RELEVANCE TREE –QUALITATIVE-QUANTITATIVE FORECASTING METHOD

Maria Cristina MURARU*

Abstract:

Most intelligence practitioners share the same experience when it comes to forecast and prognosis: the fact that, despite theoretical methods seem to offer great results on paper, when these are put into practice, expectations are rarely met. Given that quantitative methods do not take into account the subjective nature of phenomena and qualitative methods often include cognitive biases, we took a different approach. The case study I will further present is based on the application of the relevance tree, a graph-like method used by both sociology and cybernetics, as a complex combination between qualitative and quantitative methodologies.

Keywords: *forecast, prognosis, OSINT, relevance tree, energy security.*

Introduction

Prognosis is the "scientific art" of identifying the most likely event in the future, as it starts from the premise of a chain of causal events. Considering that prognosis applies to a wide range of areas, such as a company's profit and losses the progression of, weather conditions or candidates chances during elections, this form of art is an indispensable tool for intelligence services' activity: it may be a key element for decision makers' policies and strategies. However, a forecasting failure, identified or removed only too late, might generate serious disruptions to a national security system: destabilization of preventing and countering terrorism strategies, the emergence of major economic system dysfunctions, potentially resulting in a crisis situation, or even state instability.

Since experts in the field have repeatedly stressed that "if the intelligence sector is not a science yet, then it should become one", the forecast methods used by social sciences may apply to all subdomains, OSINT included.

* Romanian Intelligence Service

Though methods and patterns applied by OSINT experts are different, in terms of complexity and amount of unrefined data, the results are generally characterized by three main principles:

- Forecasts are seldom perfect;
- Forecasting accuracy is directly proportional to the number of considered variables and indicators;
- Forecasts tend to be more accurate on a short term, rather than on long term, potentially of generating strategic surprise.

Traditionally, forecasting methods used by OSINT analysis may be classified into two categories:

	Quantitative Methods	Qualitative Methods
Features	Based on quantifiable, numerical data.	Focused on opinions, proficiency and expertise.
Strong points	High degree of objectivity; It may include a significant amount of primary data.	It offers the possibility of including the latest developments and trends of the studied phenomenon, in the analysis.
Weak points	Limited access of open sources to recent, relevant information; Small number of employees with a degree in areas related to mathematics.	The risk of preconceptions and cognitive traps.

Figure no.1: Types of forecasting methods

The use of purely quantitative or qualitative methods in forecasting has been a constant subject of dispute and controversy. Upholders of each category have brought into question antithetical arguments: those in favor of quantitative patterns postulated that only the use of numerical models would contribute to making social sciences "real sciences", while those lobbying for qualitative methodology relied on the idea that quantitative methods tend to ignore social realities of the analyzed phenomena, since it neglects non-quantifiable variables, those which may prove to be the most relevant factors in the subject.

The exact contribution to forecast of each category depends both on the access to expertise and on the features of the analyzed theme. Generally, practitioners' tendency was to grant more confidence to numerical information, often seen as "strong evidence". On the other hand, facts do not always reveal the truth, since qualitative data are very important, by providing insights on the dynamics and depth of the studied phenomenon, while quantitative information is strictly related to a fixed number of indicators, limited as regards to the interpretation of reality as a whole.

Current trends in OSINT practice entail using quantitative patterns as a qualitative methodology tool. For example, the Delphi method includes experts' assignment of numerical or scalable values to future developments, subsequently analyzed opinions, reported by an observer. Later, experts meet and examine the observer's report individually, offering the latter new values. The examination procedure and the observer's reporting are repeated until all experts involved reach an agreement upon the potential development.

Quantitative Methods

This class of analytical tools massively relies on numerical data and on mathematical algorithms, being mostly used in studying evolutions on a medium term. Similar to statistics and econometrics, quantitative methods use and combine various mathematical patterns.

Methodology for quantitative forecasts apply if the following conditions are met:

1. The expert starts from the premise that the necessary information for generating forecast is available.
2. The hypothesis – "the future is an image of previous models' combinations " – is confirmed.

