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**The Landscape and Isobars of European Values in  
Relation to Science and New Technology  
(ValueIsobars)**

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**Measuring Values**

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**Authors:**

**George Gaskell, Nicole Kronberger, Stavroula Tsirogianni**

**Partner (institution):**  
**London School of Economics and Political Science (LSE)**  
**Methodology Institute**

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# 1. Introduction

The Value Isobars project aims at providing inputs to good governance of Science and Technology. The projects key research challenge are (1) understanding the very concep(s) of values, (2) improving the methodology for the study of values, (3) identifying innovative mechanisms of platforms for value-based dialogue in civil society and citizen consultation, and (4) assessing the potential of legal and regulatory instruments.

The team at the Methodology Institute of the London School of Economics (LSE) focuses on the second question, namely the measurement of values in the context of science and technology. The objectives for this workpackage include, first, a review of data quality in value surveys; second, a comparison of methodological approaches; and third, the provision of an improved survey scheme for value studies. The first phase of the project focused on the two first mentioned objectives. The overall goal was to describe the current situation on research in the domain of values and science and technology perception. More precisely, in this phase the following questions were addressed:

1. What value concepts inform empirical studies in the science and technology domain? What are the strengths and weaknesses of the respective approaches?
2. What is being published on the relationship between values and public perceptions of science and technology?
3. What data are available for analyses of the relationship between values and public perceptions of science and technology?

The three questions will be addressed in the following chapters of this report. Before we turn to the questions though, in the following paragraphs we will shortly address some issues that guide our understanding of values.

Generally speaking, we consider values as ‘ideas about what makes a good life’. As social psychologists we opt for the term ‘social values’ to identify phenomena at the intersection of the individual and the social and we employ social representations theory as the mechanism to account for the origins, structure and functions of values. Here values are socially constituted and individually manifested beliefs about the ‘oughts’ of everyday life in different contexts.

A social psychological perspective seeks on the one hand to take into account individual freedom and choice (including the possibility of dissent and change), and on the other hand social influence and the shared nature of values and beliefs. The idea of “social” values implies that values are more than individual tastes and preferences that change on a whim. Rather, social values are (a) socially shared (within cultures or subcultures), and (b) socially binding (i.e. endangering such values leads to outrage, sanctions and reprimand, and if violated needs restoration). People not only are concerned about rule violation if they suffer harm themselves, but they are also sensitive to value transgressions committed by others against others. However, agreement or consensus on values will never be complete; there is always a potential for controversy and individual (or group) variation. Finally (c), values tend to be socially acceptable ‘good’ reasons. To say, ‘it is bad to do X, but there is no special reason for this’ is no acceptable form of judgment, while saying, ‘it is immoral to do X because it is unfair’ is. To say ‘I like coffee, but there is no special reason’, in contrast, is perfectly reasonable.

Values conceptually are related to a number of concepts such as attitudes, beliefs, preferences and norms, among others.

*Values and attitudes.* The attitude is one form of representation of the world with the function of ordering objects and states of the world in terms of individual preferences. Another way of representing the world is through social values. Such values have the function of ordering states of the world in terms of normative prescriptions – what should and should not be done. Values differ from attitudes in having an ‘ought’ dimension; while they are espoused by individuals they are essentially social in origin. Values can be thought of as more general concerns, or ‘organising principles’, that give structure to various attitudes. As such, values might be understood as a latent dimension underlying attitudes. In terms of methodology this means that values often need to be reconstructed by the researcher who analyses a series of attitudes in combination. Such ‘revealed’ values complement ‘expressed’ values (here, the individual explicitly says what she or he likes). An example of revealed values is the concept of ‘technology optimism’: in the Eurobarometer on Biotechnology, respondents are asked about whether they assume a number of technologies to make life better or worse in the future. While responses for the single technologies might be considered attitudes, something like a value of technology optimism may be deduced from the pattern of responses across the different attitude items.

*Values and beliefs.* Beliefs answer to descriptive questions about expectancies (what can happen), existence (what exists), cause (why this happened), probabilities and hypotheses. Values, on the other hand, answer to questions like ‘what is good, preferable, proper, desirable’ (Scheibe, 1970). Although beliefs can often embody values, not all beliefs are value expressive.

*Values and preferences.* Preferences lack the profound evaluative and durable elements of values that are responsible for influencing socially significant behavioural decisions or statements (Hechter, 1993).

*Values and norms.* Given the obligatory nature of values, norms are another commonly associated concept. According to Sherif, norms are cultural products that comprise values, customs and traditions (Sherif, 1936). They represent socially shared expectancies (Kelvin, 1969), based on which people judge the suitability of behaviour, the validity of perceptions, attitudes and values (Secord & Backman, 1964). While both norms and values encompass prescriptive elements as contingent upon societal appropriateness, the latter also pertain to the sphere of personal needs and desires. Hence, norms could be seen more as control mechanisms pointing towards obligatory demands, whereas values as providing criteria for desirability and preferences (Williams, 1979). Opposed to the abstract and general character of values, norms have been also theorised to provide the rules of ‘proper’ behaviour –dos and dont’s – as these apply to specific situations.

A particular challenge to studying values in the context of late modernity, is that the proliferation of different constellations of social contexts necessitates the existence of hybrid and heterogeneous value systems. There is growing research evidence that demonstrates that individuals as reflective agents are able to hold multiple identities and value systems. Hence, people mix and switch between them rather than being guided by universal canons. In light of this, measurements that go beyond unitary and universal accounts of values are necessary, which will explore the different situational underpinnings of attitudes towards different

technological and scientific developments in conjunction with different cultures, milieus, regions, socio-demographic groups etc.

In the following we now turn to the questions outlined above: What value concepts inform empirical studies in the science and technology domain? What are the strengths and weaknesses of the respective approaches? What is being published on the relationship between values and public perceptions of science and technology? And what data are available for analyses of the relationship between values and public perceptions of science and technology?

## 2. What value concepts inform empirical studies on values in the science and technology domain?

Measuring values is not a straight forward task. First, there must be a theoretical understanding of what values are (conceptualisation), and then decisions on how to measure values must be taken. There are a number of different approaches that we will summarize in the following. Since the literature is extensive, we will not aim at being exhaustive. Rather, we try to provide an overview on what are the most influential approaches that have influenced value measurement. For this purpose, we suggest the distinction of eight approaches to conceptualising values. It should be noted that not all conceptualizations have been used in the science and technology domain to measure values. We do mention them nevertheless as this will allow us to highlight some of the neglected aspects in measuring values in this field of research. Furthermore, some authors and their work cannot be exclusively classified as one approach but address issues relevant to different approaches. For purposes of clarification, however, we will present the approaches as ideal cases.

