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# TECHNOLOGY FORECASTING – STATE OF THE ART UPDATE

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by  
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## **Abstract**

This document presents the state of the art in forecasting methods and tools. The list of tools was collected as a result of a literature review. Collected tools have been grouped into comprehensible categories. Insight about degree of tools' application in practice has been obtained by measuring the number of scientific publications referring to a particular forecasting tool.

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## 1. Introduction

The aim of this task is to prepare a current review of ways used to conduct forecasting in technological domain. Technological domain is specified here in order to exclude a set of methods referring to other domains like health and weather forecasting. After the updated review of methods is performed, methods should be put into groups according to their characteristics. It is expected that grouping will go beyond standard approach of normative, exploratory and qualitative, quantitative division. Other objective of this task is it to learn about significant applications of reviewed methods.

Task 2.3 was conducted in two phases. Phase one was concentrated on the preparation of the list of existing methods to perform forecasting. This phase ends with a list of methods gathered from various sources. Collected methods should be organized into categories corresponding to the nature of their application.

Phase two searched for examples of significant applications of forecasting methods. This phase ends with the indication on popularity of utilization of particular tools and references to numbers of renowned applications.

## 2. State-of-the-art in forecasting tools

Along the years, many answers to a need for reliable forecasting have been proposed. Approaches to deal with this task are numerous enough in order to prepare a review of such methods. State-of-the-art being prepared in this task builds on reviews previously prepared and published in scientific publications. It was decided to prepare our state-of-the-art as an update to a review done in the past and preferably related to the domain specific for FORMAT project, i.e. Technological Forecasting.

A review done by Dmitry Kucharavy has been selected. This review has been done in border of a paper in 2005 [1]. This review has been selected as a starting point for state-of-the-art in forecasting methods. It lists several significant reviews prepared prior to publication and preparation of that paper [2-5], but by itself does not present a list of available forecasting tools. In order to reach the list enumerating individual forecasting tools, it is necessary to refer to source publications. Reviews of methods referred to in [1], had been published in various sources: books, journal publications and on internet.

### 2.1. Starting point

The review in [1] has been treated as a starting point for the state-of-the-art update. In order to perform an update from 2005 on, until present, two approaches have been used. One approach, to look for new developments, was to search for them in indexes of scientific journals. Any publication of a new review of methods usually rises a scientific discussion. Papers containing reviews of methods usually have a high number of references from other authors that point to such papers. Additionally, such reviews are performed usually by renowned teams of researchers or a single renowned researcher. All of mentioned reasons should make a paper, containing a forecasting tools review, more distinguishable in search results. This approach however turned to be ineffective. No new significant reviews have been found after 2005.

In order to make a double check on past reviews performed before 2005 the check up was extended also into the past before 2005. It had a double objective. One was to make a secondary check. Other was to include reviews of forecasting tools that may not have been fully qualified to forecasting of technological issues in [1], but still may contain some useful descriptions of forecasting tools.

Main sources used in searching for reviews of forecasting tools were publications in scientific journals, publications in professional journals, book-form manuals and special reports. A list of sources and number of tools extracted from them is presented in Table 1. Sources from 1÷4 are listed in [1].

**Table 1 Showing sources of reviews in column, number of tools that were extracted from this source**

#	Name of source	Number of tools extracted	Number of categories used by author(s)
1	A.L. Porter et al. "Technology futures analysis: Toward integration of the field and new methods" 2004 [2]	51	9
2	Makridakis et al. "Forecasting methods and applications" 1998. [3]	19	19
3	J.Scott Armstrong et al. "Principles of forecasting" 2002. [4]	10	10
4	Vanston, "Technology futures", 2005 [5]	28	5
5	FORLEARN [6]	26	9
6	J.P. Martino "Technological forecasting for decision making", 1993. [7]	39	11
7	Futures Research Methodology Version 2.0, Millenium Project, 2002 [8]	27	-
8	Futures Research Methodology Version 3.0, Millenium Project, 2011 [9]	35	-
9	Technological Forecasting and Social Change, Special issues since 2004 [10-19]	9	-
10	International Journal of Forecasting, Special issues and sections since 2000 [20-23]	4	-
11	M3 competition [24]	24	6
12	A.L. Porter – presentation, 2005 [25]	19	13

## 2.2. Approach to perform update

State-of-the-art in technological forecasting tools was not intended to be limited to search for reviews already done. One way to provide an update would be to look for scientific papers and books introducing a new forecasting tool. However, information about new tools appear usually to be modifications to tools already known and they are not yet tested enough in order to be accepted by wider group of practitioners. Therefore this way to update existing reviews was decided not to be used.

Attention was turned to another way of recognition of a forecasting tool. This different way is publication in a special issue or special section of a scientific journal. Special issues and special sections are produced from time to time by scientific journals. Such a special edition, gathers papers written in a particular subject. In case of journals in domain of forecasting technology, special editions are frequently built around single forecasting tool.

Appearance of such special issue or section attributed to a particular forecasting tool is a way to stress a significance of a tool recognized among researchers contributing to this journal. In this way, special issues and special sections can form a list of tools that have been the most recognizable in recent years. Resources gathered in this task listed forecasting tools from special editions in two journals – shown in positions 9 and 10 in Table 1.

Each source listing TF tools collected them with different objectives. Therefore, some sets of methods have a visible profile, e.g. phenomenological tools using statistical tools, or intuitive methods for work with expert knowledge. Each source also applies a different categorization of TF tools. Number of categories used in particular source is also presented in Table 1.

As soon as a complete set of sources has been built, all forecasting tools listed in these sources have been pooled into one place. As it was expected, many tools were appearing in more than one source. A list of forecasting tools pooled together listed 266 tools (Table A.1). Some of them were names of categories of forecasting tools. Excluding obvious repetitions and category names, the list was reduced to 198 tools. Closer analysis allowed removing 107 more recognized as occurring more than once, thus leaving a set of 91 tools (Table A.2).

Name of a tool was qualified as a repeating in two cases. One it is a conventional case of repetition. Other occurs when a modified name is used for the same tool or a variation of a tool e.g. Delphi questionnaire, Delphi, Delphi techniques, Delphi forecasting, Real-time Delphi. It was decided that variations of a tool would be considered as repetitions unless their description suggests a significant modification done. The complete alphabetical list of tools pooled for further study in this project is presented in Table A.1; the list without doubles is in Table A.2.

### 2.3. Categories

A practical approach to systematize a list of TF tools is to organize it into categories. After pooling all collected forecasting tools into one list, various categorization schemes previously applied have been removed. There was a need to introduce a new categorization, or to use some existing one. Several sorts of categorization principles are available. In Table 1 it is possible to observe that previously used schemes applied many categories. With exception to one used by Vanston [5], other schemes have at least 9 positions. Number of elements is considered to be high for practical utilization by a human being, if it is higher than  $7 \pm 2$  [26] and in practice it should be even lower.

Number of categories should be large enough in order to be specific and small enough in order to be practical in use. It was proposed to use four categories of forecasting methods introduced originally by Dmitry Kucharavy (DK) (in his working material). Categories proposed by DK are following:

1. Causal models (e.g. analogy analysis, morphological analysis, laws and patterns of system evolution)
2. Phenomenological models (e.g. extrapolations of time series data, regressions)
3. Intuitive models (e.g. Delphi surveys, structured and unstructured interviews)
4. Monitoring and mapping (e.g. scanning of literature and published sources, scenarios, mapping existing information)

Allocation of each forecasting tool to above listed categories was done by a researcher working on task T2.3. Division into categories was done basing on tools' previous categorization and descriptions presented in sources where a tool had been listed. Some tools may fit two categories. In current version they are listed always only in one. The great advantage of introduced categorization is a low number of categories that is practical to use. A list of tools with allocation to particular category in alphabetical order can be found in Table A.3.

An updated list of tools has been collected. After further treatment of the list and elimination of repetitions, methods have been allocated into four categories, specifying their nature. Next step of the review performs a check up on the popularity of collected methods.

### 3. Significant applications

Different solutions used for forecasting tools are answers to a variety of needs towards forecasting that have been appearing for a long period of time. The result of answering to these needs is a wide selection of forecasting tools presented in preceding point. Preference in utilization of certain tools has been changing with time and habits of forecasters.

For the purpose of the FORMAT project it is necessary to select the most relevant group of tools according to the objectives of the project. Objectives of FORMAT are concentrated around technological forecasting in manufacturing industry, preferably with application to case studies at Whirlpool (WHRIT) company.

This profile of objectives should create guidelines for requirements towards forecasting tools that would help to select a group of tools for further use. However, after closer analysis of nature of case studies and resources for their execution, it turned out that, only a few tools could be excluded from a complete set. Moreover such a reduction would be made only with limited level of confidence based on opinion of two WHRIT experts and a forecasting tools developer, taking part in FORMAT project.

It was decided to keep a complete set of forecasting tools and look for another, objective way of selection. An approach proposed in FORMAT's Description of Work (DoW) is to learn about significant applications of forecasting tools done in past.

#### 3.1. Significant applications – search for

Search for examples of significant applications was oriented on domain of forecasting in subjects involving technology. Application examples from policy, environment, health or weather should not be concerned. As a result, it had been expected to find at least one application case for each tool. The search has been performed in: web available resources, web resources with scientific profile (Google Scholar), professional, scientific journals and in results of EU funded research projects. This question was also addressed to WHRIT experts from FORMAT project, but no records about forecasting utilization are available in WHRIT to date.

It turned up quite quickly that there are just a few examples of application of forecasting tools whose descriptions are available. However, even these few applications found, because of their little number, can not be treated as means of comparison among an entire set of collected tools.

Only one outstanding example of significant application has been found that is worth mentioning. It is an example of application of a roadmapping tool. IMS2020 (Intelligent Manufacturing Systems) was a FP7 EU project coordinated by Politecnico di Milano that ended in 2011 [27]. Results of this project provide a valuable material both as a forecast of manufacturing development and application of a roadmapping tool.

After search for application cases, performed in this task, it has been concluded, that information about practical applications of forecasting tools almost do not exist in publicly accessible domain. The most probable reason for this situation is a level of confidentiality imposed on most of forecasting case studies performed inside companies. The only example of roadmapping application relating to technological issues, presented in IMS2020 is publicly accessible because it is a result of a publicly funded project.

### 3.2. Scientific publications

A situation when results of projects are made public is common in scientific research domain. That was a clue that led to decision to modify a perception of significant application of forecasting tools. In order to obtain a quantitative measure of significance, it was decided to count a number of scientific publications that mention a particular forecasting tool. Scientific publication is counted here as a publication listed inside Scopus index [28]. Single occurrence means that a search phrase, containing a name of a forecasting tool, appeared once or more in either title, abstract or keywords in one particular scientific paper.

In order to make an occurrence measure more meaningful, three measures were taken for each search phrase in Scopus index. Basic measure is a general number of papers where a search phrase occurred at least once in at least one of following fields: title, abstract, keywords. Other measure is limitation of a basic option only to conference papers. Another measure is also Scopus search in already mentioned three fields, title, abstract, keywords, but limited to papers in one of the most important journals of the research domain, Journal of Technological Forecasting and Social Change. This journal has been chosen as the most representative for technological forecasting domain. All search options used for occurrence measurements are listed in Table 2.

Scopus index is a search engine for strictly scientific publications. For a purpose of comparison and reference to a more open search domain, Google Scholar was used. The search phrase used for a particular forecasting tool was the same as one used in Scopus index. Google Scholar search service does not provide further search tuning options as in Scopus. Number of appearance measured by Google Scholar referred to an entire searchable domain labeled by a provider as qualifying to Google Scholar search sources i.e.: articles, theses, books, abstracts and court opinions, from academic publishers, professional societies, online repositories, universities and other web sites [29].

**Table 2 Search options**

Measure	Search engine	Settings
1	Scopus	Title, abstract, keywords
2	Scopus	Title, abstract, keywords, conference paper
3	Scopus	Title, abstract, keywords, Journal of Technological Forecasting & Social Change
4	Google Scholar	No limits

The results of number of occurrences are presented in Table A.3. Please mind that lists in Table A.3 are presented for separate tools' categories and they are in alphabetical order. For a spreadsheet form of this table you will have to refer to online resources.

### 3.3. Number of occurrences – a way to understand

There are few issues that should be kept in mind reading results. Number of occurrences of a forecasting tool's name in scientific publications is overall an indication of discussion that took place. Whether a particular tool is discussed as a positive or negative

example is not known from occurrence data alone. However it can be assumed that a tool had been valued as fulfilling some needs before conclusions were published.

Numerous occurrences of a tool's name in scientific publications signify a vivid discussion. It is a discussion that took place in scientific publications that in case of Scopus indexed journals, are always reviewed by scientific community before publication. This fact adds a level of trust to occurrences measured in Scopus. Google Scholar, as a much more open search engine, includes material published at professional societies, online repositories, universities [29]. From this point of view, a discussion on certain tools may become even more vivid, but also less controlled. This fact may suggest a possibility for a measure to include also a result of an exaggeration in a discussion.