Time Sequences	Causal and Associative Patterns
- The necessary information for producing forecast is included in time sequences;	- Based on cause-effect relations between independent and dependent variables;
- **the future will follow up the patterns of the past;**	- **-** include core indicators on account of forecasts formulation;
- **future data= past pattern + errors;**	- the most used method is linear regression[1]: Y=aX+b, where y = dependent variable

[1] Concept defined and used by experts in statistics and econometrics.

- **historical patterns:** **Level: data revolve around a constant average;** **Trend: approximately linear increases and decreases;** **Cycle: usually specific to national economies;** **Seasonal: recurrent discrete patterns.** - **random errors/variations cannot be predicted.**	and x= independent variable; - multiple regression consists in expanding the number of independent variables: $Y=a_nX_n+a_{n-1}X_{n-1}+...+a_1X_1+a_0$.

Figure no.2: Types of forecasting quantitative methods

Qualitative Methods

In contrast with quantitative methodology, which relies mainly on statistics and models of the past, qualitative analysis is built around experts' advisory opinion. Qualitative forecasting is used in situations where numerical information are unavailable or lack consistency.

In time, the development of qualitative methods in social sciences and prognosis, generally, faced reluctance from researchers': practitioners' opinions must coincide on qualitative approaches, as their consent is mainly based on intuition and good judgment. On the other hand, in recent years, qualitative methodology has substantially improved as experts dispose of a wide range of tools, especially software, both for qualitative data collection and analysis.

Though qualitative methods' structure and scientific rigor are constantly increasing, analysts' creative thinking is being permanently encouraged.

Amid the rising OSINT contribution to the intelligence community's activity, a mention should be made on the ability of highlighting future changes in the security system and in interest groups' attitude, as being the main advantage of qualitative forecasting methods.

Given that OSINT is a nexus between civil society, academia and intelligence services, opinions and expertise, external to the intelligence community, which may have a crucial input on future developments, can be included in a complete analysis.

Nevertheless, qualitative forecasting methods are of particular importance when quantitative information is insufficient or non-existent: for example, in case of the outbreak of a newly discovered virus, near the borders, there won't be historical data to help outline a quantitative analysis. Extrapolating numerical data in the origin state/region of the virus is possible by means of indicators such as mortality or spread rate, but other factors, such as the endangered population's resilience to the new disease, despite being quantitative in nature, are impossible to quantify.

Moreover, this type of forecasting method provides intelligence decision makers the necessary flexibility to resort to non-quantitative information sources, such as experts' proficiency and best practices in a particular field. Applying these models can lead to an improved quality of forecast, as it is obvious that numerical data cannot capture nuances and clichés, noticeable after years of experience in the analyzed field.

Relevance Tree – Basics

The concept of relevance tree is essentially a technological method, its early stage of development being found in 1957 in operational research, a mathematics related area. Subsequently, the quantitative model was implemented by the PATTERN (Planning Assistance through Technical Evaluation of Relevance Numbers) planning program in the military and space programs of the American company, Honeywell. A year later, the same company improved and widely applied the method in all military and space activities it was involved in. Moreover, the relevance tree was massively implemented also in the cost assessment program of Apollo missions, conducted by NASA, by American air forces, as well as in advertising campaigns.

Essentially, the method is used to analyze and forecast situations and phenomena that require different levels of complexity, each level involving a high degree of specialization. The relevance tree, however, allows the identification of problems, solutions, and optimal or close to optimal solutions, as well. The long use in disjuncture was successful since the structured-like method facilitated a comprehensive approach: all important relations between the tree elements were taken into account, both in terms of present and future.

On the other hand, similar to most existing forecasting methods, relevance trees include a significant contribution of critical thinking, with the risk of a possible human error. Also, if the analysis process is not a complete one, results will be irrelevant. Similar to morphological analysis, building up a relevance tree implies:

- Strict definition of the General Objective, identification of the Methods, and subsequently, Submethods/Processes which contribute to achieve the Objective;
- Considering all Methods and Processes.

