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http://www.oeaw.ac.at/ita/pdf/ita_02_05.pdf

AUSTRIAN ACADEMY OF SCIENCES

Vienna, 10/2002
ITA-02-05
ISSN 1681-9187

http://www.oeaw.ac.at/ita/pdf/ita_02_05.pdf

Oktober/2002
(ITA-02-05)

Over-optimism Among Experts in Assessment and Foresight

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Keywords

Foresight exercises, Delphi methods, self-rating of experts, expert optimism

Abstract

It is still disputed whether foresight exercises should be based on top-expert assessments or on a broader base of less specialised experts, and whether the self-rating of experts is an acceptable method. Using the German 1993 and the Austrian 1998 Technology Delphis, this study addresses both questions: Self-rating is in fact an appropriate method for selecting experts. But the assessment of self-rated top-experts tend to suffer from an optimism bias, due to the experts' involvement and their underestimation of realisation and diffusion problems. The degree of optimism is positively correlated with the degree of self-rated knowledge, and it is more pronounced for the least pioneering and for organisational innovations. Experts with top self-ratings working in business have a stronger optimism bias than those working in academia or in the administration. Consistent with the insider hypothesis, they are most optimistic with regard to realisation, innovativeness, and potential leadership in economic exploitation. Given the optimism bias, foresight exercises should base their panels on a fair mixture of experts of different grades, with different types of knowledge and affiliation, and not only on top specialists of the respective field. Delphi-type exercises, therefore, offer an advantage relative to forum groups or small panels of specialists.

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http://www.oeaw.ac.at/ita/
ISSN 1681-9187

Inhalt

The author is grateful for discussions with his colleagues at the Institute of Technology Assessment at the Austrian Academy of Sciences and for comments on a first draft by Georg Aichholzer.

Thanks are due to Herbert Gluske for his computational assistance.

Introduction

Whether the foresight of experts and especially self-rating experts is superior to that of others has been under discussion since the earliest days of Delphi exercises. Adequate tests are rare, however, so that a broad range of positions prevails. Foresight exercises based on forum groups or expert panels implicitly assume that it pays to make use of the highest possible level of expertise. Delphi studies, in contrast, infer that it pays to base the respective assessment or foresight on different levels of expertise: They usually call for the self-rating of respondents, and make full use not only of the answers from top experts but also of experts from the upper half range at least. A close examination of the Austrian Technology Delphi (ITA 1998) underlines this practise: It reveals a marked 'optimism' among self-rating top experts. This check cannot verify, however, whether this optimism is justified or not, i. e. whether the top experts give better counsel or worse than those experts who consider themselves less informed: Due to its design as a Decision Delphi, which is not on the lookout for emerging technologies, but for technologies and/or technological market niches harbouring a potential for Austrian leadership within the next 15 years, an evaluation cannot take place for at least another decade. The German Technology Delphi, however, a classical Delphi querying the time horizons for the realization of the respective innovations, provides for such a test, and supports the hypothesis that top experts are in fact overoptimistic, clearly underestimating the realisation and diffusion period for short and medium-term projects. Top experts working in enterprises tend to have the most pronounced optimism bias according to the Austrian data. The evidence from both sources combined suggests that foresight exercises should include not only top experts of the relevant field, but also experts with a broader range of interest as well as experts with widely differing backgrounds. And it may provide a further argument in favour of the use of Delphi-type investigations as an instrument of foresight, in addition to the well-known advantages of anonymity, lack of a bias resulting from the influence of dominating personalities within the group, and especially of the convergence of results.

The paper starts with a summary of the literature on potential sources of bias in expert assessments, followed by a short description of the Austrian Technology Delphi in the second section. The main part elaborates the differences between the answers of the experts in the Austrian Technology Delphi evaluating their question-specific expertise as top (1 on an ordinal scale from 1 to 5 five), and those rating it with 2 or 3.[1] The differences in assessment among respondents of different levels of self-rating will be analysed in terms of economic area, type of innovation (technical or organisational), and degree of innovativeness. The fourth section examines the German Technology Delphi in order to find out whether the favourable assessment of top experts in fact turns out to be correct, reflecting the top-experts' better insight, or whether it results from over-optimism. The fifth section asks which group of respondents (business, academia and others, mainly bureaucrats) give the most optimistic assessment in the Austrian Delphi. The last section provides a conclusion.

[1] The answers of respondents rating their own specific knowledge with 4 or 5 were excluded as they were believed to vitiate rather than to improve the results.

1 The role of experts in Delphi exercises

The Delphi technique was developed for use in judgement and forecasting situations where pure model-based statistical methods were impractical or impossible. It is a procedure to "obtain the most reliable consensus of opinion of a group of experts … by a series of intensive questionnaires interspersed with controlled opinion feedback (Dalkey and Helmer 1963, p. 458). Top experts were assumed to provide the best judgement and forecast. But whether this was true in general and especially with respect to self-rated expertise was – and still is – at issue. In experimental studies, employing students who answer almanac questions,[2] RAND-researchers revealed that the answers given by a subgroup of more knowledgeable individuals selected in terms of their self-rating are generally not more accurate than those of the group as a whole. "On the other hand, the group reliability for average self-confidence on individual questions was quite high" (Dalkey 1969, p. 68). Since then several studies have dealt with this question, but the results are equivocal: Dalkey et al. (1970), Dalkey and Brown (1971), Jolson and Rossow (1971), Best (1974), (1987), Larréché and Moinpour (1983), Riggs (1983), Häder and Rexroth (1998), Geschka (1977) or Albach (1970) tend to give judgements and forecasts from top experts more reliability, while Weaver (1971), Welty (1972), Brockhoff (1975), or Linstone (1978) don't see significant differences or tend even towards the opposite, giving top experts less reliability.[3]

At least part of these disparate results may be due to inadequate testing procedures, which conduct laboratory experiments with students – mostly undergraduates – answering almanac questions (Rowe et al 1991; Rowe and Wright 1999). Putting almanac questions to students – a rather *homogenous* group of *non*-experts with essentially *similar* knowledge – is very different from the true Delphi goal of having unknown future events assessed by a *diversity* of experts using *differing* knowledge. In all these laboratory experiments, self-rating refers to *knowledge* or to the *ability to guess*. In a real-world Delphi, which intends to "obtain the most reliable consensus of opinion of a group of experts" (Dalkey and Helmer 1963, p. 458), self-rating should, in contrast, refer to the ability to *assess uncertain events*. What is even more important, the students in the experiments answering almanac questions are not involved, while experts assessing future developments in their field of activity definitely are. Some of the more specific results of the studies clearly demonstrate an insider bias: the relevance of involvement, as well as the influence of involvement on assessment and foresight. Zakay (1983) found that respondents perceive desirable/undesirable life events as more likely to occur/not to occur to themselves than to other similar persons. Wright and Ayton (1989; 1992) discovered a positive influence of desirability on the assessment, and emphasise the significant positive correlation of desirability with over-confidence, detected already by Ament (1970), Milburn (1978), and Weinstein (1980). Shrum (1985) found that researchers working in a specific field regard this very field as more innovative than those working in other fields. This optimism bias among experts tends to be stronger in less innovative and less promising fields. Top experts (i. e. insiders in most cases), therefore, demand a more active policy to promote their field of work (Grupp et al. 2000, p. 61), and tend to be overoptimistic with regard to the realisation of (their) innovations (Grupp et al. 2000, p. 59). Menrad et al. (1999, p. 160–61) report a much more positive

[2] Almanac questions are questions with uncontroversial, easily verifiable outcomes, mostly guesses about quantities (e. g. tonnage of yearly shipments from New York harbour, diameter of planet Jupiter, etc.).