More specifically, the eight approaches address the following issues: First, there are approaches that measure what people cherish or what constitutes *ideals, goals, and guiding principles* in their lives. Second, there are conceptualisations that focus on *what people consider dangerous, i.e. on what they want to avoid*. Third, value conceptualizations focus on *tradeoffs, dilemmas or value dynamics* arising from value clashes. Fourth, there is research addressing questions related to *enaction or putting values into practice*, and fifth, on *value differences across cultures and value change over time*. Sixth, there is research on *value variability within countries and society*. Seventh, the general question ‘what makes a good life’ can (and probably should) be considered in a limited number of life contexts and related *human problems*. Eighth, finally, there is the idea of *revealed values*. We discuss all eight aspects below, by summarizing their characteristics, their strengths, and their weaknesses.

**The first approach: values as ideals and goals.** There is research that measures what people cherish or what constitutes *ideals, goals, and guiding principles* in their lives. In terms of methods, people typically are confronted with lists of values and asked to indicate how important these are to them. Allport et al (1931), for example, distinguishes 6 types of values (reflected in different types of personalities) that can guide lives (people may cherish theoretical, economic, aesthetic, social, political or religious values). The Schwartz (1992) Circumplex model suggests 10 basic values (universalism, benevolence, conformity, tradition, security, power, achievement, hedonism, stimulation, self-direction).

*Strengths and weaknesses.* It is useful to think about what contents do play a role in thinking about the good life. The approaches in this line address the question whether there is a limited set of values that could guide value-based governance (there is no clear answer though, and maybe this is impossible). The problem with addressing positive values only is that, by definition, values are things that are considered good. Although there may be some differences, most people will consider most values important. Especially if rating scales are being used, the responses will be clearly skewed towards the agreement pole. This is the so-called ‘values as truisms’ problem (Maio & Olson, 1998). From a pragmatic point of view, it is important to distinguish what values are considered more relevant than others.

**The second approach: values as the absence of negative states.** In addition to understandings of values as goals, there are also conceptualizations that focus on *what people*

*consider dangerous, i.e. on what they want to avoid.* Such approaches mostly are not defined explicitly as value theories but nevertheless do touch upon value concepts. The Psychometric Paradigm (Slovic, 1987), for example, aims at investigating the underlying dimensions of public perceptions of risk. Research in this tradition suggests that risks that are considered to be not equitable, posing high risks to future generations, or that are involuntary (among other aspects) arouse high concern. In the language of the psychometric paradigm this latent dimension is called ‘dread’. However, one might also review this dimension in terms of ‘revealed’ values, including issues such as equity (within and across generations) or free choice that are endangered by technologies. Technologies are classified in terms of similarities and dissimilarities in their degree of touching upon these values. Further insights come from research on moral intuitions and moral feelings (Rozin, Lowery, Imada, & Haidt, 1999). Not all values are consciously held; sometimes values are revealed by ‘gut’ reactions, that is spontaneous reactions to what is perceived to be ‘unnatural’, repugnant and ‘yuck’. Controversial remains the evaluation of the intuitive reactions; see for example the idea of “wisdom of repugnance” as promoted by Kass (1997) and criticised by Nussbaum (2004).

*Strengths and weaknesses.* There is not much research in this line; however, in empirical research values often come in implicitly (without necessarily being labeled as such). The advantage of including the perspective is that it becomes clear that values not only are about what we are attracted to but also about what we want to avoid.

**The third approach: value conflict.** Third, some traditions focus on *tradeoffs, dilemmas or value dynamics* arising from value clashes. Prospect Theory’s Value Function (Kahneman & Tversky, 1979), for example, highlights that changes in values (gaining or losing something that is valued) may be experienced in different ways. Typically, movements away from the status quo that entail losses in values are experienced as more severe than those that entail gains in values (i.e. the joy of gaining more of a value will not be appreciated as much as the same amount lost will be mourned). Furthermore, it is movements away from the status quo that are most controversial. This research tradition focuses on one-dimensional tradeoffs (e.g. gains and losses in terms of money, or lives saved, etc.). Other research focuses on tradeoffs between *different* kinds of values (e.g. trading in privacy for security). In the technology domain, such tradeoffs or dilemmas are frequent. Some values are more easily traded in than others. Values that show highest tradeoff resistance within a society or milieu are called ‘protected’ or ‘sacred’ values, or ‘taboo tradeoffs’ respectively (Baron & Spranca, 1997; Fiske & Tetlock, 1997). Finally, there is research addressing the issue of value conflicts and their dynamics (see Schwartz’s circumplex model, 1992). Some values contradict each other and so are unlikely to go together, while others form frequent combinations. Schwartz suggests two dimensions, with values on one extreme being unlikely to go with values on the other extreme (the dimensions are openness to change versus conservation values; self-enhancement versus self-transcendence).

*Strengths and weaknesses.* Considering tradeoffs, conflicts and value clashes (both in terms of intra- and inter-dimensional value tradeoffs, and in terms of intra-individual and inter-individual value conflicts) addresses the value-as-truisms problem. The question no longer is what is valued but rather, what is valued more than something else (or who values what more). In terms of methodology, people might, for example, be confronted with forced-choice formats. This often is more difficult for respondents (as trading in values often is experienced as aversive and unpleasant – both values are considered important). However, it allows for important insights concerning the relative importance of different values. Similarly, people are asked how much gains in one value are needed to give up another value (e.g. how many lives need to be saved in order to allow human embryos being used for research). This allows for insights with regard to tradeoff resistance and the degree to values being ‘protected’,

‘sacred’ or ‘taboo’. For some values people even may hold the view that they should never be traded in, whatever the benefits. An untested hypothesis based on Prospect Theory might be that violated values loom larger in public controversies than respected values (the latter might be the reference point, the status quo and moving away from this may provoke concern). The question is, when do values become an issue at all? One could assume that as long as people feel values respected this is a non-issue. Values (like trust) may become a topic if people feel them to be endangered. A weakness of approaches considering value combinations, clashes or conflicts, is of course that in order to be systematic endless value comparisons are to be made. There is no survey that could ask that many questions. So the challenge is to identify value combinations (or contradictions respectively) that are relevant in the specific context.

**The fourth approach: putting values into practice.** There is research focusing on *enaction* or *putting values into practice*. This concerns the relationship between ‘in principle’ and ‘in practice’ evaluations. For example, people may consider fighting world hunger with the help of GM food laudable in principle but unlikely to happen; equally they may find using human embryos for research bad but nevertheless see it as the only solution to solve important problems. Value judgments are frequently qualified by judgments on putting them into practice. In the science and technology domain, procedural justice plays an important role. Rayner and Cantor (1987) suggest that the question ‘how safe is safe enough?’ should be replaced with ‘how *fair* is safe enough?’. It is not only the goals that are relevant but also how they are put into practice. A similar distinction is suggested by Rokeach (1979) who distinguishes between terminal and instrumental values (while terminal values are final goals, instrumental values suggest ways *how* to achieve such goals). In a similar vein, Morris (1956) distinguished between *conceived* and *operative* values. The former represent conceptions of the desirable/preferable, pertaining to those values that people endorse or claim to endorse. However, people’s actions are frequently found to contradict their values. In this respect, *operative values* refer to those values that function as guiding principles in people’s lives by actually influencing their behaviour. Values can range from mere conceptions of the ideal to their actual fulfillment, thus explaining why values do not always act as explicit guides to individuals’ behaviours. The question of enaction or putting values into practice also concerns ‘*moral focusing*’ (ascribing moral status to different beings and entities), that is, how values are *implemented* in specific contexts. Often, there is less controversy on values or principles themselves than on the contexts in which the value applies. For example, most people agree that ‘human dignity must prevail’; there is less consensus, however, on what counts as ‘human’ and whether human dignity applies to human embryos or not.