### **3.4. Graphical presentation of results**

Apart from results presented in tables, in order to make an overall comparison of all four measures (Table 2) for several tools, the same results are presented in a graphical form. Tools are arranged into four groups mentioned earlier. Charts present for each tool four columns corresponding to four measures (Table 2).

Two sets of 4 charts are presented. One shows tools arranged according to growing number of appearance in Scopus, other according to growing number of appearance in Google Scholar. Vertical axis is arranged in logarithmic scale, which may cause some small number of occurrences to be invisible.

Thanks to graphical presentation it is possible to observe a correlation between number of occurrences in Scopus and in Google Scholar. For some tools it possible to notice a lack of correlation in these two measures i.e. high position among Google Scholar and low among Scopus, e.g., Bayesian economics, Judgmental forecasting and adjustment, Technological progress function.

### **3.5. Historical record**

Number of occurrences checked today is a sum for an entire history record of a particular search engine. For instance, in Scopus it is possible to select an option back to 1960 and overall it is possible to go as far as 1823 [28]. It means that a tool that was created earlier has had a chance to collect occurrences for a long time. In results of number of occurrences such a tool is presented together with lately added solutions that may have collected the same, smaller or higher number of occurrences. A conclusion from this observation should be considered using number of occurrences as a criterion.

Another factor that plays a role here is a forum for discussion. Number of papers indexed by Scopus has grown over time therefore a number of appearances had an opportunity to grow as well.

In order to make this observation practical to use, let's consider two cases. One is a short-time growth, other is a long-time growth. For instance: Heuristic modeling has total of 8 occurrences since 1977; Adaptive policies tool has 9 occurrences since 2002. Data covering a time line of occurrences for each tool can be accessed in tabular form in Table C.1 and also in online resources.

## 4. Conclusions

Review of forecasting tools resulted in a list of 91 tools. Forecasting methodology being developed inside FORMAT project will chose among the tools collected in the state-of-the-art review. Other solution, which might be developed inside FORMAT, is to base on solutions inscribed in collected forecasting tools in order to construct a new solution customized for needs of technological forecasting in manufacturing domain.

All tools have been arranged into four groups facilitating a differentiation among they major properties. Every tool listed in this task is accompanied by a reference to a bibliographic source. Thanks to this, any time there is a need to use a tool it is possible to refer to its description, instruction of use and further references.

Number of scientific publications and other scientific sources published and dealing with a particular tool, has been applied in this task as a measure of significant applications. This measure should not be taken as a strict criterion. However a comparison among collected tools provides an insight into dynamics in scientific discussion involving a particular tool.

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13. *Special issue: Emerging Trends in Science and Technology Policy*. *Technological Forecasting and Social Change*, 2007. **74**(1).
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15. *Special issue: Knowledge Driven Planning Tools for Emerging and Converging Technologies*. *Technological Forecasting and Social Change*, 2009. **76**(1).
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18. *Special issue: The Delphi technique: Past, present, and future prospects*. *Technological Forecasting and Social Change*, 2011. **78**(9).
19. *Special issue: Backcasting for Sustainability*. *Technological Forecasting and Social Change*, 2011. **78**(5).
20. *Special Section: Time Series Monitoring*. *International Journal of Forecasting*, 2009. **25**(3).
21. *Special Issue: Bayesian Forecasting in Economics*. *International Journal of Forecasting*, 2010. **26**(2).
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## 6. Appendix A

**Table A.1 Full list of forecasting tools (including group, category names and repetitions), alphabetic order with references**

#	Name of a forecasting tool	Reference
1	26 product characteristics X 14 personality traits of target groups – assess fit (N. Pals et al., TNO)	[25]
2	A Probabilistic Biological Analogy	[7]
3	Action [options] analysis	[2]
4	Adaptive Management – implies good intelligence & quick analyses to support decision processes	[25]
5	Adaptive policies	[10-19]
6	Advanced forecasting models	[3]
7	Agent Modeling	[8]
8	Agent modeling	[2]
9	Agent Modeling (demo software)	[9]
10	Agent Modelling (e.g. MACTOR)	[6]
11	Analogies	[2]
12	Analogies	[4]
13	Analogies	[3]
14	Analogy analysis	[5]
15	Analytical hierarchy process	[2]
16	Artificial Neural Networks	[20-23]
17	Backcasting	[2]
18	Backcasting	[6]
19	Backcasting for Sustainability	[10-19]
20	Basic forecasting tools	[3]
21	Bayesian economics	[20-23]
22	Behavioral evolution	[25]
23	Bibliometrics	[2]
24	Box Jenkins	[3]
25	Brainstorming	[2]
26	Causal Layered Analysis	[9]
27	Causal Layered Analysis	[8]
28	Causal models	[7]
29	Causal models	[2]
30	Causal models economic and social	[7]
31	Causal models techno-economic	[7]
32	Causal models technology-only	[7]
33	Checklists for impact identification	[2]
34	Combining forecasts	[7]
35	Competitor analysis	[5]
36	Complex adaptive system	[2]
37	Components and Aggregates	[7]
38	Conjoint Analysis	[4]
39	Consensus-building games	[25]
40	Constrained scoring	[7]
41	Content analysis	[5]
42	Correlation analysis	[2]
43	Correlation Methods	[7]
44	Correlation Stages of Development	[7]
45	Correlation with Economic Factors	[7]
46	Cost–benefit analysis technology	[2]
47	Counter punchers	[5]
48	Creativity Methods (Brainstorming, Mindmapping...)	[6]
49	Critical & Key Technology Study	[6]
50	Cross-Impact Analysis	[9]
51	Cross-impact analysis	[2]

#	Name of a forecasting tool	Reference
52	Cross-Impact Analysis	[8]
53	Cross-Impact Analysis (e.g. SMIC)	[6]
54	Cross-Impact Models	[7]
55	Cycles vs. long-term trends	[3]
56	Decision analysis [utility analyses]	[2]
57	Decision Modeling	[9]
58	Decision Modeling	[8]
59	Decision trees	[5]
60	Delphi	[7], [8], [9], [10-19], [2], [6], [5]
61	Delphi Techniques	[8]
62	Demographics technology	[2]
63	Diagnosis	[6]
64	Diffusion modeling	[2]
65	Distribution of Time Lags	[7]
66	Dynamic regression	[3]
67	Econometric	[4]
68	Econometrics and Statistical Modeling	[8]
69	Economic base modeling	[2]
70	Ellipsoidal technology frontiers	[7]
71	Emerging Trends	[10-19]
72	Environmental monitoring	[7]
73	Environmental Scanning	[9]
74	Environmental Scanning	[8]
75	Environmental Scanning & Monitoring	[6]
76	Evolutionary Methodologies	[10-19]
77	Expert Opinions	[4]
78	Expert Panels	[6]
79	Expert Systems	[4]
80	Exploratory	[6]
81	Exponential smoothing methods	[3]
82	Extrapolation	[4]
83	Extrapolators	[5]
84	Feedback models	[5]
85	Field Anomaly Relaxation	[8]
86	Field Anomaly Relaxation (FAR)	[9]
87	Field anomaly relaxation method (FAR)	[2]
88	Fisher Pry	[5]
89	Focus groups	[2]
90	Forecasting by analogy	[7]
91	Future workshops	[2]
92	Futures Wheel	[8]
93	Gaming	[25]
94	Gaming	[6]
95	Genetic Algorithms technology innovation	[25]
96	Genius	[8]
97	Genius Forecasting, Intuition, and Vision	[9]
98	Goal analysts	[5]
99	Goals	[7]
100	Gompertz	[5]
101	Grey model	
102	Group-Based Judgmental	[20-23]
103	Growth curve	[7]
104	Growth curve - several types	[7]
105	Growth Limit Analysis	[5]
106	Heuristics Modeling	[9]

#	Name of a forecasting tool	Reference
107	Impact analysis	[5]
108	Innovation system modeling	[2]
109	Institutional analysis	[2]
110	Intentions	[4]
111	Interactive information visualization	[25]
112	Interactive Scenarios	[9]
113	Interactive Scenarios	[8]
114	Intervention analysis	[3]
115	Interviews	[2]
116	Intuitors	[5]
117	Irreversibilities	[25]
118	Judgmental	[3]
119	Judgmental Bootstrapping	[4]
120	Knowledge Driven Planning Tools	[10-19]
121	Lead-lag correlation	[7]
122	Learning curve	[5]
123	logistic curve	[25]
124	Long wave	[2]
125	Long-term	[3]
126	Long-term mega economic trends	[3]
127	Lotka-Volterra	[25]
128	Maximum Installation Size	[7]
129	Maximum Installation Size	
130	Measures of technology	[7]
131	Mega-sets	[25]
132	Micmac	[6]
133	Mission Flow Diagrams	[7]
134	Mitigation analysis	[2]
135	Modelling & Simulation	[6]
136	Monitoring [environmental scanning, technology watch]	[2]
137	Morphological Analysis	[9]
138	Morphological analysis	[2]
139	Morphological Analysis & Relevance Trees	[6]
140	Morphological Matrices	[5]
141	Morphological Models	[7]
142	Multi-Criteria Analysis	[6]
143	Multicriteria decision analysis	[2]
144	Multiple Perspective	[8]
145	Multiple Perspective Concept	[9]
146	Multiple perspectives assessment	[2]
147	Multiple regression	[3]
148	Multivariate autoregressive	[3]
149	Neural network forecasting	[3]
150	Nominal group	[5]
151	Non-linear	[3]
152	Non-Linear Dynamics	[9]
153	Normative	[6]
154	Normative	[8]
155	Normative Forecasting	[9]
156	Normative method	[7]
157	Open	[6]
158	Organizational analysis	[2]
159	Participatory Methods	[9]
160	Participatory Methods	[8]
161	Participatory techniques	[2]
162	Patent analysis	[5]
163	Patents as Leading Indicators	[7]

#	Name of a forecasting tool	Reference
164	Pattern analysis	[5]
165	Personal Futures	[9]
166	Planar technology frontiers	[7]
167	Potential Breakthrough Technologies minding the gap	[10-19]
168	Precursor analysis	[2]
169	Precursor Trend Analysis	[5]
170	Prediction Markets	[9]
171	Predictive	[6]
172	Prescription	[6]
173	Probabilistic Methods	[7]
174	Probabilistic scenario	[25]
175	Prognosis	[6]
176	Qualitative	[6]
177	Quantitative	[6]
178	Real-Time Delphi	[9]
179	Regression with ARIMA errors	[3]
180	Relevance Trees	[9]
181	Relevance Trees	[7]
182	Relevance trees [futures wheel]	[2]
183	Relevance Trees and Morphological Analysis	[8]
184	Requirements analysis [needs analysis, attribute X technology matrix]	[2]
185	Risk analysis	[2]
186	Roadmapping	[10-19]
187	Roadmapping [product-technology roadmapping]	[2]
188	Roadmaps	[5]
189	Robust Decision making	[9]
190	Role Playing	[4]
191	Rule Based	[4]
192	S&T Road Mapping	[9]
193	S&T Roadmapping	[6]
194	Scanning, Monitoring, Tracking	[5]
195	Scenario Building	[6]
196	Scenario building	[3]
197	scenario management	[2]
198	Scenario planning	[8]
199	Scenario-simulation	[2]
200	Scenarios	[7]
201	Scenarios	[5]
202	Scenarios (+A Toolbox for Scenario Planning)	[9]
203	Science fiction	[2]
204	Science mapping	[2]
205	Science technology RoadMapping	[8]
206	Simple regression	[3]
207	Simulation and Games	[9]
208	Simulation and Games	[8]
209	Social drivers	[25]
210	Social impact assessment [socioeconomic impact assessment]	[2]
211	Staggered Brainwriting	[25]
212	Stakeholder analysis	[5]
213	Stakeholder analysis	[2]
214	State of the Future sofi	[8]
215	State of the Future Index	[9]
216	State of the future index (SOFI)	[2]
217	Statistical Modeling	[9]
218	Statistical Modeling	[8]
219	Stochastic Cellular Automata	[7]
220	Stochastic Projection	[7]