[3] "Armstrong 1987 surveyed the literature and found that although minimal expertise in a given field would improve the accuracy of problem solutions, clinical diagnoses, and economic forecasts, higher level of expertise resulted in diminishing returns. This led to the popular quotation: 'Don't hire the best expert you can – or even close to the best: Hire the cheapest.'" (Parenté and Parenté 1987, p. 137).

stance among German experts from industry and academia towards biotechnology than among consumers and opponents, and their belief in a faster realisation (see also section 5 of this paper).[4]

The fragmented evidence surveyed above – in most cases based on rather small samples – appears to suggest a tradeoff between the superior knowledge of experts and the potential optimism bias resulting from the experts' involvement. Several reasons can be found to explain the optimism-bias among top experts: "Unrealistic optimism" (Weinstein 1980, p. 806) may result from the overestimation of own capabilities and the underestimation of risks inherent in one's own work, well known in risk research (Kahneman and Tversky 1972). In Weinstein's (1980, p. 814) experiments students showed the greatest optimism in relation to events perceived to be controllable and implying some degree of commitment or emotional investment in the outcome. Perceived controllability, commitment, and emotional investment are indeed typical constellations influencing an insider's points of view. Experts pushing ahead the advance in their specific field are fascinated by their task, they must believe in its significance and in its future. They are strongly influenced by the desirability of the outcome (Weaver 1971), and they believe in their ability to influence it (Tyebjee 1987). Insofar, top experts are informed advocates of their own issue, and frequently take on a strong affiliation bias (Slovic 2000a, p. xxx).[5] "We find a curious ahistoricity in the outlook of most scientists and technologists, together with a tendency for inbreeding." (Linstone 1978, p. 298). Top experts tend to reduce complexity by closing their eyes to the fact that the introduction of a new technology entails a complex of innovations rather then a single technical innovation.[6] Diffusion periods are heavily underestimated especially for major innovations (Rogers [3]1983), implementation is assumed to be smooth and devoid of serious obstacles (Linstone 1978, p. 295). Above all technical experts tend to overestimate the importance of their own technical problem and dissimulate the dependence on other technologies (Rosenberg 1994) as well as the need for organisational innovations to support the technical ones (Schnaars 1989).[7] The optimism among experts is further promoted by their assumed ability to mobilise economic, social and political resources furthering their goals (Burns 1985; Krupp 1992). Last but not least, insiders frequently overestimate their knowledge and their competitiveness relative to their competitors: Japanese experts regarded themselves as leading in nanotechnology, while German and French experts ranked them second after the U.S. German experts ranked themselves in front of France, while French experts ranked themselves in front of Germany (Grupp 1999, p. 175). Academic scientists, however, appear to be less affected by this type of bias (Corn 1986, p. 224).

This short glance at the rather sparse evaluation studies suggests that the main problem is not the appropriateness of self-rating as a true reflector of actual expertise. It is the involvement of top experts and insiders that tends to generate overconfidence and to bias their assessment and foresight.

[4] A counterexample, however, is reported by Linstone (1978, pp. 285-90): In a study on the future of medicine commissioned by a pharmaceutical company, outsiders, i. e. extramural experts, were much more optimistic with regard to the data of achievement than insiders, i. e. in-house experts. Similar results are reported in section 3 for Austria.

[5] "We also observed a strong 'affiliation bias' indicating that toxicologists who work for industry see chemicals as more benign than do their counterparts in academia and government. Compared to other experts, industrial toxicologists were somewhat more confident in the general validity of animal tests except when those tests were said to provide evidence for carcinogenicity – in which case many of the industrial experts changed their opinion about the tests being valid. Similar results have been found in follow-up studies in Canada (Slovic et al 1995) and in the UK (Slovic et all 1997; see also Lynn 1987)." (Slovic 2000a, xxx). The affiliation prejudice is particularly strong in rather closed research areas: "It seems that the fusion research community has adopted a strategy of 'harmonising assumptions' to reduce uncertainty and range of alternatives." (Kalinovski 1994, p. 25).

[6] "As those familiar with forecasting have learned, the specialist is not necessarily the best forecaster. He focuses on a subsystem and frequently takes no account of the larger system." (Linstone 1975, p. 581).

[7] See also section 3.

Including less specialised experts with a broader perspective in foresight exercises may therefore be conducive to better results. Sections 3 and 4 will test this hypothesis with the help of the Austrian and the German Technology Delphi.

The optimism bias among experts with the highest knowledge – the subject of this study – must not be confused with a potential over-optimism of long-term technology forecasts in general. Especially in the 1960s a technology optimism prevailed, particularly in popular futurism, but this widely accepted by serious media and the educated public as well (Avison and Nettler 1976; Corn 1986; Schnaars 1989). The authors of these forecasts were generally specialised in 'futurism', and it is still an open question whether experts specialised in specific technological fields were subject to this futurist optimism bias within their own field of expertise as well (Wise 1976; Schnaars 1989, p. 83), or if they were more sceptical (Corn 1986, p. 224).

2 A brief introduction to the Austrian Technology Delphi[8]

Methodologically, the Austrian Technology Delphi (ITA 1998) was designed as a Decision Delphi.[9] This specific form was considered the appropriate tool as the goal was not to forecast new emerging fields of technology, but to map out those fields and niches where Austria could attain a leading position within the next 15 years – either in applied science, in economic application, or in societal/organisational transposition. As is mandatory in the text-book Delphi (Martino 1983) – even if rarely applied in practice – an unstructured 'zero round' was used, grating the experts relative liberty to identify and elaborate on the issues they consider important – in this case promising fields for Austrian dominance with already existing Austrian strengths. In this 'zero round', 350 experts (response rate 39 percent)[10] were asked to answer a questionnaire with open questions (Tichy und Aichholzer 1997). Combined with desk research (Tichy 1997a; 1997b; 1997c), the results of the zero-round interrogation provided a respectable basis for selecting promising areas for the Delphi survey. To prepare the questions and – later on – to analyse the results, special emphasis was given to expert groups according to the bottom-up approach inherent in a Decision Delphi. In each of the selected (seven) fields of investigation an expert group was formed, comprising scientists from academia, relevant persons from businesses, administration experts, and – as far as possible – consumer representatives. The size of the expert groups varied between 14 and 23. Their task was problem-oriented rather than focused on technological development, to avoid the frequent trap of focusing only on new technologies urgently seeking just any application. This strategy was based on the assumption that innovations appropriate for solving existing problems will more easily find a market in the future than purely technical ones.