*Strengths and weaknesses.* Research in this line highlights that not everything that is said to be important indeed is materialized in behavior, and some things – although not considered good – are readily accepted (e.g. because no alternative solution is perceived to exist). Controversies may also pertain to discussions over means and ends. It is also highlighted that social representations of the ‘materials’ involved play an important role (for human dignity to be relevant, embryonic stem cells need to be considered human first). Controversies related to values are often not related to questioning the values per se but rather to questions related to their implementation. Consequently, it is important to address these questions in surveys as well. Only the combination of the value and the judgment that the value is relevant in the context will give the full picture. Particularly when it comes to public perception in the science and technology domain, there is little research on these questions, however.

**The fifth approach: value change and value differences across nations.** There is research focusing on value differences across cultures and value change across time. Guiding questions include: Are there values that are universally shared? What are local values? And, can

cultures be classified in terms of values? Triandis (1995), for example, suggested individualism and collectivism as important dimensions to compare cultures. Similarly, Hofstede (1980) proposed the following cultural dimensions: power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity, and long-term versus short-term orientation. Inglehart and colleagues address the issue of value change over time in combination with country comparison (see for example the ‘Cultural Map of the World’ in Figure 1, Inglehart & Welzel, 2005, p.64). The map plots countries according to their value development: a first dimension suggests a movement over time from traditional to secular-rational values (industrialized societies), while a second dimension addresses movement from survival values to self-expression and post-materialist values (in post-industrial societies).

*Strengths and weaknesses.* An advantage of this line of thinking is that the unit of analysis definitely moves away from the individual towards larger social units (although in terms of measurement there always is the problem how to address the social; mostly, it still is the individual that responds to survey questions. Then the challenging question is how to aggregate and segment social units. For the Value Isobars Project, Inglehart’s approach of ‘mapping’ cultures of the world is a stimulating idea as it represents a good starting point for discussing advantages and disadvantages of the mapping metaphor and the many possibilities of constructing comparative maps.

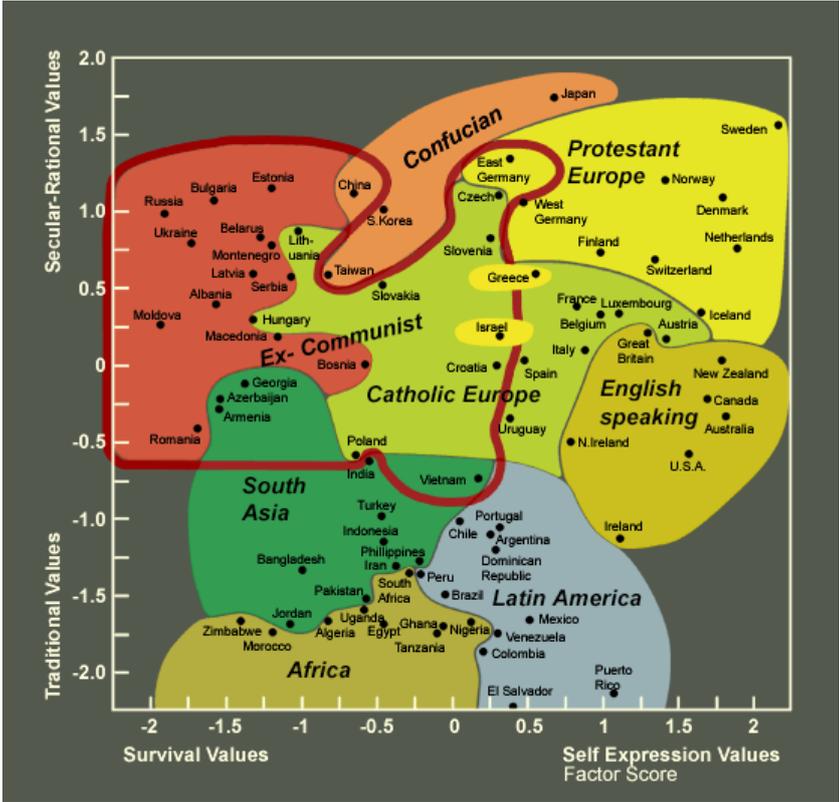


Figure 1: ‘Cultural Map of the World’ (Inglehart & Welzel, 2005, p.64)

**The sixth approach: value differences within societies.** Cultural Theory (Douglas & Wildavsky, 1982) suggests that there are also cultural differences within societies related to four different forms of social organization. Each of these cultural outlooks holds a specific worldview and focuses on specific risks. In the egalitarian worldview, cooperation is valued and risks are considered unacceptable if not distributed evenly within and across generations,

and if forced upon people by a small elite of experts or political authorities. The hierarchist worldview values order, security and control, and focuses on risks such as war, terrorism and criminality. The individualist outlook values autonomy, competition, individual freedom and free choice, and focuses on economic risks, loss of prosperity and loss of choice. The fatalist worldview, finally, is typically held by atomized individuals who are confused about risks and what to value (why bother mentality). Cultural theory offers interesting concepts but has not received much empirical support (see Dake's, 1991, questionnaire, for example). An open question concerns what is the relevant unit of measurement: individuals (but do they hold different worldviews in different contexts or is the cultural outlook a stable, personality-like characteristic?) or is it groups and types of social organization (but how to measure values on such the social level?)

*Strengths and weaknesses.* In contrast to most of the other approaches described in this chapter, Cultural Theory has been developed in relation to science and technology issues. This contextualisation clearly makes it an interesting approach for addressing values. Importantly, it furthermore highlights that there is not only *across* country variation in values but also systematic *within* country variation. In suggesting a group of fatalists, Cultural Theory adds the insight that not all people may be clear about what to value (is there something like non-attitudes in the context of values as well?). What does this mean for governance? A problem may be the question what is the best unit for analysis of change as well (within-individual, cohorts, generations, etc).