#	Name of a forecasting tool	Reference
221	Strategic foresight technology	[10-19]
222	Strategic games	[5]
223	Structural Analysis	[9]
224	Structural Analysis	[8]
225	Structured & unstructured interviews	[5]
226	Substitution Analysis	[9]
227	Sustainability analysis	[2]
228	SWOT	[6]
229	System dynamics	[2]
230	System Dynamics	[6]
231	Systems Modeling	[8]
232	Systems Perspective	[8]
233	Tech Mining	[10-19]
234	Tech Mining & QTIP (A. Porter)	[25]
235	Technological progress function	[7]
236	Technological Sequence Analysis	[8]
237	Technological substitution	[2]
238	Technology assessment	[2]
239	Technology frontiers	[7]
240	Technology push with Social pull (values, needs & objectives (H. du Jouvenal)	[25]
241	Technology Sequence Analysis	[9]
242	Technology Trend Analysis	[5]
243	Terrain mapping	[5]
244	Text Mining for Technology Foresight	[9]
245	Text Mining technology	[8]
246	The Distribution of Discoveries probabilistic	[7]
247	The Futures Polygon	[9]
248	The Futures Wheel	[9]
249	The Systems Perspectives	[9]
250	Theoretical bonds between bio, tech, and cultural evolutionary processes	[25]
251	Theory-based scenario sets (I. Miles)	[25]
252	Time series decomposition	[3]
253	Time Series Monitoring	[20-23]
254	Trend and Analogy	[7]
255	Trend and growth curves	[7]
256	Trend extrapolation	[7]
257	Trend extrapolation [growth curve fitting and projection]	[2]
258	Trend Impact Analysis	[9]
259	Trend Impact Analysis	[8]
260	Trend impact analysis	[2]
261	Trend Intra & Extrapolation	[6]
262	TRIZ	[2], [25]
263	Using Vision in Futures	[9]
264	Value models	[5]
265	Vision generation	[2]
266	Wild Cards	[9]

Table A.2 List of forecasting tools without repetitions; references included

#	Name of a forecasting tool	Reference
1	26 product characteristics X 14 personality traits of target groups – assess fit (N. Pals et al., TNO)	[25]
2	Adaptive policies	[10-19]
3	Agent Modeling	[8]
4	Analytical hierarchy process	[2]
5	Artificial Neural Networks	[20-23]
6	Bayesian economics	[20-23]
7	Behavioral evolution	[25]
8	Bibliometrics	[2]
9	Box Jenkins	[3]
10	Brainstorming	[2]
11	Causal Layered Analysis	[8]
12	Causal models	[7]
13	Checklists for impact identification	[2]
14	Combining forecasts	[7]
15	Complex adaptive system	[2]
16	Correlation Methods	[7]
17	Cost–benefit analysis	[2]
18	Cross-Impact Analysis	[8]
19	Decision analysis [utility analyses]	[2]
20	Decision Modeling	[8]
21	Delphi	[7], [8], [9], [10-19], [2], [6], [5]
22	Demographics technology	[2]
23	Dynamic regression	[3]
24	Econometric technological	[4]
25	Economic base modeling	[2]
26	Emerging Trends	[10-19]
27	Environmental monitoring	[7]
28	Evolutionary Methodologies	[10-19]
29	Expert Systems	[4]
30	Field Anomaly Relaxation	[8]
31	Focus groups	[2]
32	Forecasting by analogy	[7]
33	Future workshops	[2]
34	Futures Wheel	[8]
35	Genetic Algorithms technology innovation	[25]
36	Genius	[8]
37	Group-Based Judgmental	[20-23]
38	Growth curve	[7]
39	Innovation system modeling	[2]
40	Interactive Scenarios	[8]
41	Interviews technological	[2]
42	Irreversibilities	[25]
43	Judgmental	[3]
44	Judgmental Bootstrapping	[4]
45	Knowledge Driven Planning Tools	[10-19]
46	Logistic curve	[25]
47	Long-term	[3]
48	Measures of technology	[7]
49	Mega-sets	[25]
50	Multiple Perspective	[8]
51	Multiple regression	[3]
52	Multivariate autoregressive	[3]
53	Non-linear models	[3]
54	Normative	[8]

55	Normative method	[7]
56	Organizational analysis	[2]
57	Participatory Methods	[8]
58	Potential Breakthrough Technologies minding the gap	[10-19]
59	Probabilistic Methods	[7]
60	Probabilistic scenario sets (T. Modis)	[25]
61	Risk analysis	[2]
62	Role Playing	[4]
63	Rule-Based Forecasting	[4]
64	Science fiction	[2]
65	Science mapping	[2]
66	Science technology RoadMapping	[8]
67	Simple regression	[3]
68	Simulation and Games	[8]
69	Social drivers	[25]
70	SOFI (State of the Future) System	[8]
71	Staggered Brainwriting	[25]
72	Stakeholder analysis	[2]
73	Statistical Modeling	[8]
74	Strategic foresight	[10-19]
75	Structural Analysis	[8]
76	Sustainability analysis	[2]
77	SWOT	[6]
78	System dynamics	[2]
79	Systems Perspective	[8]
80	Tech Mining	[10-19]
81	Technological Sequence Analysis	[8]
82	Technological substitution	[2]
83	Technology assessment	[2]
84	Text Mining for technology forecast	[8]
85	Theoretical bonds between bio, tech, and cultural evolutionary processes	[25]
86	Time series decomposition	[3]
87	Time Series Monitoring	[20-23]
88	Trend extrapolation	[7]
89	Trend Impact Analysis	[8]
90	TRIZ	[2], [25]
91	Vision generation	[2]

Table A.3 List of forecasting tools – category 1: Causal models

#	Name of a forecasting tool	Reference	Search phrase	Scopus	Scopus, conference papers	Scopus, Journal of Tech. Forecasting & Social Change	Google Scholar
Number of occurrences							
1	A Probabilistic Biological Analogy	[7]	"A Probabilistic Biological Analogy"	0	0	0	0
2	Agent Modeling	[8]	"Agent Modeling" forecasting	12	3	0	926
3	Artificial Neural Networks	[20-23]	"Artificial Neural Networks" forecasting	6305	2255	3	40000
4	Behavioral evolution	[25]	"Behavioral evolution" forecasting	3	0	0	116
5	Causal Layered Analysis	[8]	"Causal Layered Analysis" forecasting	3	0	0	221
6	Causal models	[7]	"Causal models" forecasting	52	7	2	4380
7	Combining forecasts	[7]	"Combining forecasts" forecasting	141	24	2	3790
8	Complex adaptive system	[2]	"Complex adaptive system" forecasting	16	6	1	2320
9	Cross-Impact Analysis	[8]	"Cross-Impact Analysis" forecasting	51	3	14	1660
10	Decision Modeling	[8]	"Decision Modeling" forecasting	18	7	2	1520
11	Diffusion modeling	[2]	"Diffusion modeling" forecasting	28	10	3	699
12	Distribution of Time Lags	[7]	"Distribution of Time Lags" forecasting	0	0	0	26
13	Economic base modeling	[2]	"Economic base modeling" forecasting	0	0	0	15
14	Evolutionary Methodologies	[10-19]	"Evolutionary Methodologies" forecasting	2	1	0	58
15	Expert Systems technological	[4]	"Expert Systems" forecasting	91	38	2	1660
16	Forecasting by analogy	[7]	"technological forecasting" forecasting	6	0	0	362
17	Genetic Algorithms technology innovation	[25]	"Forecasting by analogy" forecasting	0	0	0	307
18	Heuristics Modeling	[9]	"Genetic Algorithms" forecasting	8	0	0	15
19	Impact analysis	[5]	"Heuristics Modeling" forecasting	47	6	13	1380
20	Judgmental Bootstrapping	[4]	"Impact analysis" forecasting	2	0	0	106
21	Mission Flow Diagrams	[7]	"Judgmental Bootstrapping" forecasting	1	0	0	19
22	Morphological analysis	[2]	"Mission Flow Diagrams" forecasting	20	3	2	2650
23	Multi-Criteria Analysis	[6]	"Morphological analysis" forecasting	71	17	2	11200
24	Normative	[8]	"Multi-Criteria" forecasting	10	0	2	426
25	Normative method	[7]	"Normative Forecasting" forecasting	4	0	0	207

#	Name of a forecasting tool	Reference	Search phrase	Scopus	Scopus, conference papers	Scopus, Journal of Tech. Forecasting & Social Change	Google Scholar
				Number of occurrences			
			forecasting				
26	Personal Futures	[9]	"Personal Futures" forecasting	10	0	0	112
27	Probabilistic Methods	[7]	"Probabilistic Methods" forecasting	161	76	0	5200
28	Relevance Trees	[7]	"Relevance Trees" forecasting	10	0	3	477
29	Risk analysis	[2]	"Risk analysis" forecasting	72	35	6	1420
30	Stochastic Cellular Automata	[7]	"Stochastic Cellular Automata" forecasting	3	0	1	344
31	Stochastic Projection	[7]	"Stochastic Projection" forecasting	7	0	0	214
32	System dynamics	[2]	"system dynamics" forecasting	62	23	16	1810
33	Systems Perspective	[8]	"Systems Perspective" forecasting	29	9	2	6920
34	Technological Sequence Analysis	[8]	"Technological Sequence Analysis" forecasting	0	0	0	5
35	Technological substitution	[2]	"Technological substitution" forecasting	38	1	24	1350
36	The Distribution of Discoveries probabilistic	[7]	"The Distribution of Discoveries" probabilistic forecasting	0	0	0	6
37	Backcasting	[6]	Backcasting forecasting	53	3	6	4690
38	Causal models economic and social	[7]	Causal models forecasting "economic and social"	9	2	0	465
39	Causal models techno-economic	[7]	Causal models forecasting "techno-economic"	0	0	0	21
40	Causal models technology-only	[7]	Causal models forecasting "technology-only"	0	0	0	9
41	Irreversibilities	[25]	Irreversibilities forecasting	25	4	2	8790
42	Micmac	[6]	Micmac forecasting	1	0	0	875
43	Science technology RoadMapping	[8]	Science technology RoadMapping forecasting	21	3	11	2440
44	TRIZ	[2], [25]	TRIZ forecasting	44	30	1	1890

Table A.4 List of forecasting tools – category 2: Phenomenological models

#	Name of a forecasting tool	Reference	Search phrase	Scopus	Scopus, conference papers	Scopus, Journal of Tech. Forecasting & Social Change	Google Scholar
Number of occurrences							
1	Bayesian economics	[20-23]	"Bayesian Forecasting" economics	2	0	0	2680
2	Box Jenkins technological	[3]	"Box Jenkins" technological forecasting	21	1	1	285
3	Correlation Methods	[7]	"Correlation Methods" forecasting	1372	413	2	2130
4	Dynamic regression	[3]	"Dynamic regression" forecasting	51	11	1	2590
5	Fisher-Pry Analysis	[5]	"Fisher Pry" forecasting	11	3	5	512
6	Grey model		"grey model" technological forecasting	16	9	2	235
7	Growth curve	[7]	"Growth curve" forecasting	137	20	15	5130
8	Logistic curve	[25]	"logistic curve" forecasting	39	7	12	3150
9	Long wave	[2]	"Long wave" forecasting	186	37	10	17400
10	Forecasting by analogy	[3]	"long-term" technological forecasting	565	194	33	14000
11	Lotka-Volterra	[25]	"Lotka-Volterra" forecasting	15	1	5	1720
12	Multiple regression technological	[3]	"Multiple regression" technological forecasting	13	2	4	796
13	Multivariate autoregressive	[3]	"Multivariate autoregressive" forecasting	26	7	0	1780
14	Non-linear technological	[3]	"Non-linear" technological forecasting	61	28	2	91
15	Precursor analysis	[2]	"Precursor analysis" forecasting	2	2	0	94
16	Simple regression	[3]	"Simple regression" forecasting	75	12	1	10300
17	SOFI (State of the Future) System	[8]	"State of the Future" forecasting sofi	1	0	0	65
18	Statistical Modeling	[8]	"Statistical Modeling" forecasting	203	57	0	10100
19	Time series decomposition	[3]	"Time series decomposition" forecasting	21	4	0	1140
20	Time Series Monitoring	[20-23]	"Time Series Monitoring" forecasting	2	1	0	174
21	Trend extrapolation	[7]	"Trend extrapolation" forecasting	50	6	9	2810
22	Trend Impact Analysis	[8]	"Trend Impact Analysis" forecasting	8	1	5	341
23	Demographics	[2]	Demographics "technology forecasting"	9	1	0	789
24	Econometric Methods	[4]	Econometric	74	11	5	3940

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			"technological forecasting"				
25	Gompertz	[5]	Gompertz forecasting	114	19	11	5000

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Table A.5 List of forecasting tools – category 3: Intuitive models