[8] For a more detailed description in English see Aichholzer 2001 a, b, or Tichy 2001a.

[9] Rauch (1979) distinguishes three types of Delphi studies: (1) The Classical Delphi as a tool to discover the group opinion of experts about future facts. It ensures that the future evolves according to some law or at least some regularity. (2) The Policy Delphi as a tool to clarify the positions of decision-makers. It deals with ideas and concepts, not with data and facts. (3) The Decision Delphi, a tool to co-ordinate decisions with relevance to the future, if the future does not follow a law but is influenced by a large number of small, uncoordinated decisions (the "tyranny of small decisions"). In a Decision Delphi, reality is not predicted or described, it is made. Its main social function is to co-ordinate and structure the general lines of thought in diffuse and unexplored fields of social relations and to transform future development in such an area from mere accident to the result of carefully considered decisions.

[10] Among which 17 % entrepreneurs, 23 % physical scientists, 16 % technicians, 13 % social scientists, 19 % civil servants.

The task of each expert group was to formulate some 40 hypotheses within their specific field, with regard to a situation 15 years hence.[11] For any one of these 40 hypotheses within the 7 fields, the respective respondents in the two Delphi rounds had to answer questions about their specific knowledge, the innovativeness implied in the respective hypothesis, the importance of the hypothesis, its chance of realisation in Austria in general, and the probability of Austrian dominance with respect to R&D, economic exploitation as well as organisational-social implementation. In addition, the panellists were asked to assess the indicated development as desirable or undesirable, and which policy measures – out of a given list – they considered to be appropriate to enforce the envisaged development. Room for comments was provided. The respondents for each one of the seven fields were selected according to their expertise and an planned composition of the sample, intending to comprise academia, businesses, and a group comprising administration and several groups of lobbyists (including NGOs) in equal parts.

As usual the Austrian Delphi comprised two rounds: 3,748 questionnaires were mailed in the first and 1,597 in the second round, of which a formidable 46 percent and 71 percent were returned. Out of the respondents in the second round, some 35 percent were employed in businesses, 25 percent in academia, 17 percent in administration, 7 percent in lobbies, and 16 percent elsewhere. Functionally, one third worked in R&D, one fifth in market-related jobs, one eighth indicated a combination of several functions. Women were heavily underrepresented while the age structure was representative (ITA 1998, vol. 1, p. 74).

The Austrian foresight exercise in the form of a Technology-Delphi proved highly successful. The expert groups did a perfect job in elaborating the questions and proved helpful in evaluating the results. The response rate in the two rounds was extremely high – considering the length of the questionnaire of about 40 pages –, the knowledge of the respondents was very good, and the answers highly consistent. In total, 14 percent of the respondents indicated a very high and 29 percent a high knowledge[12] with respect to the relevant hypothesis, 81 percent considered the questionnaires' hypotheses to be very important or important, 92 percent as desirable. The innovativeness of the products and processes addressed by the questions was given a mark of 2.2 (on a scale decreasing from 1 to 5), realisation in Austria a mark of 2.6. 52 percent of the respondents expected good chances for technological as well as for economic dominance of Austria in realising the relevant innovations, 62 percent expected good chances with respect to social-organisational transposition. The study (ITA 1998, vol. 2, pp. 277-99) revealed several problem-oriented fields of potential leadership for Austrian scientists (R&D-dominance) and businesses (economic dominance). Classifying the Delphi results according to standard industry classifications helped find an explanation for the Old structures/High performance paradox (Tichy 2001b), i. e. the contrast between Austria's old structures and its rather good economic performance. It revealed that Austrian experts awarded top marks for innovativeness to low- and high qualification as well as to mainstream and research-intensive industries, not to medium qualification and to marketing and labour-intensive ones. This implies that innovation in Austria is by no means restricted to high-tech industries, and that the standard industry classification is not suited to deal with aspects of technology policy.

[11] E. g. "Simulation-software for virtual optimisation of vehicles and their components with respect to weight, safety, and emissions will be developed."

[12] Marks 1 and 2 respectively on a 5 point Lickert scale.

3 'Top-Expert Optimism' in the Austrian Technology Delphi

In the Austrian Technology Delphi – as in any Delphi – the questionnaires were sent to persons considered to be experts, i. e. persons with specific knowledge in the relevant field, who have been accepted by the scientific community, and have an influence on other actors in the respective field (Bogner und Menz 2001, p. 486). The design of the Austrian Delphi intended to have representatives of academia, businesses,[13] and others (civil servants, consumers, lobbyists, etc. – 'administration' in short) roughly equally represented among the respondents. At the end of the day, i. e. in the second round, however, 'others'(40 percent) and 'business' (35 percent) were somewhat overrepresented, at the cost of 'academia' (25 percent). The respondents were asked to indicate their specific knowledge using an ordinal five point scale of integers (Lickert scale)[14] for each hypothesis in the questionnaire. As presented in ITA (1998, vol. 1, p. 89), the Austrian Technology Delphi made full use of the answers provided by all experts with a self-rating of 1 to 3 for the respective question. This is in accordance with the state of the art (cf. e. g. Cuhls et al 1998, p. 10). In general, the self-appraisal differed more among the fields than among the occupations (see table 1).

Table 1: Knowledge as revealed by self-rating (round 2: N = 1127)

	Business	Academia	Others	Total
BE	2.5	2.4	2.4	2.5
BW	2.3	2.3	2.5	2.5
LL	2.5	2.2	2.3	2.3
MZ	2.9	3.0	2.6	2.8
UP	2.9	2.9	2.9	3.0
VK	3.1	3.2	3.2	3.1
WK	3.1	3.0	-	3.1
Average	2.8	2.7	2.6	2.7

Arithmetic means; differences due to rounding
Abbreviations see table 2

[13] Distinguishing criterion is the place of work, indicating their primary interest: Researchers working in industry therefore fall into the category 'business'.

[14] This implies that 'top experts' had to fulfil two criteria: firstly, they had to be selected as experts in the specific Delphi field, and, secondly, they had to rate their own knowledge with regard to a specific question with '1' using a five-point scale.