**The seventh approach: values as addressing specific human problems.** The general question 'what makes a good life' can be considered in a number of different contexts. Kluckhohn and Strodtbeck (1961) suggest that there is a limited number of human problems that are addressed in different ways in different cultures (while all solutions are present in all societies at all times, they are differentially preferred). These human problems include:

- A time focus (past, present, future)
- Human-nature relationship (mastery, submission, harmony)
- Human relationships (relate hierarchically, according to merit, as equals)
- Motivation for behavior (being, being-in-becoming, doing)
- What is human nature (good, evil, a mixture)

*Strengths and weaknesses.* What the perspective adds is the question whether there are a number of problems that materialize in discussions on science and technology. Conceptualizing the human-nature relationship may be important both in medicine (with the body as part of nature) and in controversies on global warming or on environmental issues. What kind of 'human problems' are relevant for the S&T domain? In what ways? In terms of measurement, Kluckhohn and Strodtbeck used interviewing techniques (which became the basis of Kohlberg's moral dilemmas as well). This method allows for detailed insights but is difficult to use if one aims at representative results.

**The eighth approach: revealed values.** Sometimes, individual attitude data are related to 'revealed' values as expressed in state-level indicators (such as economic development, state religion, democratic development, gender relationships, etc.). This approach differs from other traditions that follow the idea of *expressed values* in that the individual participant is not necessarily interviewed on his or her values. Rather, revealed values address the issue of value climates or materialised value expressions that characterize larger social units or societies as a whole.

*Strengths and weaknesses.* The advantage of this approach is that it allows for insights into aspects that are of such importance to societies or groups that they materialize in laws and/or specific action. Such aspects may represent an important frame for individual thinking and

perception; it may determine the limits of what is thinkable in a society and what is not. Importantly, members of such a society need not necessarily be aware of this influence. A weakness of the approach certainly is that it will give a rather rough measure of values, and furthermore, within societal variation is not addressed.

In the preceding sections we reviewed the literature on value concepts that are of relevance to value measurement. This (by no means exhaustive) review resulted in the differentiation of eight approaches to understanding values in different theoretical traditions and disciplines. For each approach, we discussed the major strengths and weaknesses. The review shows that conceptualising and measuring values is a complex endeavour. There are many different understandings of the term value, and the literature is fragmented. In the following, we want to focus our interest on whether and how these lines of thought left their marks on empirical research on values in the context of science and technology issues. What has actually been published on the issue and which theoretical traditions provided the framework used?

### **3. What is being published on the relationship between values and public perceptions of science and technology?**

A starting point of this research endeavour is to explore the breadth and nature of academic discussions that exist on values in relation to science and technology. For this reason, we sought to discover what is being published on values and public perceptions of science and technology, hoping to also uncover what is also missing.

#### ***3.1. Method***

We used the ISI Web of Science data base to review the literature (empirical and non-empirical) on values and science and technology. For our search we included the Science Citation Index (1970-present), the Social Sciences Citation Index (1956-present) and the Arts and Humanities Citation Index (1975-present). We excluded the Conference Proceedings Citation Index because we were interested in peer-reviewed publications that allow for an evaluation of the current academic debate in the sense that some degree of consensus is ensured. We are well aware that the coverage of the databases is not exactly the same for all times and all disciplines. This limitation should be kept in mind when interpreting our results. However, we consider it a useful tool for getting a systematic overview on trends and developments. We also decided to include English publications only. Knowing that this disadvantages some disciplines and all non-English languages, we voted for this procedure both because we are unable to read most of the non-English languages and also because non-English languages are not equally covered in the database. By concentrating on English contributions we deal with what might be called the international quintessence of the debate.

On the basis of the preceding theoretical discussion, we conducted our search using keywords that are normally connected to discussions around public perceptions of science and technology and value concepts. More specifically we searched for: value\* or worldview\* or ethic\* or moral\* or cultu\* or relig\* AND scien\* or technol\*. We searched for these keywords in the *titles* of English only publications in all years of the data bases. We decided to search within titles because we wanted the search to result in publications that focus on the value topic and do not address it only peripherally. We included articles, reviews, letters, notes and discussions excluding other document types such as conference proceedings, editorial material etc. The search derived 4,389 results. For comparison, we also searched for the same keywords within topics but this search generated more than 100,000 results, which evidently is a difficult number to manually review and analyse and was abandoned for pragmatic reasons.

The results were exported to a library of the Endnote software, where they were further coded. This process aimed at cleaning the database from publications that did not take a social scientific angle in examining issues pertinent to values in the broadest sense and science and technology (for example, the term 'value' also is frequent in methodological or statistics papers). Each record was checked for its relevance and was coded either as an empirical or a non-empirical paper. Empirical was defined in a broad sense, including different social research methods such as surveys, interviews, focus group studies, experiments and case studies. The final database consisted of 2,767 results, which were then exported to SPSS for further analyses.

### 3.2. Findings

The first question we want to address is the proportion of empirical and non-empirical publications within our data. Being concerned with the measurement of values, empirical papers are of special interest as they need to translate value concepts into measurement. The number of such empirical studies, however, is surprisingly low. Out of 2,767 publications from 1956 to 2010, only 200 were empirical.

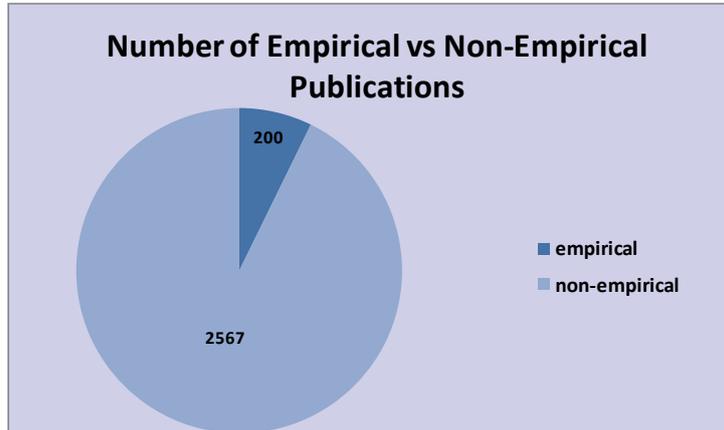


Figure 2: *Frequencies of empirical and non-empirical publications*

We then explored how the publications are distributed over time. Figure 3 presents the distribution for 10 year periods. We observe a linear increase of publications on values and science & technology. Please note that the period between 1956 and 1960 only includes 5 years. In addition, the data available for the period 1956 to 1970 represent publications only from the Social Sciences Citation Index.