#	Name of a forecasting tool	Reference	Search phrase	Scopus	Scopus, conference papers	Scopus, Journal of Tech. Forecasting & Social Change	Google Scholar	Number of occurrences	
1	Analytical hierarchy process	[2]	"Analytical hierarchy process" forecasting	57	18	4	4540		
2	Brainstorming	[2]	brainstorming forecasting	17	6	0	16100		
3	Delphi	[7], [8], [9], [10-19], [2], [6], [5]	Delphi forecasting	542	141	88	25900		
4	Expert Panels	[6]	"Expert Panels" forecasting	39	8	2	2340		
5	Field Anomaly Relaxation	[8]	"Field Anomaly Relaxation" forecasting	4	0	2	157		
6	Focus groups	[2]	"Focus groups" forecasting	70	15	3	18400		
7	Future workshops	[2]	"future workshops" forecasting	3	1	0	506		
8	Futures Wheel	[8]	"Futures Wheel" forecasting	2	1	0	207		
9	Genius	[8]	"Genius Forecasting"	1	0	1	170		
10	Group-Based Judgmental Forecasting	[20-23]	"Group-Based Judgmental Forecasting"	1	0	0	23		
11	Innovation system modeling	[2]	"Innovation system modeling" forecasting	0	0	0	12		
12	Interviews	[2]	interviews "technological forecasting"	129	47	16	7350		
13	Judgmental forecasting and adjustments	[3]	"Judgmental forecasting"	109	3	1	1560		
14	Nominal group conferencing	[5]	"Nominal group" "technological forecasting"	7	2	3	576		
15	Participatory Methods	[8]	"Participatory Methods" forecasting	7	1	0	1600		
16	Role Playing	[4]	"Role Playing" technology forecasting	3	0	0	5380		
17	Rule Based	[4]	"Rule Based Forecasting"	19	4	0	397		
18	Science fiction	[2]	"Science fiction" forecasting	42	11	4	14200		
19	Staggered Brainwriting	[25]	"Staggered Brainwriting"	0	0	0	2		
20	The Futures Polygon	[9]	"The Futures Polygon" forecasting	0	0	0	6		
21	Vision generation	[2]	"Vision generation" forecasting	0	0	0	36		
22	Wild Cards	[9]	"Wild Cards" forecasting	10	0	2	1290		

Table A.6 List of forecasting tools – category 4: Monitoring and mapping

#	Name of a forecasting tool	Reference	Search phrase	Scopus	Scopus, conference papers	Scopus, Journal of Tech. Forecasting & Social Change	Google Scholar
Number of occurrences							
1	Adaptive policies	[10-19]	"Adaptive policies" forecasting	9	2	0	480
2	Bibliometrics	[2]	bibliometrics forecasting	35	8	6	4970
3	Checklists for impact identification	[2]	"Checklists for impact identification" forecasting	0	0	0	5
4	Constrained scoring	[7]	"constrained scoring" forecasting	0	0	0	6
5	Correlation with Economic Factors	[7]	"Correlation with Economic Factors" forecasting	0	0	0	3
6	Cost–benefit analysis technology	[2]	"Cost–benefit analysis" "technology forecasting"	5	0	2	339
7	Ellipsoidal technology frontiers	[7]	"ellipsoidal technology frontiers"	0	0	0	0
8	Emerging Trends	[10-19]	"Emerging Trends" forecasting	64	24	1	8640
9	Environmental monitoring	[7]	"Environmental monitoring" forecasting	1313	188	0	23200
10	Environmental Scanning	[8]	"Environmental Scanning" forecasting	21	5	3	4410
11	Feedback models	[5]	"Feedback models" forecasting	11	3	0	591
12	Institutional analysis	[2]	"Institutional analysis" forecasting	4	1	0	2510
13	Interactive information visualization	[25]	"Interactive information visualization" forecasting	1	1	0	46
14	Interactive Scenarios	[8]	"Interactive Scenarios" forecasting	2	1	0	125
15	Knowledge Driven Planning Tools	[10-19]	"Knowledge Driven Planning Tools" forecasting	0	0	0	20
16	Lead-lag correlation	[7]	"lead-lag correlation" forecasting	2	0	0	207
17	Maximum Installation Size	[7]	"Maximum Installation Size" forecasting	0	0	0	5
18	Maximum Installation Size		"Maximum Installation Size" forecasting	0	0	0	1
19	Measures of technology	[7]	"Measures of technology" forecasting	2	0	2	450
20	Mega-sets	[25]	Mega-sets forecasting	0	0	0	0
21	Minding the Gap: Previewing the Potential of Breakthrough Technologies	[10-19]	Pote Breakthrough nologies forecasting "minding the gap"	19	6	0	36
22	Mitigation analysis technological	[2]	"Mitigation analysis" technological forecasting	3	0	0	192
23	Multicriteria decision analysis	[2]	"Multicriteria decision analysis" forecasting	4	2	0	1790
24	Non-Linear Dynamics	[9]	"Non-Linear Dynamics" forecasting	111	45	0	4400
25	Organizational analysis	[2]	"Organizational analysis" forecasting	4	1	0	2780
26	Patent analysis	[5]	"Patent analysis" forecasting	57	22	6	1400
27	Planar technology frontiers	[7]	"planar technology frontiers"	0	0	0	1
28	Probabilistic scenario	[25]	"Probabilistic scenario" forecasting	5	1	0	165

#	Name of a forecasting tool	Reference	Search phrase	Scopus	Scopus, conference papers	Scopus, Journal of Tech. Forecasting & Social Change	Google Scholar
Number of occurrences							
29	Scenario management	[2]	"scenario management" forecasting	6	4	0	614
30	Scenario planning	[8]	"Scenario planning" forecasting	87	13	12	5960
31	Scenario-simulation	[2]	"Scenario-simulation" forecasting	44	11	0	1720
32	Science mapping	[2]	"Science mapping" forecasting	3	3	0	186
33	Simulation and Games	[8]	"Simulation and Games" forecasting	119	52	0	352
34	Stages of Development (correlations)	[7]	correlation "Stages of Development" forecasting	6	1	0	16000
35	Stakeholder analysis	[2]	"Stakeholder analysis" forecasting	3	1	1	1930
36	Structural Analysis	[8]	"Structural Analysis" forecasting	330	113	1	10100
37	Sustainability analysis	[2]	"Sustainability analysis" forecasting	4	2	0	1060
38	SWOT	[6]	SWOT forecasting	22	9	1	12700
39	Tech Mining	[10-19]	"Tech Mining" forecasting	5	1	2	249
40	Technological progress function	[7]	"technological progress function" forecasting	5	0	2	75
41	Technology assessment	[2]	"Technology assessment" "technological forecasting"	332	159	48	3710
42	Technology frontiers	[7]	"technology frontiers" forecasting	5	0	2	135
43	Text Mining for technology forecast	[8]	"Text Mining" technology forecasting	39	13	14	3780

## 7. Appendix B

This appendix covers a graphical representation of number of occurrences included into Appendix A. Charts are described in section 3.4. The following charts present number of occurrences arranged in two orders. One order presented on charts Figure B.1 through Figure B.4 is arranged according to rising number of occurrences in Scopus. The other order presented on charts Figure B.5 through Figure B.8 is arranged according to rising number of occurrences in Google Scholar.

DK\_1 Causal models (e.g. analogy analysis, morphological analysis, laws and patterns of system evolution)

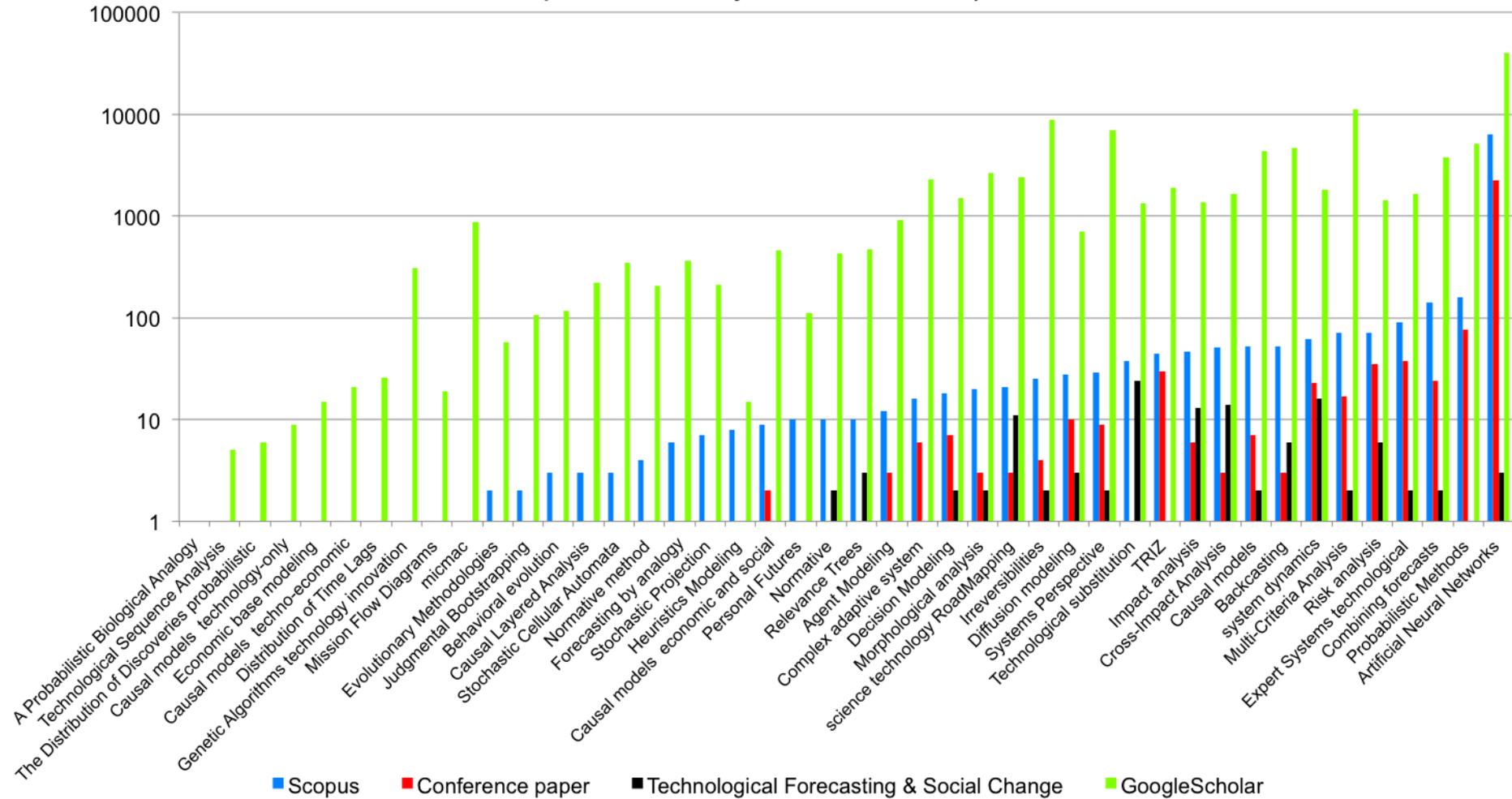


Figure B.1. Number of occurrences for tools in category 1: Causal models; arranged for rising occurrences in Scopus

DK\_2 Phenomenological models (e.g. extrapolations of time series data, regressions)

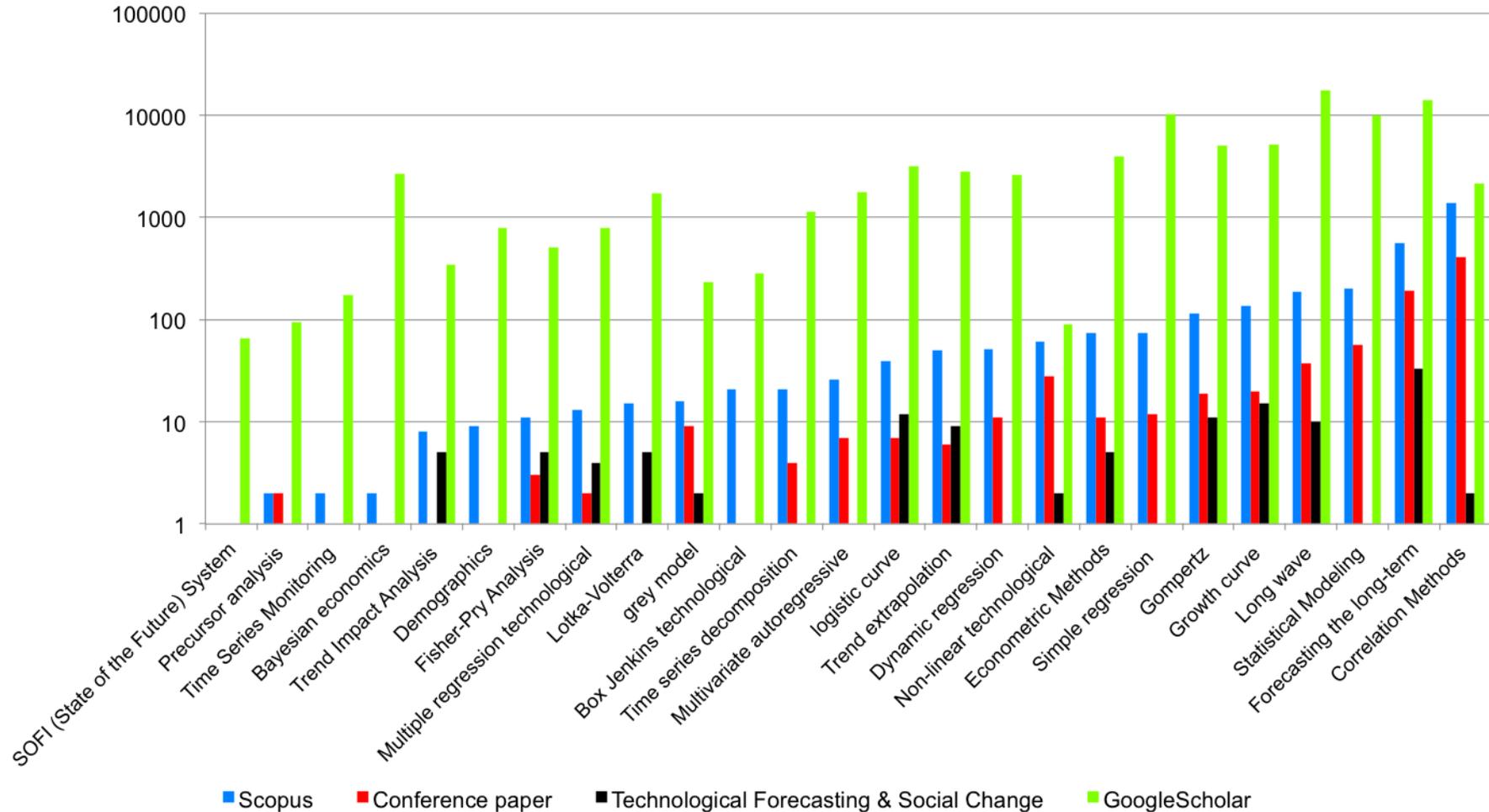


Figure B.2. Number of occurrences for tools in category 2: Phenomenological models; arranged for rising occurrences in Scopus

