014).

■ ***Identification of the personal finance core concepts and competencies for undergraduate college students (Kabaci & Cude, 2012)***

The aim of this study was to identify basic knowledge, skills, and behavior in personal finance necessary for undergraduate college students. A panel of participants consisted of experts with knowledge of college students' financial literacy and needs. A list of personal finance concepts and competencies was developed based on the reports of the Financial Literacy and Education Commission (a part of the of U.S. Department of the Treasury), prior studies on surveys of college students, and additional input from the authors of the study. Personal finance concepts included borrowing, budgeting, consumer protection, financial services, insurance, saving, and others. Researchers used descriptive statistics (including mean, median, standard deviation, first and third quartiles and interquartile range) to rank the finance concepts according to their importance as provided by the participants. Based on the results, Kabaci and Cude (2012) suggested that the personal finance curricula at the universities be reconsidered, and that additional research was needed.

■ ***Generating cash flow estimates (Ang, Chua & Sellers, 1979)***

The aim of the study was to obtain cash flow estimates to make a capital budgeting decision for a new product, an industrial chemical, with the use of the Delphi method in one company. According to Ang, Chua and Sellers (1979), quantitative methods were not efficient, because historical data available were unlikely to reflect changing future patterns and the appearance of new projects. Fifteen experts who took part in the study were from R and D, finance, production, market research and sales departments of the company. At the beginning of the study the experts learned additional information about the company, including current marketing plan, statement of the initial pricing plans, some financial

forecasting documents prepared by the budget department, and other data. Questions were about the product itself, factors that can influence cash flows, and many others. After three rounds of the study, factors identified by the experts were used to estimate future cash flow concerned with the new product. The results were used by participants of the study in their own department planning.

■ ***Forecasting selected U.S. economic variables and determining rationales for judgments (Gordon & Easson, 2005)***

A group of 28 experts took part in the study; they were actuaries, economists, investment managers, scientists, futurists and modelers. The main goal of the study was to forecast plausible range of values of U.S. economic variables for 2024: (i) annual increase in the consumer price index, (ii) 10-year treasury spot yield, (iii) S and P 500 total rate of return and (iv) corporate Baa spot yield (a credit rating used by Moody's credit agency for long-term bonds and some other investments). The experts also attempted to identify factors that could influence the development of these variables in future. The study resulted in long-term forecasts about selected economic parameters along with a list of factors that can influence development of the variables.

## CONCLUSIONS

For over 60 years the Delphi method has been used by academia, private companies, public administration, and national and international organizations in many studies with varying purposes. It has had its up and downs, being criticized (Sackman, 1974; Keeney et al., 2001) and endorsed (e.g., Gordon & Easson, 2005; Graefe & Armstrong, 2011). Yet it is still under development and new methodological solutions are proposed (Real-Time Delphi being a prominent example). Many studies conducted to evaluate the Delphi method for forecasting, decision-making, evaluation of policy options proved its worth in many disciplines (e.g. Rowe & Wright, 1999; Czinkota & Ronkainen, 2005; Gnatzy et al., 2011). The implementation of Delphi in finance and related disciplines has been presented above with a step-by-step outline. The method's potential suggests, however, that its application possibilities are much wider than it might be concluded from the presented literature. Various topics related to finance can benefit from using the Delphi method. Some of the selected examples from a

variety of issues concerned with finance are as follows:

- 1) identification of future changes in economic environment (on regional, national or international level),
- 2) identification of demand development for the new product of a company,
- 3) allocation of resources by public administration,

- 4) alternative scenarios for long-term development of a company,
- 5) allocation of funds in public health care,
- 6) evaluation of long-term investments of a company,
- 7) identification of factors that influence financial performance of a company.

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