Table 2: Share of grades 1 and 2 among expert groups

	IN		WI		RE		FE		OG		WV	
	Exp. 1*	Exp. 2+3*	Exp. 1	Exp. 2+3	Exp. 1	Exp. 2+3	Exp. 1	Exp. 2+3	Exp. 1	Exp. 2+3	Exp. 1	Exp. 2+3
BE	**72**	68	**85**	83	**58**	46	**58**	48	**71**	60	**65**	55
BW	**76**	75	**91**	84	**57**	43	**54**	53	**68**	57	**60**	51
LL	**79**	73	**89**	80	**41**	31	**45**	33	**81**	80	**38**	32
MZ	**67**	56	**83**	81	**58**	46	**57**	47	72	**73**	**50**	40
VP	**62**	53	**77**	74	**57**	51	**60**	55	**55**	46	**70**	66
VK	**79**	68	**89**	82	**64**	47	**72**	63	**63**	52	**60**	51
WK	**86**	66	**90**	76	**81**	55	**94**	88	**35**	18	**85**	78

** Level of expertise 1 and 2+3, respectively, according to self-rating*

IN: Innovativeness

WI: Importance

RE: Chance of Economic Realisation

FE: Chance of Austrian dominance with respect to R&D

OG: Chance of Austrian dominance with respect to organisational transposition

WV: Chance of Austrian dominance with respect economic exploitation

BE: Production and processing of organic food

BW: Environm. sound construction & new forms of housing

LL: Life-long learning

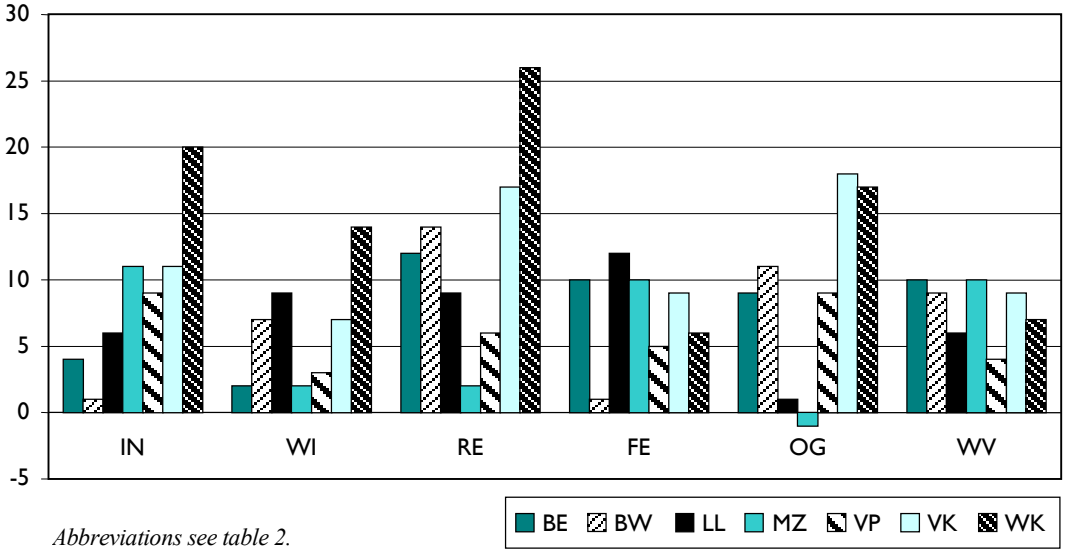
MZ: Medical technology & support for elderly people

UP: Clean and sustainable production

VK: Physical mobility

WK: Characteristics-defined materials

A closer look at the data quickly revealed that the group of 'experts' selected for analysis (1 to 3 on the five point scale) was not at all homogenous. The experts who rated themselves highest (grade 1 – 'top experts' or 'experts 1') tended to be overconfident by assessing most questions more positively than the rest. Table 2 gives a first impression of this optimism bias: Experts with top self-ratings gave many more top marks (1 or 2 on a five point Lickert scale) to the hypotheses than experts with a self-rating of 2 and 3; in all fields and in all types of questions. There was only one tiny exception: the chance of Austrian dominance with regard to Organisational Transposition (OG) in the field Physical Mobility (VK) received marginally lower marks by top experts. Figure 1 visualises top-expert optimism by plotting the differences among the shares of top grades given by experts 1 and experts 2+3 respectively: On average the share of top grades (1 or 2) given by experts 1 is about ten percent higher than those of experts 2+3. The optimism among top experts appears to be highest in the technology-dominated field of Characteristics-defined Materials (WK) with respect to Innovativeness (IN), Importance (WI), Chance of Realisation (RE), and of Austrian Dominance with regard to Organisational Transposition (OG). It is slightly less in the second primarily technical field: Physical Mobility, primarily concerning the Chance of Realisation and Chance of Austrian Dominance with regard to Organisational Transposition. In general, the optimism bias among experts appears to be most articulate with regard to Realisation (except in Medical Technology) followed, with quite a lag, by optimism in Organisational Transposition and Innovativeness.



Abbreviations see table 2.

Source: Table 2: Differences between columns 'experts 1' and 'experts 2+3'.

Figure 1: Differences in the share of top grades among 'experts 1' and 'experts 2+3'

The ranking order changes when the analysis is restricted to the significant differences. One fifth of the differences between the marks of experts 1 and experts 2+3 is significant at the 90 percent level, one eighth at the 95 percent level. Given the wide range of evaluations – a quite normal and desired quality of Delphi responses – this strongly supports the existence of expert optimism. Lifelong Learning instead of Characteristics-defined Materials now appears as the field with most pronounced expert optimism.[15] The significant differences are strongly correlated with the degree of (self-rated) knowledge, except for Physical Mobility, which ranks second in optimism but – together with Characteristics-defined Materials – last in knowledge.

The rest of this section concentrates on analysing the significant differences. As to the *fields of the Delphi exercise,* top-expert optimism is most pronounced in Lifelong Learning and Physical Mobility (see table 3), least in Clean and Sustainable Production and – contrary to the overall data – in Characteristics-defined Materials.[16] For Physical Mobility the share of top grades (1 and 2) given by top experts was significantly higher for 49 (95 percent significance) and 68 (90 percent significance) of the 246 answers, i. e. in 20 percent and 28 percent of all the answers, for Lifelong Learning in 17 percent and 30 percent. For Clean and Sustainable Production the figures fall to a still remarkable 8 percent and 15 percent.

[15] See footnote 16.

[16] An explanation could be that very specific technical questions prevail in characteristics-defined materials, so that for all questions a fraction of the respondents considered themselves less knowledgeable, which reduced the number of significant differences.