### DK\_3 Intuitive models (e.g. Delphi surveys, structured and unstructured interviews)

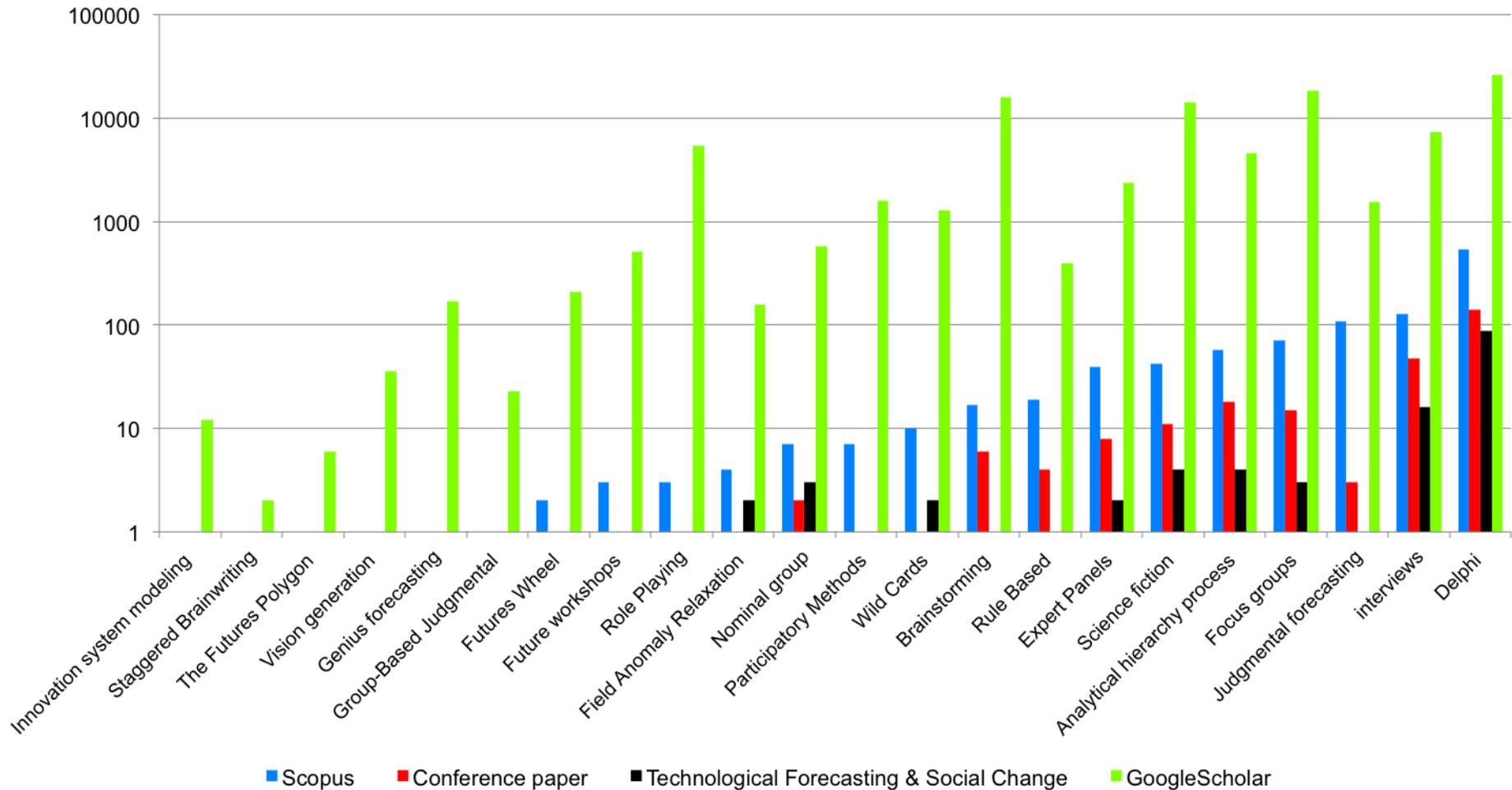


Figure B.3. Number of occurrences for tools in category 3: Intuitive models; arranged for rising occurrences in Scopus

DK\_4 Monitoring and mapping (e.g. scanning of literature and published sources, scenarios, mapping existing information)

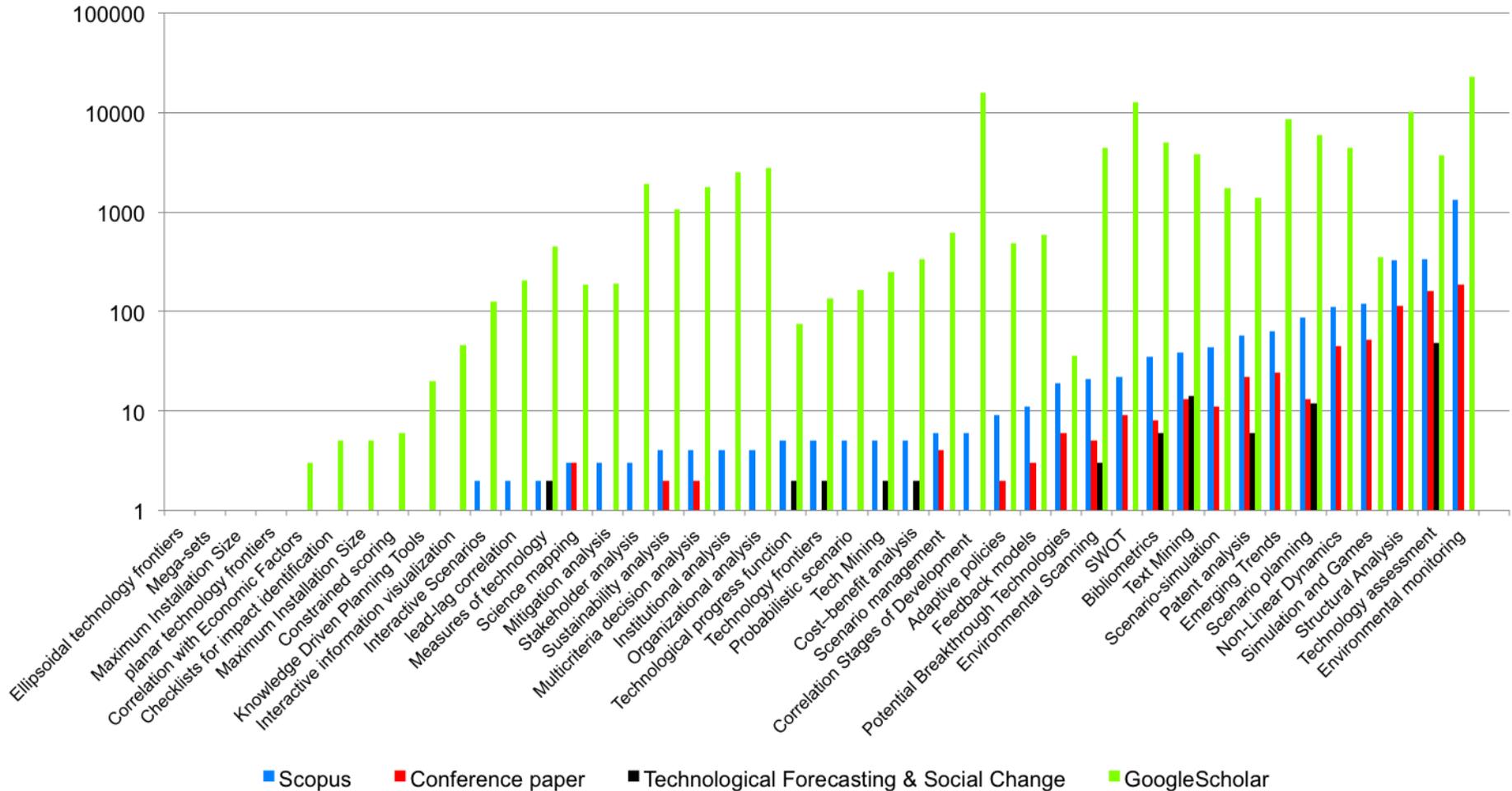


Figure B.4. Number of occurrences for tools in category 4: Monitoring and mapping; arranged for rising occurrences in Scopus

DK\_1 Causal models (e.g. analogy analysis, morphological analysis, laws and patterns of system evolution)

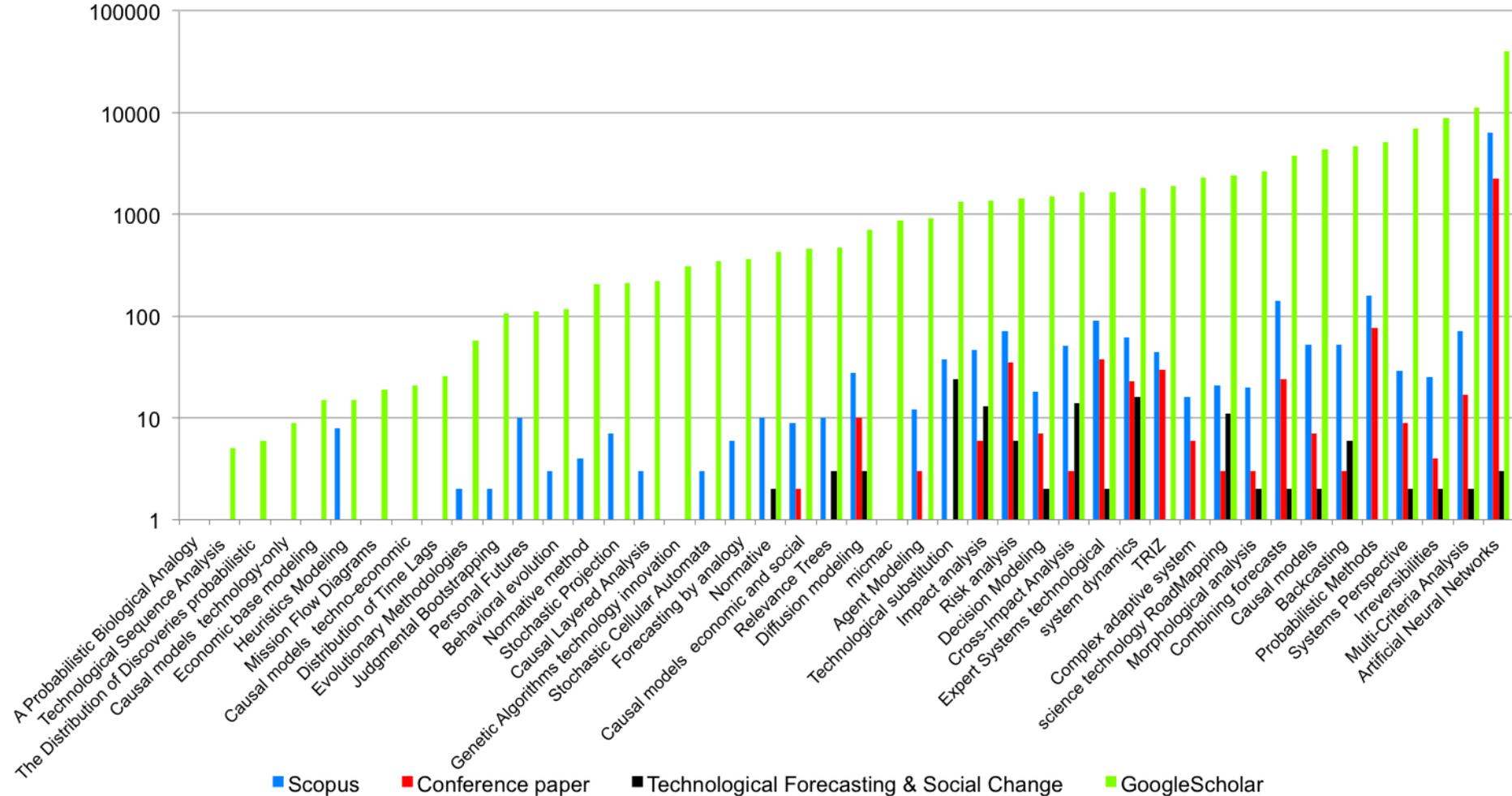


Figure B.5. Number of occurrences for tools in category 1: Causal models; arranged for rising occurrences in Google Scholar