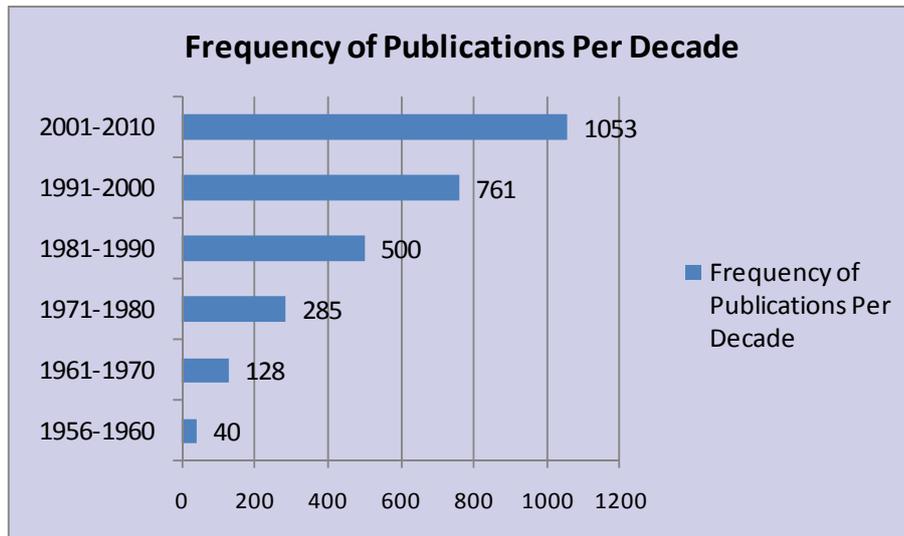


Figure 3: *Distribution of publications per decade*

Our next step in the analysis was to explore similarities and differences in the distribution of empirical and non-empirical publications over time. Figure 4 presents the results confirming a similar trend, thus showing a linear increase in the publication of empirical and non-empirical contributions. Although the number of empirical studies is chronically low in comparison to

non-empirical papers, it is the last two decades that saw a number of empirical work to be published.

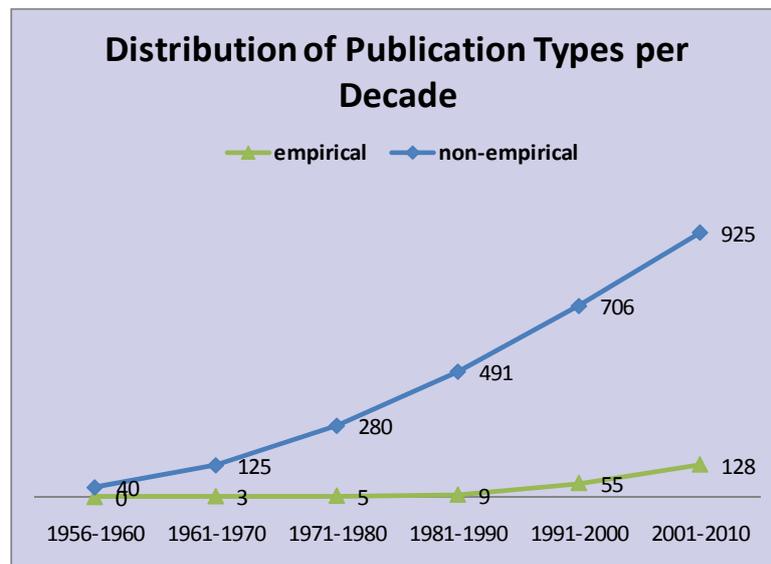


Figure 4: *Distribution of empirical and non-empirical publications per Decade*

We were also interested in examining which are the key journals that publish on the topic of interest. Figure 5 presents the frequencies of publications by Journal. This graph presents only those that appear more than ten times. *Zygon* (125 times) is by far the most important journal in this area, followed by *Science* (50), *Nature* (48), *Scientist* (44) and *Chemical and Engineering News* (41). *Zygon* is an interdisciplinary journal existing since 1966, with contributions from the natural sciences and from the humanities, and it is dedicated to the areas of science, religion and morality. *Science*, *Nature*, *Scientist* and *Chemical and Engineering News* are journals with a focus on the natural sciences.

The remaining journals come from a mixture of disciplines, covering both the social and the natural sciences, and addressing two further issues: science education (*Science Education* -27-, *International Journal of Science Education* -26-, *American Biology Teacher* -15-, *Journal of Chemical Education* -14-) and ethics related to specific professions and disciplines (*Science and Engineering Ethics* -27-, *Journal of Medical Ethics* -15- and *Journal of Business Ethics* -12-).

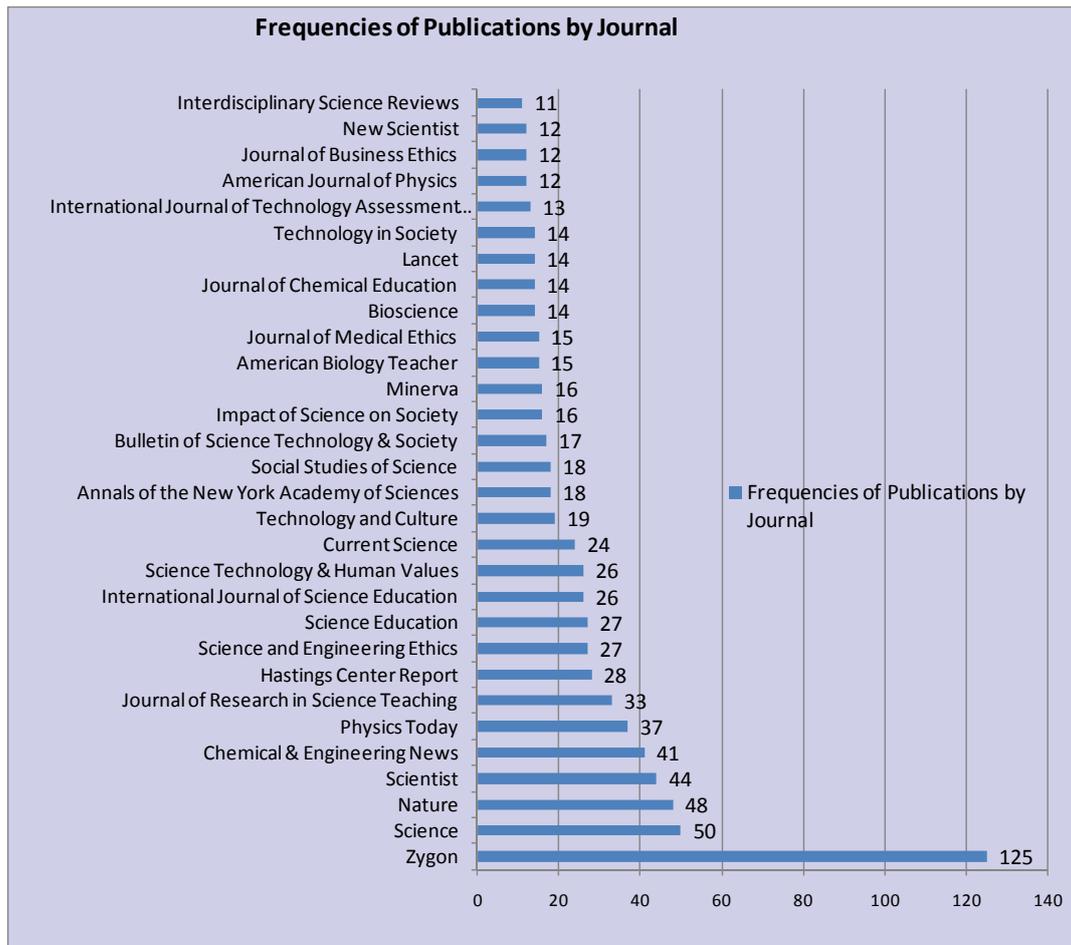


Figure 5: *Frequencies of Publications by Journal*

When we examine which journals publish *empirical* papers on values, science and technology, we can see that Zygon, Science, Nature and Scientist disappear. Unsurprisingly, empirical studies tend to come from the social sciences and not from the natural sciences. When it comes to empirical studies, the *Journal of Research in Science Teaching* (22), the *International Journal of Science Education* (18) and *Science Education* (9) take the lead. All three journals are dedicated to science education and so are some of the remaining journals. We can also see that business and management journals play a considerable role.

