# Precaution in public: the social perception of the role of science and values in policy making

Luján, José Luis; Todt, Oliver

Public Understand. Sci. **16** (2007) 97–109

# Precaution in public: the social perception of the role of science and values in policy making

**José Luis Luján and Oliver Todt**

This article presents the results of a study of public perception recently completed in Spain which questioned citizens about their views on the precautionary principle, the role of science in policy making, as well as their level of trust in science. The results show that Spanish citizens, by a significant margin, consider that scientists may be influenced by economic interests, that values play a key role in policy making, and that policy should be guided by precaution. Two groups were identified, one with a moderate and the other one with a more stringent interpretation of precaution. The results indicate that public policies that do not sufficiently take into account precaution and exclude values from decision making are likely to encounter resistance among many citizens.

## 1. Introduction: science and public policy

The relationship between science and policy, in the form of policy for science (policies for promoting science and technology) as well as science for policy (scientific knowledge as basis for regulation and decision making), has been the object of extensive analysis in the field of interdisciplinary science and technology studies (Elzinga and Jamison, 1995; Sarewitz, 1996). But in recent years, this relationship has also become a topic of public debate and social conflict. Most of the controversy has centered on the role of scientific knowledge in regulatory decision making (Raffensperger and Tickner, 1999; Tesh, 2000; Jasanoff, 1990). Public concerns for the human health, social and environmental effects of modern technology are giving rise to a reformulation of the relationship between risk analysis and decision making. Policymakers are beginning to understand that risk analysis cannot be separated from reflections on governance, ultimately leading to the incorporation of social concerns into risk management, especially because of the uncertainties and value commitments involved (De Marchi and Funtowicz, 2004). The importance of this has already been recognized at the policy level (National Research Council, 1996; OECD, 2001).

Public concerns about undesired effects of scientific-technological development are particularly pronounced in the European Union (EU). This is one of the reasons why the EU executive branch, the European Commission, has been especially active in this area, trying to start a dialogue with society on issues related to science and technology. One of the first results is the *Science and Society Action Plan* (European Commission, 2001a), which aims at increasing understanding of science among Europeans, as well as more clearly regulating the use of expert knowledge in science and technology policy making. The stated goal is to guarantee public scrutiny, transparency and opening up of decision making to a wide range

 ISSN 0963-6625 DOI: 10.1177/0963662506062467

of social actors, as laid down in the Commission's own guidelines on the use of expert knowledge (European Commission, 2002).

The European White Paper on governance (European Commission, 2001b) raises the issue of "democratizing expertise," by making it respond more directly to social demands and preoccupations. The Commission, in fact, expresses the need for more citizen participation in policy making in order to increase public trust. In fact, the citizens' trust in decision-making processes is now regarded as one of the fundamental pillars of technology development (Slovic, 1997; Todt, 2003). The most recent EU regulatory law-making is already taking account of this. The completely revamped European food safety system, for instance, now based on a new EU food law (European Parliament and Council, 2002), includes systematic actor involvement in decision making, transparency in operation and wide-reaching public access to information, with the explicit goal of regaining citizens' trust in the food system (see the EC *White Paper on Food Safety*, European Commission, 1999).

Despite those policy changes and the importance given to the analysis of the relationship between science and public policy, this topic has been given relatively little explicit attention in studies of public perception. So far, few surveys have posed questions directly related to policy making or precaution. One of the most recent perception studies to include questions on the relationship between science and policy was a 1999 Norwegian survey (Kallerund and Ramberg, 2002). It included two questions related to public trust in science, two on the precautionary principle, as well as two on the role of scientific knowledge in the elaboration of laws and regulations related to science and technology.

## 2. The Spanish study of public perception of science

This article presents the results of a recent study of public perception conducted by the Spanish Foundation for Science and Technology (FECYT) which included a number of questions directly related to science and technology policy making (FECYT, 2005). About 3,000 individuals were surveyed through personal interviews, in September and October of 2004. The questions related to policy making were selected in order to parallel the ones from the Norwegian survey already mentioned. But while in the case of the latter, the interviewed individuals had to choose between two options (one of two respective alternative statements), the Spanish study was designed to measure the level of agreement independently for each statement (see Tables 1 to 4). This is the first time that a perception study in Spain has included questions specifically addressing the topic of policy making.