DK\_2 Phenomenological models (e.g. extrapolations of time series data, regressions)

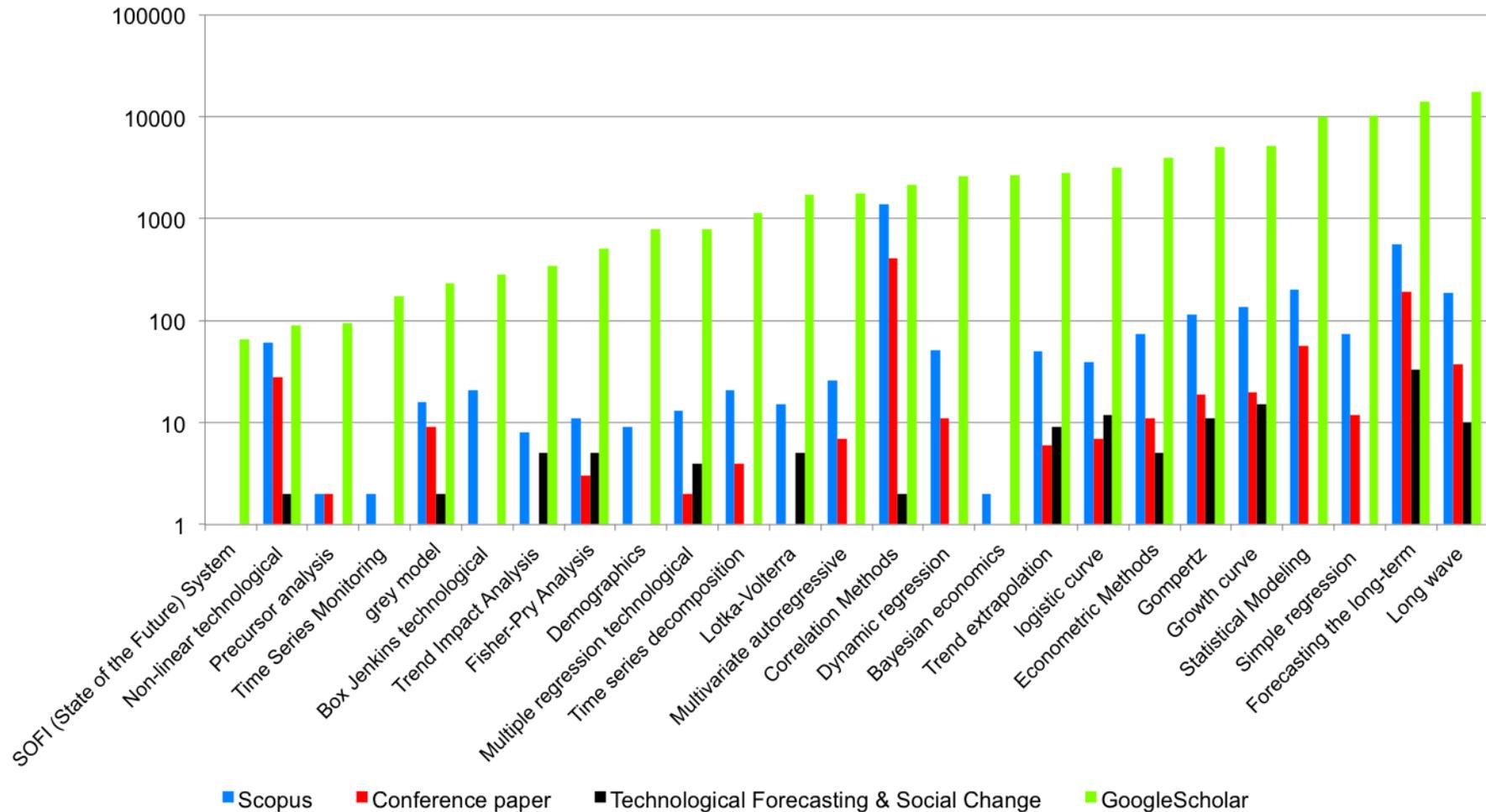


Figure B.6. Number of occurrences for tools in category 2: Phenomenological models; arranged for rising occurrences in Google Scholar

### DK\_3 Intuitive models (e.g. Delphi surveys, structured and unstructured interviews)

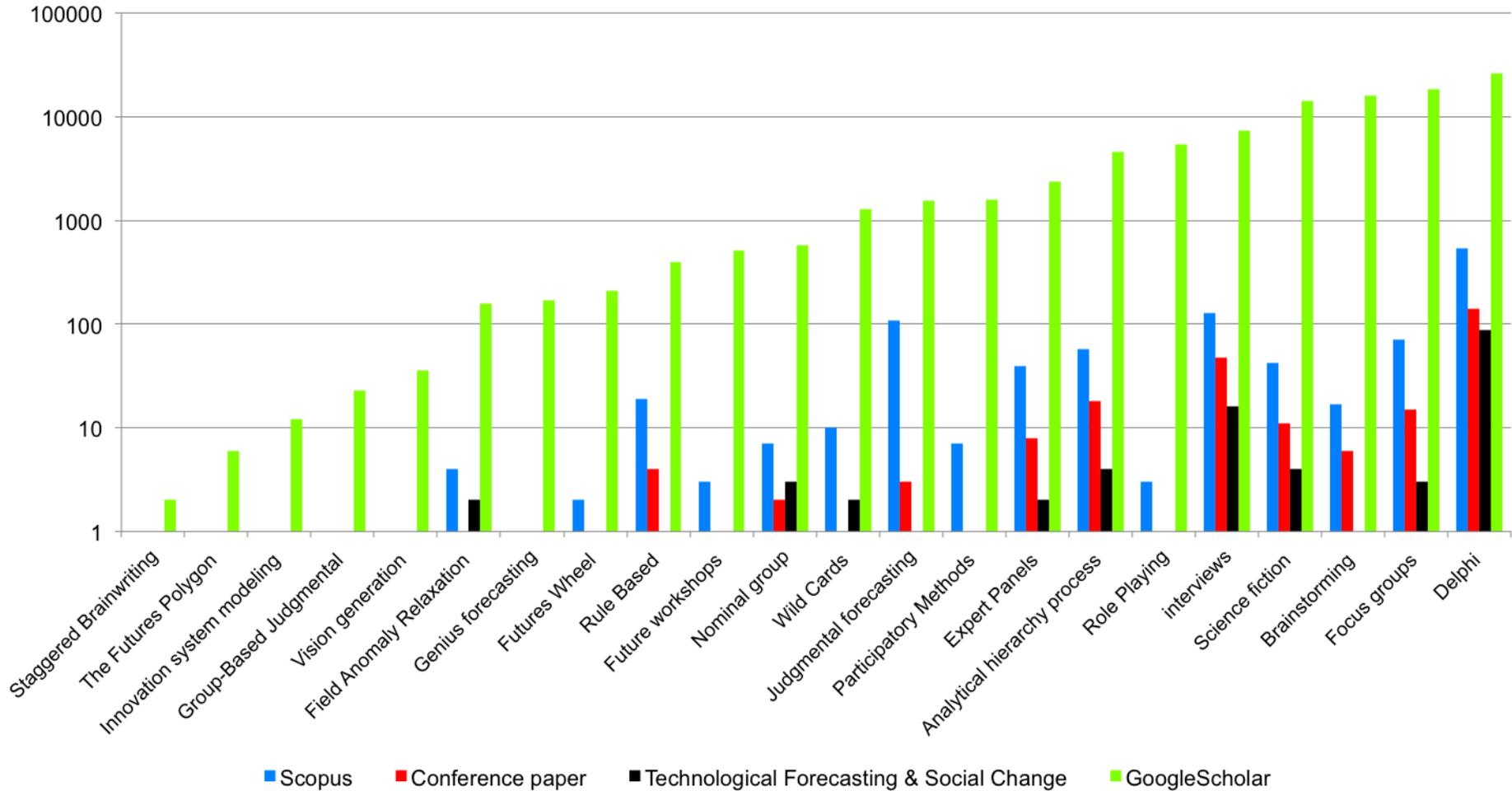


Figure B.7. Number of occurrences for tools in category 3: Intuitive models; arranged for rising occurrences in Google Scholar

DK\_4 Monitoring and mapping (e.g. scanning of literature and published sources, scenarios, mapping existing information)

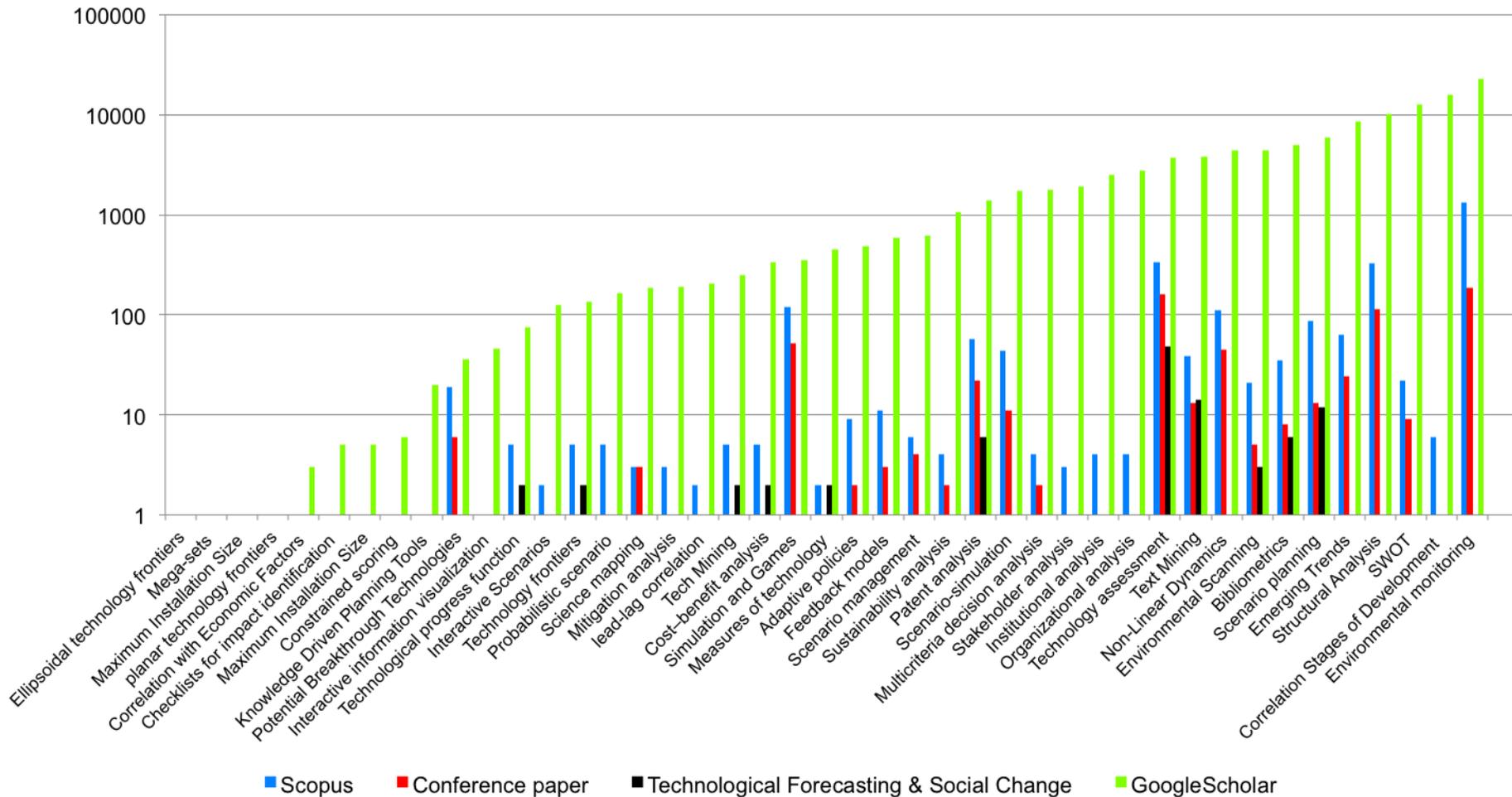


Figure B.8. Number of occurrences for tools in category 4: Monitoring and mapping; arranged for rising occurrences in Google Scholar