*Table 3: Expert optimism according to fields and topics**

	IN	WI	RE	FE	OG	WV	Average
BE	7/12 %	7/12 %	20/27 %	10/17 %	10/20 %	17/27 %	12/19 %
BW	10/10 %	14/14 %	29/33 %	7/12 %	7/26 %	17/36 %	14/18 %
LL	13/23 %	20/47 %	17/37 %	37/43 %	0/17 %	3/13 %	17/30 %
MZ	14/19 %	8/14 %	25/39 %	3/3 %	11/14 %	6/14 %	11/17 %
UP	11/17 %	9/9 %	11/26 %	9/20 %	9/14%	0/6 %	8/15 %
VK	20/27 %	17/29 %	32/41 %	22/29 %	10/12 %	20/22 %	20/28 %
WK	14/19 %	5/14 %	19/19 %	–	14/14 %	2/19 %	9/15 %
Average	13/18 %	11/19 %	23/31 %	12/17 %	9/17 %	10/20 %	12/20 %

** Percentage difference between the share of top grades among expert 1 and experts 2+3, significant at the 5/10 percent level).*

Abbreviations see table 2

Among the *topics of the Delphi exercise,* top experts were most optimistic with regard to the Chance of Realisation (23 and 31 percent; see table 3) and least optimistic with regard to the Chance of Austrian Dominance with regard to Organisational Transposition (9 and 17 percent). When taking a closer look, expert optimism is most pronounced in Physical Mobility and Environmentally Sound Construction as to Chance of Realisation, and in Lifelong Learning as to Importance and Chance of Austrian Dominance with regard to R&D.

It is not easy to detect a comprehensible pattern in the *fields* in which expert optimism dominates: Life-long Learning and Physical Mobility have little in common. Much more sense can be found in the answers to the *topics* of the questions: Top experts are much more optimistic than others with regard to the Chance of Realisation of the respective innovation, i. e. in most cases the innovation they are working on, and they are least optimistic the Chance of Austrian Dominance with regard to Organisational Transposition in the respective field, which may be beyond their control.

Further evidence can be gained by distinguishing between the *types of innovation.* The Austrian Technology Delphi differentiated between technological, mixed, and organisational innovation on the one hand, and three stages of innovativeness on the other.[17] According to table 4, the optimism bias among top-experts is by far the strongest in terms of organisational innovations, especially in the fields of *Life-long Learning* and *Physical Mobility*. It is important to emphasise that enthusiasm is greater for minor innovations ("In general use within 15 years") than for major ones in all fields, i. e. for those with a longer horizon of realisation. This could reflect the pessimism among respondents regarding Austrian innovativeness.[18] It is, however, in concordance with the results of the German Delphi, in which expert optimism appears to be restricted to the short and medium run as well (see section 4), and with at least part of the literature: Shrum (1985) underlines that the optimism bias with respect to innovativeness is stronger in less innovative and less promising fields.[19]

[17] The most advanced is "Developed within 15 years", the medium is "Available within 15 years", and "In general use within 15 years" is the least innovative.

[18] For further evidence see Tichy 2001b.

[19] It contradicts Corn's (1996) hypothesis of the innovators' underestimation of the diffusion process, which, however, appears to refer to radical systemic innovations.

*Table 4: Expert optimism according to field and type of innovation**

	T	M	O	E	A	V	Average
BE	10/12 %	13/17 %	12/23 %	11/11 %	13/27 %	16/23 %	12/19 %
BW	19/26 %	13/24 %	9/16 %	8/17 %	15/20 %	15/23 %	14/18 %
LL	–	14/28 %	19/31 %	–	20/30 %	16/30 %	17/30 %
MZ	7/12 %	–	16/21 %	4/6 %	11/15 %	8/14 %	11/17 %
UP	8/15 %	–	10/13 %	–	5/12 %	9/17 %	8/15 %
VK	11/16 %	–	36/46 %	6/11 %	24/32 %	26/33 %	20/28 %
WK	8/13 %	(50/50 %)**	(17/33 %)**	3/3 %	13/20 %	7/14 %	9/15 %
Average	9/15 %	8/14 %	18/27 %	6/10 %	10/15 %	17/27 %	12/20 %

** Percentage difference between the share of expert 1 marks significantly (5/10 percent level) more positive than those of experts 2+3*

*** Small numbers*

T: Technical innovation *E: Developed within 15 years*

M: Mixed *A: Available within 15 years*

O: Organisational innovation *V: In general use within 15 years*

It is less obvious, however, why people who self-rated themselves as top experts are more optimistic than other experts when assessing organisational rather than technical innovations. This appears to be in contrast to their weak optimism with regard to the potential Austrian Dominance in Organisational Transposition. It is, however, strongly confirmed by the data (see table 5): Expert optimism is weaker for technical questions in *all* topics except Chance of Austrian Dominance *in* Organisational Transposition.

*Table 5: Technical versus organisational questions**

	IN	WI	RE	FE	OG	WV
Technical	14 %	12 %	26 %	8 %	19 %	15 %
Organisational	27 %	27 %	36 %	27 %	**12** %	25 %

** Percentage difference between the share of expert 1 marks significantly (10 percent level) more positive than those of experts 2+3.*

Abbreviations see table 2.

It is interesting to note that the optimism among top experts refers more to the hypotheses per se than to the specific topics: If top experts are over-optimistic (compared to the less specialised experts) with respect to one hypothesis, this frequently implies that they are over-optimistic with respect to several of its topics. For 16 of the 271 Delphi hypotheses top experts expressed their optimism for at least four of the six possible topics simultaneously. The most frequent combinations were:

- Innovativeness + Importance + Chance of Realisation + Austrian Dominance in R&D (5 times);
- Importance + Chance of Realisation + Austrian Dominance in R&D + in Economic Exploitation (4);
- Importance + Chance of realisation + Austrian dominance in Org. Transpos. + in Ec. Exploitation (3).

Ten of these cumulations affected organisational questions (O), twelve belonged to the least innovative category (V), and eight were organisational questions dealing with less innovative subjects (OV questions), confirming that top expert optimism refers primarily to the least innovative and to organisational hypotheses.

4 'Optimism' in the German Technology Delphi of 1993

The task of the Austrian Technology Delphi was to assess the degree of innovativeness, the importance, and the chance of realisation of various technical and organisational innovations, as well as the chance of Austrian dominance with regard to R&D, economic application, and organisational-social implementation. Section 3 demonstrated that the Austrian (self-rated) top experts tend to give more optimistic answers to almost all questions than the other experts. The optimism bias among top experts was discovered to be especially strong in terms of Physical Mobility and Lifelong Learning, Chance of Realisation, and for organisational and less innovative hypotheses. The type of questions in the Austrian Delphi and the time horizon of 15 years give little chance, however, to figure out, whether the top experts' 'optimistic' answers reflect better knowledge and will prove true in the future, or if an unjustified optimism bias prevails. The German Delphi (BMFT 1993) provides the chance of a test: As a classical Delphi, it asked for the time horizons required to realise the respective innovations. Since a decade has passed in the meantime, at least some evidence can be gained on whether the optimism among top experts exists in Germany as well as in Austria, and whether it turns out to be justified.