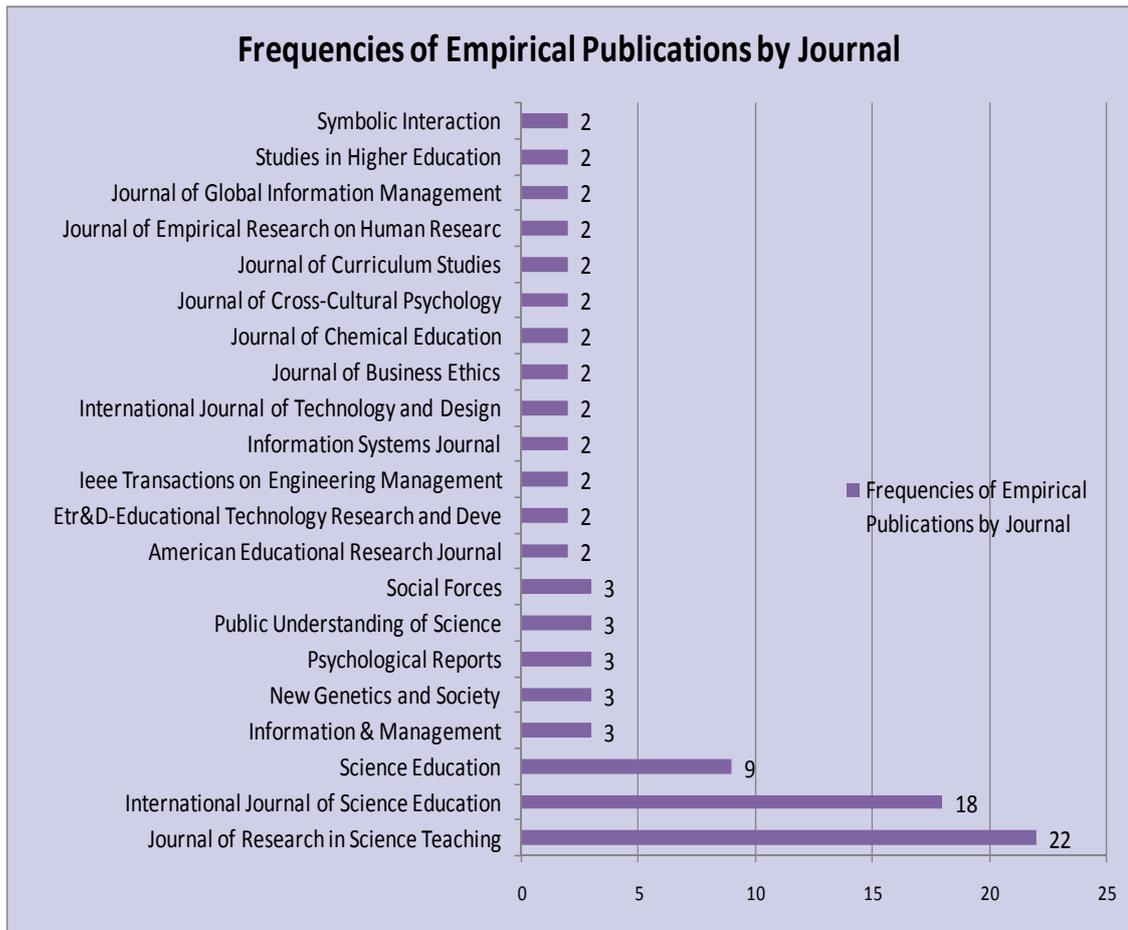


Figure 6: *Frequencies of Empirical Publications by Journal*

In order to explore the contexts and topics that dominate research on science and technology we conducted an exploratory analysis, using the qualitative software Atlas.ti. For the purpose of this analysis, we used the titles of all empirical papers and counted all the words these include. We did this by using the Word Cruncher function in Atlas.ti, which counts all words present in the assigned documents. Given that the program does not distinguish between words that have the same root such as culture, cultures, cultural, etc., we combined terms that shared a root manually. We present the results in Table 1.

Unsurprisingly, many of the words included in the titles correspond to the search terms we introduced (see the words in italics). The term of major interest – *values* – is only part of 48 published titles and keywords, about one quarter of the empirical studies. *Ethics* and *culture* are more frequent title components, while the terms *moral* and *worldview* are more infrequent. The frequency of *religion* compares to that of *values*.

Exploring the words coming up that were not part of our search string, the word *attitude* attracts attention. As the issue is empirical measurement, this is not surprising. As detailed earlier on, the attitude concept is one of the most widely used concepts when it comes to the issue of ordering the world in terms of good and bad. Similarly, the concepts of *beliefs* and *perceptions* are present in the data as well. Moreover, in accordance with the findings presented in Figure 6, we find that the empirical publications tend to focus on issues related to science education (teach\*, educat\*, student, school, learn\*, achiev\*, knowledge) and management (manage\*, organis\*, innov\*).

Topics of Empirical Publications	Frequency
<i>SCIEN*</i>	218
<i>TECHNOLO*</i>	146
<i>ETHIC*</i>	113
<i>CULTUR*</i>	98
ATTITUDE	67
STUD*(STUDY, STUDIES etc)	60
TEACH*	50
RESEARCH*	49
<i>VALUE*</i>	48
<i>RELIG*</i>	46
INFORMAT*	44
EDUCAT*	35
STUDENT	32
SCHOOL	24
INNOVAT*	23
MANAGE*	22
KNOWLEDGE	20
USE	20
BELIEF*	17
INFLUENCE	17
ACHIEV*	16
LEARN*	16
ORGANIS*	15
PERCEP* (PERCEPTION, PERCEIVE etc)	15
CASE	14
COMMUNIC*	14
SOCIAL	14
.....	
<i>MORAL*</i>	6
<i>WORLDVIEW*</i>	4

Table 1: *Frequencies of words present in the titles of empirical publications* (note: search strings appear in italics).