Furthermore, each method will be assigned a grade or relevance coefficient (M_{1}....M_{n}, where n – number of identified methods), with the necessary condition that the sum $M_1+M_2+....+M_n=1$. Equally, Submethods/ Processes will be attributed grades ($P_{1(M1)}$....$P_{j(Mn)}$), with the necessary condition that, on each level (Method) of the tree, the sum $P_{1(M1)}+...+P_{m(M1)}=1$, where m – number of Submethods corresponding to a Method.

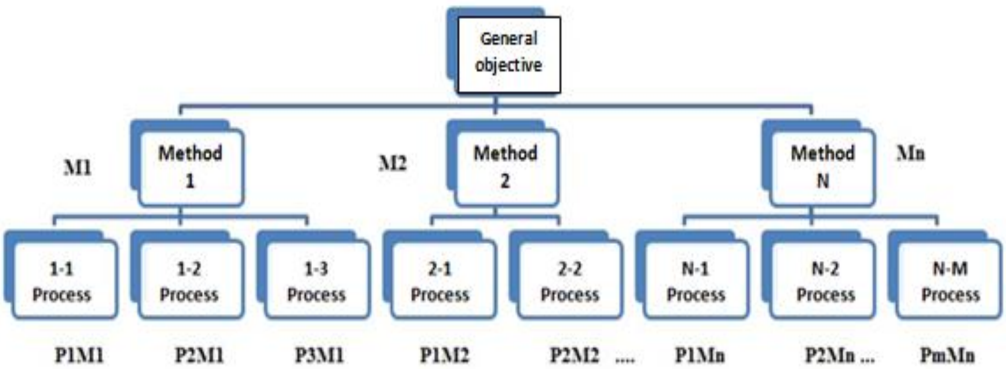

Figure no. 3: Relevance tree and relevance coefficients associated to each level of importance

Finally, products M_i x $P_{j(Mi)}$ type are calculated and the following chart are filled in:

Chart no. 1 – Relevance grades						
Relevance grade	$\mathbf{M_1}$	$\mathbf{M_2}$	**...**	$\mathbf{M_i}$	**...**	$\mathbf{M_n}$
$\mathbf{P_{1(M1)}}$	$P_{1(M1)}$ x M_1	-	-	-	-	-
$\mathbf{P_{2(M1)}}$	$P_{2(M1)}$ x M_1	-	-	-	-	-
...	**...**	**...**	**...**	**...**	**...**	**...**
$\mathbf{P_{j(Mi)}}$	**...**	**....**	**...**	M_i x $P_{j(Mi)}$	**...**	**...**
....	**...**	**...**	**...**	**...**	**...**	**...**
$\mathbf{P_{m(Mn)}}$	-	-	-	-	**...**	M_n x $P_{,(Mn)}$

Similar to the cases of relevance grades sums, associated to Methods and Processes, the sum of all products M_i x $P_{j(Mi)}$ type must be equal to one. The last step shall consist in the arranging the product values in decreasing order, the largest of them representing the most likely evolution/solution of the phenomenon/studied issue.

Relevance Tree – Application

Since the relevance tree was usually applied to macro issues, the case study of the article focuses on the simplified application of this method while identifying the most likely answer to the question: What will be Romania's solution in its efforts to diversify the energy mix?

In this respect, five experienced practitioners in energy were invited to attend a round of talks, inherent to a Delphi-type methodology.

After the first meeting, the following were set up as immediate Methods of diversifying energy resources:

- Entry into production of natural gas deposits in the Black Sea (Method 1);
- Exploration and exploitation of shale gas deposits (Method 2);
- Constant development of renewable resources sector (Method 3).

Also, each Method was assigned a specific process, thus contributing to its implementation:

1. Method 1
   - Exploration-exploitation licensing by the Romanian state (1-1 Process);
   - Development of royalties' national system (1-2 Process).
2. Method 2
   - Providing environmental license (2-1 Process);
   - Exploration-exploitation licensing by the Romanian state (2-2 Process);
   - Constant research and development in exploration-exploitation sector (2-3 Process).
3. Method 3
   - Development of support system for renewable energy (3-1 Process);
   - Constant research and development in the field, including the nuclear one (3-2 Process);
   - Providing location permits (3-3 Process).