Table 6: Expert optimism in the German Technology Delphi

	Occurrence as to top experts' assessment (%)			
	earlier	same time	later	no indication
Medicine	52	17	19	13
Communication	51	38	11	0
Agriculture and fishery	51	37	12	0
Aerospace	47	43	9	5
Maritime & Geoscience	43	28	6	23
Materials	41	22	19	19
Biotechnology	39	30	26	4
Society & culture	38	20	16	26
Electronics & information	36	27	18	21
Raw mat.& water resources	36	10	38	15
Atomic energy	35	35	20	10
Energy	29	33	38	0
Ecology	26	36	30	8
Production	25	19	28	28
Transportation	24	34	23	19
Construction	17	32	46	5
Average	38	28	21	14

In the German Delphi, respondents were asked to indicate their specific knowledge on an ordinal four point scale of integers (high – medium – low – alien to the field). Results are published separately for knowledge high + medium + low, and for top experts (evidently 'high knowledge'). Table 6 indicates results that are very similar to the Austrian ones: top experts expected the realisation of innovations to

be earlier than the group as a whole (including top experts!)[20] for 38 percent of the questions, a later realisation for 21 percent only. Medicine, Communication, and Agriculture & Fishery are the fields with the greatest expert optimism, Production, Transportation, and Construction those with the lowest.

Table 7: Top-experts assessment for short and medium term topicsNumber of questions for which top experts expect earlier/later realisation

	earlier/later
Medicine	52/4
Communication	33/4
Agriculture & Fishery	33/5
Aerospace	17/2
Maritime & Geoscience	34/2
Materials	42/5
Biotechnology	34/2
Society & Culture	31/4
Electronics & Information	31/0
Raw mat.&Water Resources	14/3
Atomic energy	13/1
Energy	12/1
Ecology	12/1
Production	18/1
Transportation	13/3
Construction	11/10
Total	400/48

An evaluation of the accuracy of expert optimism is possible for innovations where forecasts believed that realisation would be in the periods "before 1995", "1996–2000" and "2001–2005".[21] As the questions were answered in 1992, this implies an analysis restricted to forecasts for ten years or less, i. e. to the short and medium term aspects. According to table 7, top-expert optimism is much greater for this shorter horizon. Medicine remains the field with the most pronounced top-expert optimism for short and medium range innovations as well, followed by Materials, Maritime & Geoscience, and Biotechnology. Communication and Agriculture & Fishery show less top-expert optimism in the short and medium run. The fact that top-expert optimism is much stronger for the shorter horizon (table 7) than on average (table 6) implies less top expert optimism or even top-expert pessimism for innovations with a longer horizon. This is in full accordance with the Austrian results, but at variance with the conclusions of Corn (1986) or Schnaars (1989) cited in section 1. As both authors investigate mainly long-term 'futuristic' forecasts of the 1960s, two explanations are possible: That the 'futuristic' forecasts generally tend more towards optimism, or that technological optimism was typical for the 1960s but not for the late 1990s. Indications exists for both explanations, but are not the subject of this study.

[20] Note that the difference would be even greater if it were possible to compare the answers of experts 1 with those of experts 2+3 as in the Austrian case. The published data, however, do not allow a more detailed analysis.

[21] Innovations where forecast believed that realisation would be in the on-going period 2001–2005 were included as they should be at least partly realised.

To analyse the accuracy of the optimism in the assessments of the German Delphi, 19 experts were asked to assess for this study whether the specific innovations in 10 of the 16 fields of the German Delphi have now (July 2002) been realised, partially realised, or not realised. Seven experts did not reply or their answers were late so that their replies could not be included. Table 8 gives the percentage of the optimistic top experts in the German Delphi whose optimism proved accurate, partially accurate, or wrong. On average, in only 20 percent of the cases where top experts foresaw an earlier realisation than the whole group of experts (including top experts!) their optimism proved fully and in 45 percent at least partially accurate. In 33 percent it was wrong. The German data, therefore, suggest the existence of (unjustified) expert optimism, even if the degree differs widely among the fields. It is most marked in Electronics & Information and in Transport, but rather high in Biotechnology and Medicine as well, i. e. in quickly expanding fields. Unjustified expert optimism is least marked in Energy and Atomic energy. Both observations contrast statements of Shrum (1985), who accentuates a stronger expert-optimism bias in less innovative and less promising fields. No correlation exists between the degree of top-expert optimism in the various fields (table 6) and the respective accuracy of the assessment (table 8).

Table 8: Accuracy of top-expert medium-run optimistic assessment

	Percent of optimistic top experts being		
	accurate	partially acc.	wrong
Aerospace	46 %	31 %	23 %
Energy	40 %	50 %	10 %
Atomic energy	31 %	54 %	15 %
Communication	30 %	40 %	30 %
Ecology	28 %	39 %	33 %
Materials	21 %	42 %	36 %
Electronics & information	20 %	20 %	60 %
Biotechnology	11 %	48 %	41 %
Medicine	2 %	53 %	44 %
Transport	0 %	50 %	50 %
Average	20 %	45 %	33 %

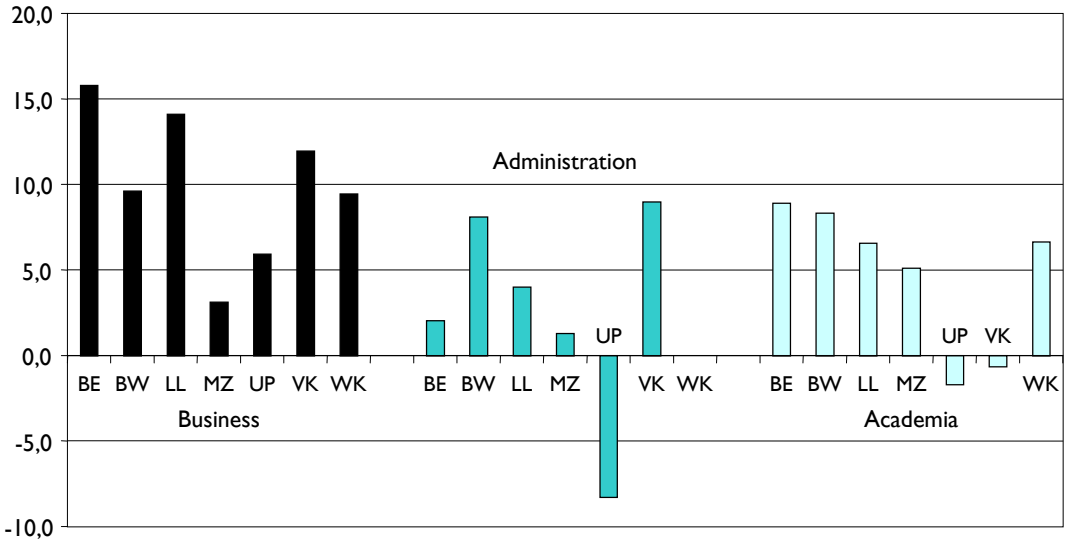
5 Who is optimistic?