Finally, we explored which of the lines of theoretical thinking discussed in chapter two influenced empirical studies. For this purpose, the most important authors for each approach are listed in Table 2 (as the “revealed values” approach is not linked to specific author names this approach is excluded from the table). We analysed how often these authors were cited (a) in the non-empirical and (b) in the empirical publications.

A first look at the table shows that the frequencies are very low. This is not surprising if we take into account that only 48 publications mentioned the term “value” in their titles. Most of the theories we addressed focus on the topic of values. What we furthermore take from the table is, first, that not only the theoretical literature on values is fragmented but empirical work as well. All of the approaches identified in our review have influenced empirical work but there is no such thing as a standard tool or standard practice that dominates the field. Second, comparing the importance of the different approaches for empirical studies in science and technology contexts, it becomes clear that the cross-cultural approach focusing on country differences is the most frequent approach used. In our data, the cultural dimensions suggested by Hofstede are particularly influential, both with regard to non-empirical and empirical

publications. Other authors that can be classified within the cross-cultural approach are also influential, with Inglehart being more important for empirical work and Triandis being cited exclusively in non-empirical publications. Cultural Theory as well as Kluckhohn's Theory of Value Orientations, both anthropological approaches to conceptualising and measuring values with an interest in within societal variability, are well cited in non-empirical work as well, but their influence on empirical work is delimited. The approach by Schwartz, which has become increasingly influential in many other fields of research, is present but less influential in the field of science and technology studies than in other areas.

<b>Approach to conceptualising and measuring values</b>	<b>Author name</b>	<b>Frequency: Author cited in non-empirical publications</b>	<b>Frequency: Author cited in empirical publications</b>
1. ideals/goals	Schwartz S.	6	5
	Allport G.	7	2
2. dangers	Slovic	4	5
3. value conflict	Kahneman D.	7	0
	Baron J.	4	1
4. values in practice	Fiske A.	0	1
	Rokeach M.	8	2
	Morris C.	4	1
5. cross-country comparison	Rayner S.	4	1
	Hofstede G.	28	18
	Inglehart R.	8	4
6. within country variability	Triandis H.	18	0
	Douglas M.	18	3
	Wildavsky A.	3	0
7. human problems	Dake K.	0	0
	Kluckhohn C./F.	11	2

*Table 2: The influence of theoretical approaches to conceptualising and measuring values on empirical studies (N = 2768 publications)*

In summary, our review of published work suggests that empirical studies are scarce, that they are more common in the field of science education and management but nearly absent in the field of public perceptions of technologies, and that the theoretical approaches that have inspired empirical work are widespread. This leaves us with a rather fragmented picture of the scene. For governance informed by European values the lacuna of empirical research in the domain represents an important issue.

#### 4. What data are available to address values in relationship to public perceptions of science and technology?

Our third approach to reviewing data quality of value measurement was to search for measurement instruments, and more precisely for large-scale surveys. What data is available for addressing issues related to values and public perceptions of technologies?

Three aspects were considered (see Figure 7): First, data to be considered should have a European dimension. Here, 'European' is understood in a very pragmatic sense, meaning that data should be available for a number of European member states so that within-European similarity and variation can be addressed. Of course it is interesting to compare Europe against other parts of the world, but for inclusion in our review the availability of data for non-European countries was not a necessary criterion for selection. Surveys with one-country data availability only are excluded.

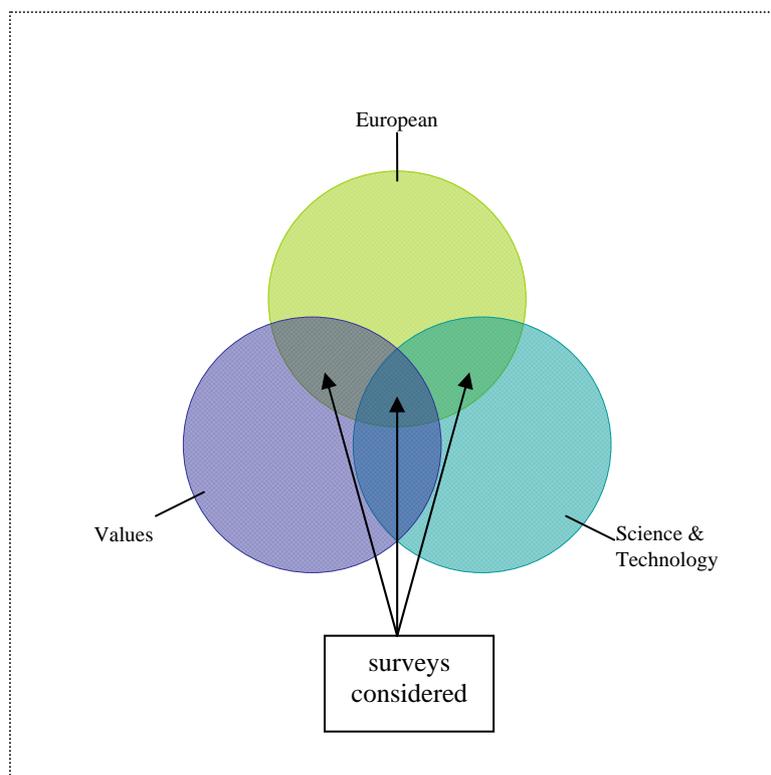


Figure 7: Selection criteria for surveys

Second, we are interested in public perceptions of science and technologies and consequently surveys should include items addressing this issue.

Thirdly, the surveys selected should contribute to understanding the topic of the Value Isobars Project, which is 'values'. Thereby, both surveys explicitly addressing values (expressed values) and surveys including interesting items that can be used as a basis to construct value indicators (revealed values) are to be considered.

Of course, the ideal is surveys that combine all three aspects (availability of data for European countries, items on perceptions of science and technology, and explicit and/or revealed value indicators). In Figure 7 this is the overlap of all three areas. However, there are very few data available for this selection and so we relaxed this strict criterion. While we will remain strict to only consider surveys with data availability for several European countries, we will relax the necessity for surveys to both fully address values and science and technology issues. Consequently, we will also consider surveys that either address values *or* science and technology issues.