Following the Methods and Processes set up, experts gathered during multiple rounds of discussions, giving relevance coefficients to each Method and Process, as follows:

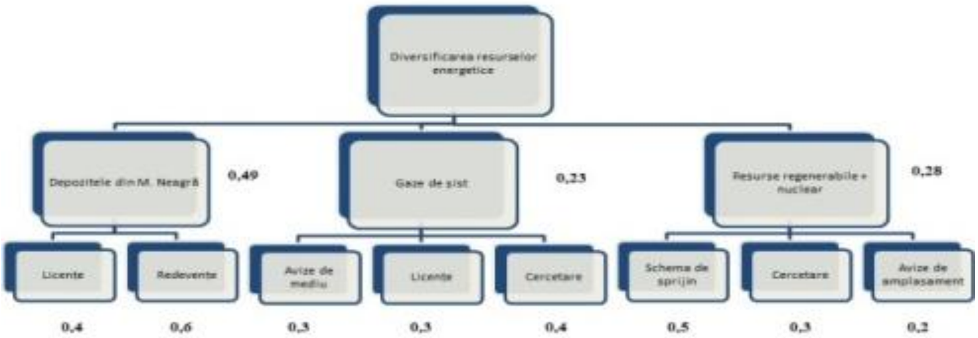

Figure no. 4: Relevance tree related to the issue of Romania's energy resources diversification

The product chart was filled in below, resulting in:

Chart no. 2 – Relevance coefficients			
Relevance coefficient	$\mathbf{M_1}$	$\mathbf{M_2}$	$\mathbf{M_3}$
$\mathbf{P_{1(M1)}}$	0,196	-	-
$\mathbf{P_{2(M1)}}$	0,294	-	-
$\mathbf{P_{1(M2)}}$	-	0,069	-
$\mathbf{P_{2(M2)}}$	-	0,069	-
$\mathbf{P_{3(M2)}}$	-	0,92	-
$\mathbf{P_{1(M3)}}$	-	-	0,14
$\mathbf{P_{2(M3)}}$	-	-	0,084
$\mathbf{P_{3(M3)}}$	-	-	0,056

Following the ordering of relevance grades, it's worth mentioning that reconfiguring the royalty system associated to the hydrocarbon reserves is the most likely solution to diversify our country's energy resources.

Nevertheless, ranking the first three solutions is supplemented by licensing exploration - exploitation of natural gas resources in the Black Sea and by further development of the support scheme for renewable energy resources, conclusions also supported by official documents issued by Romanian authorities.

References:

1. Armstrong, J. Scott. *Principles of forecasting: A Handbook for Researchers and Practitioners.* Available at http://www.gwern.net/docs/predictions/2001-principlesforecasting.pdf, accessed on August 3, 2014.

2. *Cia Historical Review Program*, *Intelligence as a science*", available at https://www.cia.gov/library/center-for-the-study-of-intelligence/kent-csi/vol2no2/html/v02i2a09p_0001.htm, accessed on 04.08.2014.

3. Glenn, Jerome C. *Introduction to the Futures Research Methods Series*. Available at www.cgee.org.br/atividades/redirKori/3298, last accessed on August 6, 2014.

4. Goldstone, Jack. *Using Quantitative and Qualitative Models to Forecast Instability*. Available at http://www.usip.org/sites/default/files/sr204.pdf, accessed on August 6, 2014.

5. Kachru, Upendra. *Strategic Management: Concept and Cases*. Available at http://books.google.ro/books?id=AunEMmTu7fkC&printsec=frontcover&dq=inauthor:%22Upendra+Kachru%22&hl=ro&sa=X&ei=cvU2VLvSA4asPMGpgIgG&ved=0CCYQ6AEwAQ#v=onepage&q&f=false, last accessed on September 1, 2014.

6. Surve, Abhaysinh V. Study of Technology Forecasting Methods" în "International Journal of Emerging Trends in Science and Technology. Available at http://ijetst.in/ems/index.php/ijetst/article/view/171, accessed on September 3, 2014.
7. Tănăsoiu, Ovidiu. *Modele econometrice, Volumul 1"*. Available at http://www.biblioteca-digitala.ase.ro/biblioteca/carte2.asp?id=414&idb=11., accessed on August 5, 2014.