In both the Austrian and the German Technology Delphi, top experts definitely gave more positive answers than those experts who rated themselves as somewhat less knowledgeable. The German Delphi reveals that this optimism among top experts is to a considerable part unjustified, at least with regard to the period of realisation, indicating a distinct optimism bias. As foresight exercises increasingly gain significance in policy formulation, particularly in industry and technology policy, it is important to examine the reasons for this bias. The Austrian Technology Delphi offers a chance to analyse at least two aspects:

- Which groups of experts appear to be most affected by an optimism bias, on the one hand, as it distinguishes among experts coming from academia, business, and other occupations, mostly administration.

- And, on the other hand, which topics are most affected by an optimism bias, as it asked questions on the innovativeness implied by the respective hypothesis, the importance of the hypothesis, its chance of realisation in Austria in general, and the chance of Austrian dominance with respect to R&D, economic exploitation as well as organisational-societal implementation.

The method applied in this section is similar to that of section 3: The relevant statistic is the percentage-point difference between the share of top experts and the share of experts 2+3 giving marks 1 or 2 to the respective topics. The only difference is that in this chapter all the differences are analysed, while section 3 concentrated merely on the significant ones.[22] Averaging the differences of all topics (IN, WI, RE, FE, OG, WV) raised in the questions on each hypothesis (figure 2) clearly indicates that the *top experts coming from the business sector* are the ones most tempted to give unjustified optimistic assessments.[23] They are more optimistic than the less specialised business experts in each one of the seven fields, and their optimism is more pronounced than the optimism of top experts coming from academia or administration in six of the seven fields. The only exception is medicine, a field characterised by excessive optimism among *academic* top experts. This is not unexpected, as in a study on the future of medicine commissioned by a pharmaceutical company (Linstone 1978, pp. 285-90), outsiders, i. e. non-business experts, were likewise much more optimistic with respect to achievement than insiders, i. e. in-house (business)experts.



Abbreviations see table 2

Source: Table 9: Average of rows IN, WI, RE, FE, OG, and WV.

Figure 2: Indication of expert optimism according to field

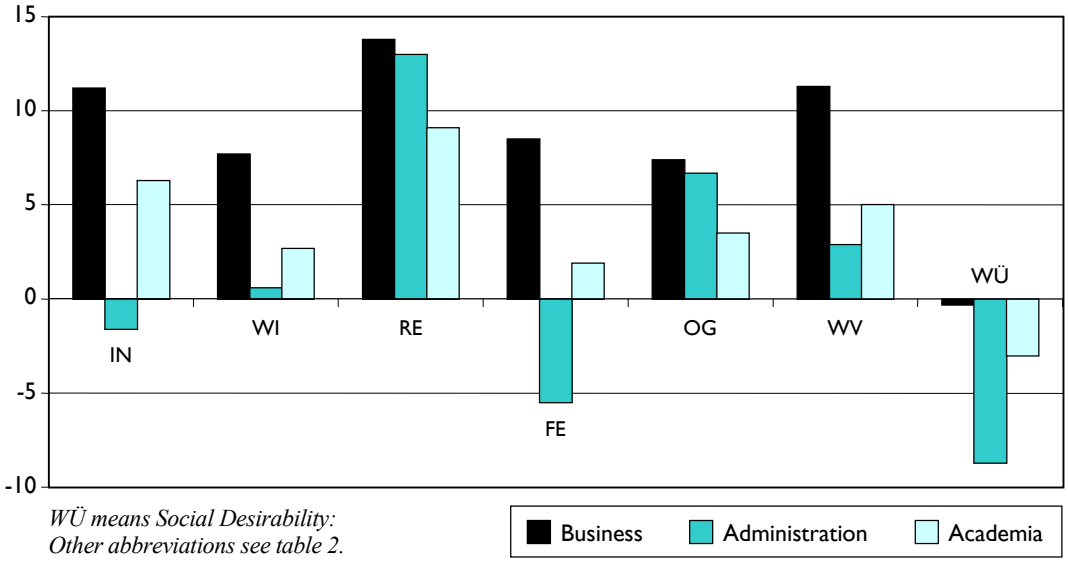
[22] This comes from the fact that the number of responses in most of the cross classifications is smaller, and implies a less detailed analysis and less stringent conclusions.

[23] This may appear strange at first but is confirmed by recent evidence of over-optimistic entrepreneurs with regard to their confidence in the swift success of UMTS, the prospects of the New Economy in general, or of quick profits in the biotech business.

The over-optimism of top *experts coming from administration and academia* is markedly less pronounced than that of business experts. In administration, top experts are even less optimistic than experts 2+3 in the field of Clean and sustainable production, and in academia top experts are less optimistic in the fields Clean and sustainable production and Physical mobility.

With regard to the *fields*, top-expert optimism is relatively most pronounced

- in Production & processing of organic food and Lifelong learning for experts in business,
- in Physical mobility and Environmentally sound construction & new forms of housing for experts working in the administration,
- and in Production & processing of organic food and Environmentally sound construction & new forms of housing for experts working in academia.



WÜ means Social Desirability:
Other abbreviations see table 2.

Source: Table 9

Figure 3: Indication of top expert optimism according to topic

The optimism bias of top experts in business does not only comprise all the fields (excluding medicine), it clearly appears in all the topics as well (see figure 3). Top business experts are more optimistic than 2+3-business experts regarding the Importance of the respective hypothesis, its Innovativeness and as with regard to the Chance of Austrian dominance with regard to R&D, as well as Organisational-social implementation. They are even more optimistic (difference more than 10 percentage points) in terms of the Innovativeness of the respective hypotheses, its Chance of realisation in Austria in general, and the Chance of Austrian dominance with regard to Economic application. Top experts in administration are least inclined to an optimism bias. They even have a pessimism bias compared to their less knowledgeable fellows with regard to Innovativeness and potential Austrian R&D-Leadership, and their optimism bias is the smallest in terms of Importance, Austrian Dominance with regard to Organisational-social implementation, and the Chance of Austrian dominance with regard to Economic application.