	<b>Survey name</b>	<b>Year of fielding</b>
<b>Value Surveys</b>	World Values Survey <sup>1</sup>	Every 5 years, since 1981
	European Values Study <sup>2</sup>	Every 9 years, since 1981
	European Social Survey <sup>3</sup>	Every 2 years, since 2002
	Value Survey Module <sup>4</sup>	Availability of country scores since 2001
<b>Science &amp; Technology Surveys</b>	Science and technology (EB 73.1) <sup>5</sup>	2010
	Europeans and Biotechnology in 2010 (EB 73.1) <sup>6</sup>	2010
<b>Surveys addressing both values and S&amp;T</b>	Special Eurobarometer on Europeans, Science and Technology (EB 63.1) <sup>7</sup>	2005
	Special Eurobarometer Social Values, Science & Technology (EB 63.1) <sup>8</sup>	2005

Table 3: *Availability of survey data for European countries on values, and/or perceptions of science and technology*

Table 3 presents the most important surveys that satisfy our selection criteria and that provide public access to the data. There are four important survey series focusing on the issue of values that, however, include very few – if any – items addressing public perceptions of science and technology. These are the World Values Survey (WVS), the European Social Survey (ESS), the European Values Study (EVS) and the Value Survey Module (VSM). WVS is based on the value concept of Inglehart but in the 2005 wave also included value items by Schwartz. The ESS uses Schwartz’s Human Values Scale to measure values, which is complemented by questions that inquire about attitudes and behaviors in relation to different topics. The EVS follows an approach that measures values implicitly through different questions on attitudes and behaviors across a wide range of topics. The VSM contains scales

<sup>1</sup> <http://www.worldvaluessurvey.org/>

<sup>2</sup> <http://www.europeanvaluesstudy.eu/evs/about-evs/>

<sup>3</sup> <http://www.europeansocialsurvey.org/>

<sup>4</sup> <http://www.geerthofstede.nl/research--vsm.aspx>

<sup>5</sup> [http://ec.europa.eu/public\\_opinion/archives/ebs/ebs\\_340\\_en.pdf](http://ec.europa.eu/public_opinion/archives/ebs/ebs_340_en.pdf)

<sup>6</sup> forthcoming

<sup>7</sup> [http://ec.europa.eu/public\\_opinion/archives/ebs/ebs\\_224\\_report\\_en.pdf](http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf)

<sup>8</sup> [http://ec.europa.eu/public\\_opinion/archives/ebs/ebs\\_225\\_report\\_en.pdf](http://ec.europa.eu/public_opinion/archives/ebs/ebs_225_report_en.pdf)

that were developed by Geert Hofstede. While these latter data are not fully accessible, country indicators for a number of cultural dimensions are available.

We also looked at whether these surveys include items related to science and technology and we found that they do, but only to a very limited extent. From all three surveys, the ESS includes the least questions on science and technology (one item), whereas the EVS has the most questions, which mainly focus on the environment and nature, followed by the WVS which covers three questions on science and technology. These survey data –when used on the aggregate level- have the potential to classify nations both in relation to values and science and technology, which can then be compared and contrasted with data that come from surveys covering only science and technology. Such comparisons could also help unveil potential benefits or disadvantages of different measurement and analytical approaches.

When it comes to surveys on public perceptions of science and technology, it is primarily the Eurobarometer surveys that provide an excellent European data base. As there are many such Eurobarometer surveys on a wide variety of topics, we decided to focus on a small selection of Eurobarometers that focus on the project's topics of interest. We selected the 'Science and technology' Eurobarometer and the 'Europeans and Biotechnology' Eurobarometer because both provide up to date data (they were fielded in early 2010); they were fielded in tandem which allows for a combined analysis of the data; they address both general and more specific issues related to science and technology (such as perceptions of specific technologies); and they include items that can be used to construct value indicators.

Finally, Table 3 lists two surveys, that again were fielded in tandem, that both focus on values *and* science and technologies. It is the 2005 Special Eurobarometers on 'Europeans, Science and Technology' and 'Social Values, Science & Technology'. Although these surveys were fielded five years ago, we will include them in our selection as they satisfy all three of our selection criteria and hence allow for both individual level and aggregate level analyses.

In summary, our review of surveys in the domain of values, and science and technology respectively, represents an important preparatory step for the next phase of the Value Isobars project. It shows that, although data are available, there are not many surveys that address the issues of interest in combination. The concepts used cover, in accordance with our literature review, several different approaches. Again, a somewhat fragmented picture emerges.

In the next phase of the project, we will review the data quality of the surveys in more detail. Furthermore, we will pick up some research questions that will be investigated on the basis of the available data. This in turn will allow for further insights on standards for value measurement.

## Conclusion and Outlook

In this report we set out to explore the questions: What value concepts inform empirical studies in the science and technology domain? What are the strengths and weaknesses of the respective approaches? What is being published on the relationship between values and public perceptions of science and technology? And what data are available for analyses of the relationship between values and public perceptions of science and technology?

We reviewed the most influential value conceptualisation and distinguished eight types of approaching values and their measurement. The heterogeneity and fragmentation of the field were mirrored in the empirical articles published in journals that are indexed in the ISI Web of science data bases. Our analysis also suggests that the classic psychometric paradigm (values as attitudes held by individuals) seems to be given priority over the anthropological view when studying values. Hofstede and Schwartz seem to dominate research on values, at least what concerns published contributions. Given that a large proportion of empirical publications were found to concentrate on issues around management, it is not surprising that we find many references to Hofstede's work, which originally stems from an organisational approach. Empirical research on values in the context of science and technology seems to be preoccupied with issues on religion, science education and management, while the relationship between public perceptions of technologies and values are rarely addressed. What concerns the data bases available for addressing this lacuna, we have identified a number of surveys that provide data for different European countries, and that address the topics of values and/or public perceptions of technologies. All these surveys provide specific opportunities for research but also specific methodological challenges.

Exactly these later challenges will be further explored in the next phase of the Value Isobars project. More precisely, the following issues will be addressed:

*Individual level analyses:* if a survey provides information both on values and on technology perception, the analysis can aim at identifying patterns of individual technology perception in relation to values held (what are relevant values and value tradeoffs predict technology evaluation?)

*Country level analyses:* if surveys do not provide information on both values and technology evaluation, these surveys – providing information on one of the two aspects – nevertheless may provide useful information. For example, some surveys classify nations on the basis of values; these aggregate data can be used as value indicators in analyses relating this information to indicators stemming from other surveys (e.g. surveys focusing on technology perception). On an aggregate level, what values and value conflicts are relevant to better understand technology evaluation in different countries? Can countries, on the basis of such indicators, be classified into value regions?

*Measurement issues:* different formats (e.g. rating importance versus forced choice options) will be analysed in terms of their strengths and weaknesses. Furthermore, what is the role of non quantitative methodologies in values research in general and in the context of science and technology? To what extent are these methodologies important in empirical research (i.e. in the 200 studies we found) and how do they relate to different conceptualisations of values?

*Typology issues:* are there specific types of values that surveys attempt to measure? How do existing theoretical typologies influence the data analyses (e.g. Rokeach's, Schwartz's, Hofstede's typologies). How universal are these typologies and what does this mean in relation to perceptions of science and technology?

What is aimed at in this project is a critical analysis of the relationship between values and technology evaluation. As such, the research goal is to identify what can be learned from general value research and to provide an adapted version for the context of technology perception. Consequently, the outcome will be mainly useful to future research in the domain of technology evaluation that wants to systematically address the concept of values.

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