## 8. Appendix C

Table C.1 Historical occurrences for Scopus results

"Adaptive policies" forecasting	
Number of results : 9	
YEAR	Occurrences
2012	3
2011	1
2010	2
2009	1
2007	1
2002	1
"Agent Modeling" forecasting	
Number of results : 12	
YEAR	Occurrences
2012	3
2011	1
2010	2
2009	1
2008	1
2007	1
2005	1
2004	1
2002	1
"Analytical hierarchy process" forecasting	
Number of results : 57	
YEAR	Occurrences
2012	5
2011	5
2010	12
2009	11
2008	9
2007	4
2006	1
2005	4
2004	1
2003	1
2002	1
1997	1
1996	1
1994	1
"technology frontiers"	
Number of results : 136	
YEAR	Occurrences
2013	1
2012	10
2011	18
2010	8
2009	13
2008	11
2007	3
2006	14
2005	10
2004	6
2003	4

2002	7
2001	1
2000	6
1999	3
1998	1
1997	5
1996	3
1995	3
1994	3
1993	2
1988	1
1987	1
1983	1
1980	1
"Artificial Neural Networks" forecasting	
Number of results : 6305	
YEAR	Occurrences
2013	9
2012	678
2011	1041
2010	943
2009	626
2008	658
2007	423
2006	351
2005	284
2004	197
2003	173
2002	148
2001	136
2000	113
1999	101
1998	87
1997	73
1996	90
1995	71
1994	53
1993	18
1992	12
1991	17
1990	2
1988	1
Backcasting forecasting	
Number of results : 53	
YEAR	Occurrences
2012	5
2011	9
2010	3
2009	3
2008	2
2007	5
2006	4
2005	2
2004	2
2003	3
2002	2
2000	2
1999	3
1998	1
1997	1
1992	1

1988	2
1985	1
1982	1
1974	1
bibliometrics forecasting	
Number of results : 35	
YEAR	Occurrences
2012	2
2010	2
2009	6
2008	5
2007	3
2006	4
2005	4
2004	1
2003	1
2002	1
2001	3
1997	1
1995	1
1994	1
"Box Jenkins" "technological forecasting"	
Number of results : 21	
YEAR	Occurrences
2007	2
2004	2
2002	1
1994	1
1990	1
1988	1
1987	3
1986	2
1985	1
1984	1
1978	3
1975	2
1973	1
brainstorming forecasting	
Number of results : 17	
YEAR	Occurrences
2012	2
2011	2
2010	1
2009	4
2008	1
2007	1
2006	1
2004	1
1998	1
1996	1
1986	1
1974	1
"Combining forecasts" forecasting	
Number of results : 141	
YEAR	Occurrences
2012	10
2011	21
2010	12
2009	8
2008	12
2007	14

2006	4
2005	5
2004	7
2003	2
2002	2
2001	3
2000	4
1999	4
1997	2
1996	6
1995	2
1994	1
1993	2
1991	1
1990	3
1989	5
1988	2
1987	4
1986	1
1983	1
1982	1
1979	1
1975	1
"Complex adaptive system" forecasting	
Number of results : 16	
YEAR	Occurrences
2012	2
2011	2
2010	2
2009	1
2008	1
2007	1
2006	1
2004	3
2003	1
2002	1
2000	1
"Correlation Methods" forecasting	
Number of results : 1372	
YEAR	Occurrences
2012	22
2011	51
2010	55
2009	41
2008	242
2007	106
2006	101
2005	103
2004	129
2003	73
2002	52
2001	42
2000	30
1999	32
1998	20
1997	30
1996	50
1995	59
1994	89
1993	22
1992	12

1990	2
1986	1
1984	3
1982	1
1981	1
1979	1
1972	1
1966	1
"Cost-benefit analysis" "technology forecasting"	
Number of results : 5	
YEAR	Occurrences
2008	1
2006	1
2005	1
2003	1
2000	1
"Cross-Impact Analysis" forecasting	
Number of results : 51	
YEAR	Occurrences
2011	1
2007	2
2006	3
2005	2
2004	2
2000	1
1997	1
1995	2
1994	1
1991	1
1988	4
1987	2
1986	1
1984	1
1981	1
1980	2
1979	3
1978	3
1977	4
1976	3
1975	4
1974	3
1973	1
1972	3
"Decision Modeling" forecasting	
Number of results : 18	
YEAR	Occurrences
2011	1
2010	1
2009	3
2008	4
2007	2
2004	1
2001	1
2000	1
1994	1
1991	1
1982	1
1978	1
Delphi forecasting	
Number of results : 542	
YEAR	Occurrences

2012	18
2011	38
2010	40
2009	85
2008	59
2007	17
2006	12
2005	13
2004	10
2003	12
2002	14
2001	11
2000	6
1999	8
1998	11
1997	8
1996	5
1995	3
1994	2
1993	2
1992	2
1991	1
1990	7
1989	5
1988	7
1987	7
1986	9
1985	7
1984	7
1983	6
1982	6
1981	5
1980	4
1979	5
1978	6
1977	12
1976	9
1975	15
1974	5
1973	8
1972	14
1971	3
1970	10
1969	7
1968	1
Demographics "technolog* forecast**"	
Number of results : 9	
YEAR	Occurrences
2009	3
2008	1
2007	1
2005	1
2001	1
1994	1
1988	1
"Diffusion modeling" forecasting	
Number of results : 28	
YEAR	Occurrences
2012	2
2011	2
2010	3

2009	2
2008	6
2007	5
2006	1
2004	1
2003	3
1997	1
1994	1
1973	1
"Dynamic regression" forecasting	
Number of results : 51	
YEAR	Occurrences
2013	1
2012	3
2011	5
2010	3
2009	6
2008	2
2007	3
2006	4
2005	3
2004	1
2003	1
2002	1
2001	1
2000	1
1998	3
1997	4
1996	2
1995	1
1993	1
1986	1
1980	1
1979	2
1975	1
Econometric "technological forecasting"	
Number of results : 74	
YEAR	Occurrences
2010	3
2009	4
2007	2
2006	4
2005	4
2004	4
2003	3
2002	1
2000	2
1995	1
1992	2
1991	1
1987	4
1986	3
1985	3
1984	1
1983	3
1982	2
1981	3
1980	1
1979	1
1978	7
1977	4

1976	6
1974	2
1973	2
1972	1
Causal models forecasting "economic and social"	
Number of results : 9	
YEAR	Occurrences
2011	1
2010	1
2007	1
2006	2
2005	1
2004	1
2001	1
1996	1
"Environmental monitoring" forecasting	
Number of results : 1313	
YEAR	Occurrences
2012	79
2011	99
2010	135
2009	89
2008	111
2007	54
2006	80
2005	70
2004	109
2003	102
2002	138
2001	106
2000	31
1999	12
1998	14
1997	12
1996	6
1995	7
1994	15
1993	15
1992	6
1991	4
1990	4
1988	1
1986	3
1985	3
1984	1
1983	2
1981	1
1980	1
1977	1
1976	1
1972	1
"Environmental Scanning" forecasting	
Number of results : 21	
YEAR	Occurrences
2011	2
2010	4
2009	1
2008	1
2007	1

2004	3
2003	1
1998	1
1997	1
1990	1
1989	1
1985	1
1982	1
1981	1
1980	1
"Expert Panels" forecasting	
Number of results : 39	
YEAR	Occurrences
2012	1
2011	3
2010	2
2009	4
2008	4
2007	2
2006	2
2005	3
2004	1
2003	3
2002	1
2001	4
1998	2
1992	1
1991	1
1990	1
1986	1
1985	2
1982	1
"Expert Systems" "technological forecasting"	
Number of results : 91	
YEAR	Occurrences
2011	1
2010	4
2009	6
2008	2
2007	2
2006	1
2005	3
2004	5
2003	1
2002	4
2001	2
2000	2
1999	1
1997	3
1996	4
1995	2
1994	5
1993	1
1992	2
1991	3
1990	4
1989	3
1988	4
1987	3
1986	9
1985	6

1984	4
1983	4
"Feedback models" forecasting	
Number of results : 11	
YEAR	Occurrences
2012	1
2011	1
2009	2
2008	3
2006	1
2005	1
1996	1
1980	1
"Field Anomaly Relaxation"	
Number of results : 15	
YEAR	Occurrences
2011	1
2008	1
2004	2
2001	1
1997	3
1996	1
1995	1
1994	2
1984	1
1981	1
1973	1
"Field Anomaly Relaxation" forecasting	
Number of results : 4	
YEAR	Occurrences
2004	1
1984	1
1981	1
1973	1
"Fisher Pry" forecasting	
Number of results : 11	
YEAR	Occurrences
2011	1
2008	1
2004	2
2003	1
2002	1
2000	1
1999	1
1989	1
1987	1
1985	1
"Focus groups" forecasting	
Number of results : 70	
YEAR	Occurrences
2012	4
2011	4
2010	8
2009	6
2008	7
2007	7
2006	5
2004	5
2003	2
2001	2
2000	3

1999	2
1998	2
1997	3
1996	3
1995	2
1994	1
1993	2
1992	2
"Futures Wheel"	
Number of results : 9	
YEAR	Occurrences
2011	3
2007	2
2004	1
2003	1
2002	1
1980	1
"Genetic Algorithms" "technology innovation"	
Number of results : 14	
YEAR	Occurrences
2012	2
2011	2
2009	1
2008	5
2006	3
1999	1
"grey model" "technolog* forecast**"	
Number of results : 16	
YEAR	Occurrences
2012	2
2011	2
2010	2
2009	3
2008	2
2007	2
2004	1
2003	1
2001	1
"Growth curve" forecasting	
Number of results : 137	
YEAR	Occurrences
2012	9
2011	8
2010	16
2009	8
2008	12
2007	5
2006	9
2005	8
2004	6
2003	5
2002	5
2001	5
1999	3
1998	2
1996	3
1995	4
1994	3
1993	3
1992	3
1991	1

1990	1
1989	3
1988	4
1986	1
1985	3
1983	1
1982	1
1980	1
1977	1
1972	2
1970	1
"Heuristics Modeling" forecasting	
Number of results : 8	
YEAR	Occurrences
2012	1
2011	1
2008	1
2007	2
2004	1
1991	1
1977	1
"Impact analysis" "technolog* forecasting"	
Number of results : 47	
YEAR	Occurrences
2011	1
2009	1
2008	3
2007	2
2006	3
2004	1
2001	1
1997	2
1995	1
1992	1
1991	2
1988	3
1987	1
1985	1
1982	1
1981	1
1980	1
1979	2
1978	3
1977	4
1976	3
1975	3
1974	2
1973	1
1972	3
"Institutional analysis" forecasting	
Number of results : 4	
YEAR	Occurrences
2006	2
2004	1
2000	1
interviews "technological forecasting"	
Number of results : 129	
YEAR	Occurrences
2012	1
2010	16
2009	26

2008	27
2007	5
2006	11
2005	5
2004	3
2003	5
2002	1
2001	1
2000	1
1997	5
1994	3
1993	1
1990	2
1988	1
1987	1
1986	7
1984	3
1981	1
1979	1
1977	1
1972	1
Irreversibilities forecasting	
Number of results : 25	
YEAR	Occurrences
2012	2
2011	1
2009	5
2008	2
2006	1
2005	2
2004	1
2001	1
1999	1
1997	1
1996	1
1995	1
1994	2
1993	1
1990	1
1987	1
1980	1
"Judgmental forecasting"	
Number of results : 109	
YEAR	Occurrences
2013	2
2012	7
2011	13
2010	5
2009	3
2008	4
2007	9
2006	1
2005	4
2004	3
2003	3
2002	1
2001	1
2000	4
1999	4
1998	3
1997	4

1996	8
1995	2
1994	1
1993	4
1992	4
1991	2
1990	4
1989	2
1988	3
1987	3
1986	2
1985	2
1984	1
"logistic curve" forecasting	
Number of results : 39	
YEAR	Occurrences
2012	1
2011	2
2010	5
2009	8
2008	2
2007	2
2005	1
2004	1
2002	1
1998	1
1988	1
1987	1
1986	2
1985	2
1984	3
1981	2
1977	1
1975	1
1973	1
1971	1
("Long wave" forecasting) AND NOT TITLE-ABS-KEY(fluid AND water AND weather)	
Number of results : 186	
YEAR	Occurrences
2012	20
2011	30
2010	24
2009	19
2008	17
2007	7
2006	6
2005	6
2004	11
2003	5
2002	3
2001	5
2000	6
1999	2
1998	2
1997	4
1996	3
1993	2
1991	1
1990	1
1989	1