It is interesting to note, but difficult to explain, that the top experts from all occupations, even from the business sector do not reveal any more optimism bias with regard to the *Desirability* (WÜ) of the respective innovations (most of the right bars in figure 3) than their less knowledgeable fellows. The top experts in the ``administration'' group are even significantly more pessimistic, which may

be explained by the fact that they include representatives of NGOs and consumer organisations. Anyhow, top experts in administration appear to be rather consistent in this specific aspect, as they are least optimistic, relatively, in terms of all other topics as well. The top experts from business and academia, however, consider the respective innovations to be more innovative and more important than experts 2+3, yet undesirable, which appears to be a paradox indeed. Probably some element of technological euphoria, and an element of belief in continuous technical progress as an unavoidable precondition of corporate and national competitiveness marks the view of these experts, which they, nevertheless, consider to be a limited contribution to human welfare.

Table 9: Expert optimism according to group of respondents

		IN	WI	RE	FE	OG	WV	WÜ
BE	F	3.7	4.3	16.2	10.0	3.1	16.1	1.8
	U	**19.4**	**6.1**	**18.1**	**17.4**	**13.0**	**20.7**	**2.6**
	A	-8.3	1.3	11.0	3.5	-1.4	6.1	-3.3
BW	F	0.8	6.8	9.9	**6.9**	17.1	8.4	2.1
	U	2.6	**8.8**	14.3	6.4	12.5	**13.1**	**3.6**
	A	**3.5**	2.6	**24.2**	-6.4	**20.6**	4.0	-7.7
LL	F	5.0	10.5	9.1	6.7	**2.3**	5.8	2.4
	U	**15.5**	**13.5**	8.3	**22.2**	-1.8	**27.0**	**2.6**
	A	-1.3	3.6	**11.6**	7.5	0.1	2.4	1.5
MZ	F	**16.7**	0.0	6.7	-0.3	-1.0	8.5	-4.8
	U	11.8	2.9	11.6	-0.9	-3.5	-3.3	-4.1
	A	-0.5	**9.7**	**12.4**	-20.3	-5.9	**12.2**	-13.5
UP	F	-1.1	-5.4	-4.7	-4.0	3.1	1.9	-6.5
	U	**6.2**	**3.0**	**9.4**	**4.8**	7.3	**4.9**	-5.0
	A	-2.6	-11.8	-5.7	-18.9	**9.2**	-19.8	-23.5
VK	F	5.1	-4.2	7.1	-4.9	-0.4	-6.5	-16.5
	U	**13.2**	**9.9**	21.2	**11.2**	3.8	12.3	**1.7**
	V A	-0.3	-2.1	**24.3**	1.6	**17.6**	**12.7**	-5.5
WK	F	**13.7**	6.7	**19.6**	-1.3	0.3	0.9	**0.6**
	U	9.4	**9.7**	13.6	-1.3	**20.5**	**4.7**	-3.6
	A	.	.	.	.	.	.	.

** Percentage difference between the share of expert 1top grades and those of experts 2+3.*
WÜ means Social Desirability: Other abbreviations see table 2.

The cross classification in table 9 suggests some clustering of the optimism bias among top business experts in terms of Innovativeness, Realisation, and Austrian Realisation dominance in production & processing of Organic food (BE), Lifelong learning (LL), and Physical mobility (VK). The optimism bias among top experts from administration refers to Realisation and Austrian dominance in Organisational transposition and Economic exploitation in Lifelong learning (LL) and Physical mobility (VK). While no pattern of optimism bias among academia's top experts can be detected, the former two clusters tend to underline the insider hypothesis.

6 Some conclusions and suggestions

Experts with the highest self-rating of their specific knowledge tended to give the most positive assessments to almost all topics raised in the Austrian Technology Delphi. The degree of optimism is positively correlated with the degree of self-rated knowledge, and it is more pronounced for the least pioneering innovations. On the one hand, an examination of the German Technology Delphi discovered the same top-expert optimism with regard to the short and medium-term realisation of innovations, while on the other hand, expert pessimism may prevail in the long run, i. e. for emergent technologies. Control calculations with regard to the hypotheses of the German Delphi that should have been realised in the meantime, revealed that the larger part of the German optimism is unjustified to the extent that the optimistic experts clearly tended to underestimate the period of realisation.

These results are important as they shed some new light on two controversial issues raised in the methodological literature on foresight: Are the assessments of highly specialised top experts preferable to those of less specialised experts in foresight exercises, and is self-rating an appropriate method to select experts. The new facts revealed by this study tend to answer both questions in the positive, yet not without some qualifications. As the nature of the potential qualifications depends on the causes for the optimism among top experts, attempts were made to dig somewhat deeper into the potential arguments.

As opposed to some of the pertinent literature (Shrum 1985), the *field of investigation* does not appear to be essential for top expert optimism. Neither more technical, nor high-tech, nor fast growing fields are characterised by more top-expert optimism than others. Generally, the same holds true for the *topics of the hypotheses*, even if questions referring to the possibility of realisation tend to raise slightly more top-expert optimism than those referring to, say, potential Austrian leadership in R&D.[24] More relevant is the *type of hypothesis:* The answers to hypotheses of an organisational nature were much more optimistic than to hypotheses of a technological nature. This is in agreement with previous studies maintaining that the respondents tend to neglect – or at least underestimate – difficulties that lie beyond their own field of work, even if these are key to success (Linstone 1978; Schnaars 1989; Rosenberg 1994). And organisational aspects are typically beyond the single respondent's influence. The main explanation for differences in expert optimism appear to be their *occupational affiliation.* Delphi respondents with a top self-rating who work in business have a much greater optimism bias than those working in academia and in particular those working in the administration. The over-optimism of people working in business – to a large extent involved in R&D – is evidently consistent with the insider hypothesis, stressing the overestimation of subjects a researcher is working on (Ament 1980; Weinstein 1980; Wrigth and Ayton 1992). Their strongest optimism bias is expressed with regard to the Chance of realisation, to Innovativeness, and to the Potential Austrian leadership in Economic exploitation. The insider hypothesis can help to explain the over-optimism among experts in academia as well. It is consistent with the observation that their greatest over-estimation applies to the Chance of realisation and Innovativeness. It is, however, not clear why the over-optimism among experts is generally weaker in academia than in business.

Given the over-optimism among top experts in general and among insiders in particular, foresight exercises should base their panels on a fair mixture of experts of different grades, with different types of knowledge and affiliation, and not only on top specialists of the respective field. The same consideration implies that Delphi-type exercises offer an advantage over forum groups or small panels of specialists. But even in Delphi exercises the interpretation of the results should take the insider bias into account. Otherwise the forecast exercise is likely to bring assessments that are too optimistic.

[24] Don't forget that the tests refer to the *difference* between the optimism of top experts and 'normal' experts.

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