1988	1
1986	2
1982	1
1981	1
1980	2
1978	1
1956	1
1954	1
1950	1
"long-term" "technological forecasting"	
Number of results : 565	
YEAR	Occurrences
2012	4
2011	5
2010	44
2009	88
2008	46
2007	32
2006	17
2005	18
2004	26
2003	16
2002	11
2001	10
2000	9
1999	6
1998	9
1997	13
1996	9
1995	5
1994	4
1993	5
1992	5
1991	7
1990	8
1989	7
1988	14
1987	19
1986	16
1985	16
1984	16
1983	6
1982	4
1981	5
1980	4
1979	6
1978	10
1977	10
1976	7
1975	7
1974	6
1973	4
1972	8
1970	3
"Lotka-Volterra" forecasting	
Number of results : 15	
YEAR	Occurrences
2012	3
2011	2
2010	2
2009	3

2008	1
2006	1
2005	1
2004	1
2003	1
"Morphological analysis" forecasting	
Number of results : 20	
YEAR	Occurrences
2012	2
2011	4
2010	2
2009	2
2006	1
2004	1
2002	1
1999	1
1998	1
1993	1
1976	1
1974	1
1971	1
1970	1
"Multi-Criteria" Analysis forecasting	
Number of results : 71	
YEAR	Occurrences
2013	1
2012	7
2011	8
2010	13
2009	16
2008	7
2007	3
2006	4
2005	6
2004	2
2003	1
2000	1
1993	1
1990	1
"Multiple Perspective" forecasting	
Number of results : 14	
YEAR	Occurrences
2012	1
2011	1
2010	1
2009	3
2008	1
2005	1
2003	1
2002	1
2000	1
1996	1
1982	1
1981	1
"Multiple regression" "technological forecasting"	
Number of results : 13	
YEAR	Occurrences
2008	1
2007	2
2006	1
2005	1

1995	1
1992	1
1990	1
1982	1
1978	1
1974	1
1972	2
"Multivariate autoregressive" forecasting	
Number of results : 26	
YEAR	Occurrences
2012	2
2011	3
2010	2
2009	1
2008	4
2007	2
2005	2
2003	1
2001	1
1999	1
1996	1
1995	1
1994	1
1986	2
1983	1
1982	1
"Nominal group*" "technolog" forecasting	
Number of results : 7	
YEAR	Occurrences
2011	1
2009	1
2008	1
2005	1
2003	1
1995	1
1984	1
"Non-Linear Dynamics" forecasting	
Number of results : 111	
YEAR	Occurrences
2012	8
2011	16
2010	20
2009	18
2008	21
2007	6
2006	1
2005	3
2004	2
2003	2
2002	2
2001	1
1999	1
1998	1
1997	3
1996	4
1995	1
1993	1
"Non-linear" "technological forecasting"	
Number of results : 61	

YEAR	Occurrences
2011	1
2010	9
2009	13
2008	10
2007	4
2006	3
2005	3
2004	1
2003	1
2002	2
2001	1
1998	1
1995	2
1994	2
1993	2
1992	1
1991	1
1987	2
1986	1
1978	1
"Normative Forecasting"	
Number of results : 10	
YEAR	Occurrences
2011	1
1998	1
1997	1
1996	2
1985	1
1972	1
1971	2
1969	1
"Normative method"	
Number of results : 74	
YEAR	Occurrences
2012	2
2011	7
2010	6
2009	5
2008	4
2007	3
2006	2
2005	3
2004	9
2003	3
2002	4
2001	3
2000	2
1998	1
1997	1
1994	1
1992	2
1991	2
1990	1
1987	2
1986	2
1985	1
1984	2
1981	1
1979	1
1978	1

1974	1
1972	1
1970	1
"Patent analysis" forecasting	
Number of results : 57	
YEAR	Occurrences
2012	9
2011	8
2010	3
2009	16
2008	10
2007	3
2006	1
2005	2
2001	1
1997	3
1985	1
"Personal Futures" forecasting	
Number of results : 10	
YEAR	Occurrences
2011	1
2010	1
2009	2
2008	2
2007	1
1995	1
1982	1
1979	1
Potential Breakthrough Technologies forecasting	
Number of results : 19	
YEAR	Occurrences
2012	1
2010	3
2009	1
2008	5
2007	1
2006	1
2002	1
1999	1
1997	1
1996	1
1995	1
1990	1
1972	1
"Prediction Markets" forecasting	
Number of results : 107	
YEAR	Occurrences
2012	14
2011	24
2010	31
2009	11
2008	15
2007	4
2006	4
2005	2
2003	2
"Probabilistic Methods" forecasting	
Number of results : 161	
YEAR	Occurrences
2013	1
2012	9

2011	15
2010	21
2009	21
2008	14
2007	8
2006	27
2005	5
2004	2
2003	5
2002	8
2001	1
2000	4
1999	3
1998	2
1996	3
1995	1
1994	2
1993	1
1992	1
1991	1
1987	1
1983	1
1982	1
1976	1
1974	1
1969	1
"Probabilistic scenario" forecasting	
Number of results : 5	
YEAR	Occurrences
2010	1
2009	1
2007	1
2004	1
1998	1
"Relevance Trees" forecasting	
Number of results : 10	
YEAR	Occurrences
2003	1
1995	1
1985	1
1982	1
1974	1
1973	3
1972	2
"Risk analysis" "technological forecasting"	
Number of results : 72	
YEAR	Occurrences
2010	5
2009	22
2008	18
2007	3
2006	1
2004	1
2003	4
2002	2
2001	1
1997	1
1994	1
1992	4
1990	1
1989	1

1986	1
1985	1
1983	1
1982	1
1981	1
1976	1
1974	1
"Rule Based Forecasting"	
Number of results : 19	
YEAR	Occurrences
2012	1
2011	3
2010	1
2009	3
2007	1
2006	1
2001	1
2000	2
1999	1
1996	3
1993	1
1989	1
science technology RoadMapping forecasting	
Number of results : 21	
YEAR	Occurrences
2010	3
2009	2
2008	1
2007	1
2005	2
2004	7
2003	2
2002	1
2001	2
"Scenario planning" forecasting	
Number of results : 87	
YEAR	Occurrences
2012	7
2011	10
2010	7
2009	7
2008	5
2007	3
2006	9
2005	6
2004	7
2003	7
2002	1
2001	3
2000	3
1999	2
1997	1
1996	1
1994	1
1993	2
1992	1
1988	1
1987	1
1984	1
1977	1
"Scenario-simulation" forecasting	

Number of results : 44	
YEAR	Occurrences
2012	9
2011	5
2010	9
2009	4
2008	4
2007	3
2006	2
2004	2
2003	1
2000	1
1999	2
1998	1
1994	1
"Science fiction" forecasting	
Number of results : 42	
YEAR	Occurrences
2012	4
2011	1
2010	2
2008	1
2007	5
2006	1
2005	4
2004	1
2001	2
2000	1
1999	3
1997	1
1995	1
1994	1
1993	3
1992	1
1990	2
1987	1
1986	1
1984	1
1979	1
1975	3
1969	1
"Simple regression" forecasting	
Number of results : 75	
YEAR	Occurrences
2013	1
2012	3
2011	6
2010	10
2009	4
2008	8
2007	2
2006	4
2005	3
2004	4
2003	2
2002	4
2001	4
1999	1
1998	1
1997	4
1996	4

1995	1
1993	1
1989	3
1988	2
1986	1
1978	1
1974	1
correlation "Stages of Development" forecasting	
Number of results : 6	
YEAR	Occurrences
2011	2
2009	1
2008	1
2007	1
2002	1
"Stakeholder analysis" forecasting	
Number of results : 3	
YEAR	Occurrences
2012	1
2008	1
2000	1
"Statistical Modeling" forecasting	
Number of results : 203	
YEAR	Occurrences
2012	13
2011	19
2010	21
2009	13
2008	31
2007	18
2006	10
2005	15
2004	10
2003	9
2002	1
2001	5
2000	4
1999	6
1998	2
1997	8
1996	3
1995	5
1993	1
1992	2
1991	1
1990	2
1989	1
1987	1
1980	1
1978	1
"Stochastic Cellular Automata" forecasting	
Number of results : 3	
YEAR	Occurrences
2008	1
2001	2
"Stochastic Projection" forecasting	
Number of results : 7	
YEAR	Occurrences
2009	1
2007	2

2003	1
1992	1
1989	1
1982	1
"Strategic foresight" technolog*	
Number of results : 20	
YEAR	Occurrences
2012	4
2011	1
2010	9
2008	1
2006	1
2004	1
2001	1
2000	1
1998	1
"Structural Analysis" forecasting	
Number of results : 330	
YEAR	Occurrences
2013	1
2012	20
2011	33
2010	39
2009	28
2008	22
2007	7
2006	18
2005	9
2004	11
2003	6
2002	6
2001	12
2000	10
1999	7
1998	2
1997	3
1996	14
1995	13
1994	35
1993	4
1992	5
1990	2
1989	6
1986	3
1985	5
1984	1
1983	1
1980	1
1979	1
1977	2
1976	1
1974	1
1972	1
Substitution Analysis forecasting	
Number of results : 1	
YEAR	Occurrences
1994	1
1987	1
1985	1
1980	1
1978	1
1976	1
SWOT forecasting	

Number of results : 22	
YEAR	Occurrences
2010	6
2009	6
2008	4
2007	3
2002	2
1997	1
"system dynamics" "technolog* forecasting"	
Number of results : 62	
YEAR	Occurrences
2012	1
2010	3
2009	6
2008	10
2007	5
2006	2
2005	4
2002	3
2001	2
1998	2
1997	1
1992	2
1991	1
1988	1
1986	2
1985	1
1980	1
1979	1
1978	1
1977	2
1976	3
1975	3
1974	1
1973	2
1972	2
"Systems Perspective" forecasting	
Number of results : 29	
YEAR	Occurrences
2012	3
2011	1
2010	3
2009	4
2008	2
2006	2
2005	1
2004	3
2003	2
2000	2
1999	2
1994	1
1991	1
1990	1
1987	1
"Tech Mining" forecasting	
Number of results : 5	
YEAR	Occurrences
2012	3
2008	1
2005	1
"technological progress function"	

Number of results : 8	
YEAR	Occurrences
1997	1
1996	1
1995	1
1980	1
1976	1
1975	1
1972	1
1970	1
"technological progress function" forecast*	
Number of results : 5	
YEAR	Occurrences
1997	1
1976	1
1975	1
1972	1
1970	1
"Technological substitution" forecasting))	
Number of results : 38	
YEAR	Occurrences
2009	2
2007	2
2004	1
2003	2
2002	1
1999	2
1997	2
1996	2
1994	1
1989	2
1987	2
1983	3
1982	2
1981	3
1980	2
1979	3
1976	4
1975	1
1974	1
"Technology assessment" "technolog* forecasting"	
Number of results : 332	
YEAR	Occurrences
2012	3
2011	3
2010	36
2009	63
2008	91
2007	11
2006	9
2005	10
2004	3
2003	6
2002	4
2001	1
2000	1
1998	11
1997	5
1996	4

1994	3
1993	3
1990	2
1989	1
1988	1
1987	1
1986	3
1984	10
1983	3
1982	3
1981	5
1980	3
1979	6
1978	3
1977	4
1976	4
1975	5
1974	2
1973	6
1971	3
"technology frontiers" forecast*	
Number of results : 5	
YEAR	Occurrences
2005	1
2002	1
1996	1
1995	1
1980	1
"Text Mining" technology forecasting	
Number of results : 39	
YEAR	Occurrences
2012	4
2011	2
2010	4
2009	5
2008	9
2007	4
2006	3
2005	2
2004	2
2003	1
2002	2
2001	1
"Time series decomposition" forecasting	
Number of results : 21	
YEAR	Occurrences
2012	4
2011	3
2009	3
2008	2
2007	1
2006	1
2003	1
1997	1
1993	1
1990	1
1989	1
1987	1
1985	1
"Trend extrapolation" forecasting	
Number of results : 50	

YEAR	Occurrences
2013	1
2012	1
2011	2
2010	3
2009	3
2008	3
2007	1
2003	1
2002	1
2001	1
2000	2
1998	1
1997	1
1996	1
1995	2
1994	2
1992	2
1991	1
1989	1
1988	1
1987	1
1986	1
1985	1
1982	2
1981	2
1980	1
1978	1
1977	1
1976	3
1975	1
1973	3
1972	1
1971	1

"Trend Impact Analysis" forecast\*

Number of results : 8

YEAR	Occurrences
2010	1
2009	1
2008	1
2004	1
1988	1
1987	2
1976	1

TRIZ forecasting

Number of results : 44

YEAR	Occurrences
2012	2
2011	7
2010	9
2009	9
2008	3
2007	4
2006	2
2004	2
2003	1
2002	1
2001	1
1999	1
1998	1
1997	1

"Wild Cards" forecasting	
Number of results : 10	
YEAR	Occurrences
2011	3
2007	1
2005	1
2004	1
2000	2
1994	2