In the following we will analyze the data on public trust in science, the role of science in policy, as well as the issue of public participation.

### *Trust in science*

The pair of questions related to the topic of trust in science (see Table 1) expresses two ideas: (a) scientists can be influenced in their work by economic interests, and (b) scientists are able to counter this influence. Slightly more than half of the individuals questioned (53 percent) consider that the scientists' research can be influenced by those who finance their work (with about 17 percent denying this possibility). In contrast, the answers to the alternative question are more equally distributed: one third considers that scientists defend themselves against being influenced, while one quarter believes they are unable to counter this influence. The percentages of both the neutral ("neither agreement nor disagreement") and the "don't know" answers are higher in this second question than in the case of the first

**Table 1.** Trust in science

| | Complete or partial disagreement | Neither agreement nor disagreement | Complete or partial agreement | Don't know |
|---|---|---|---|---|
| Those who pay for research can exert influence on the scientists so that these come to the conclusions those desire | 17.2 | 13.9 | 53.0 | 15.9 |
| The scientists and experts do not allow those who finance their work to influence the results of their research | 25.5 | 21.9 | 33.0 | 19.6 |

*Source*: our elaboration (data: FECYT). All data in percent.

question (Table 1). In other words, there is a relatively clear perception among the interviewed individuals about this issue: not only does a majority suppose that scientists are likely to be influenced by those who pay for their work but at the same time citizens are rather split about the scientists' capacity to effectively counter such influence.

Relatively more citizens with a high degree of formal education agree with the statement about scientists being influenced by economic interests (58 percent of those with a high school or second level university diploma, and even 65 percent of those with a first level university diploma, compared to the average of 53 percent). However, the level of agreement drops to only 35 percent among those with less than primary education. Among those with a medium–high or high socioeconomic status, the agreement with the statement (58 percent) is also above average. In turn, among those with a medium–low or low socioeconomic status the agreement (46 percent) drops to below average. Other groups that show slightly higher than average agreement are the non-religious and those who situate themselves politically on the left. It is important to point out that the relatively higher level of agreement among university graduates and those with a higher socioeconomic status is related to the relatively low percentage of "don't know" answers among these groups. In contrast, we find the highest percentage of "don't know" answers among those with a low or medium-to-low socio-economic status, as well as among the most religious (practicing Catholics).

This majority opinion about the possibility of scientists and experts being influenced by economic interests contrasts with the consistently high levels of trust in science among the Spanish population (Luján and Todt, 2000). The answers to the question about the role of experts in policy making (see the following section on public participation) confirm this general trust in science. In fact, these results are consistent with the level of trust which the Spanish population places in different professions or types of organizations: the data from the FECYT study confirm previous data (European Commission, 2001c) that indicate Spaniards (and other Europeans) show higher levels of trust in scientists and medical doctors than in private companies or politicians, with organizations from civil society occupying intermediate positions (Table 2).

The data from Tables 1 and 2 indicate that Spaniards, while generally placing trust in scientists, understand the complexity of the context in which scientists do their work and presuppose that economic interests can exert influence on scientific activity. The citizens' perception of scientific institutions and work is not naive, they are conscious of the pressures or conflicts of interests which such work may imply.

**Table 2.** Levels of citizens' trust in different professions or organizations

| For each of the following professions or organizations, would you place trust in them when it comes to issues related to science and technology? | Percentage of "yes" answers |
|---|---|
| Medical doctors | 87.0 |
| Scientists | 84.7 |
| University professors | 80.5 |
| Engineers and architects | 74.3 |
| Environmentalist organizations | 64.1 |
| Consumer organizations | 57.3 |
| Journalists | 49.4 |
| Private companies | 42.9 |
| Religious organizations | 32.8 |
| Political organizations | 25.7 |

*Source*: our elaboration (data: FECYT). All data in percent.

### *Public participation*

The survey included a pair of questions related to the role of experts and non-experts in policy making. Their formulation was rather general, as they did not ask directly for a judgment on citizen participation in decision making (Table 3).

On the one hand, we find 70 percent of the population agreeing with the statement that "decisions on science and technology are best left with the experts" (only a small percentage, 7 percent, rejects this statement). On the other hand, 40 percent show agreement with the alternative statement ("the citizens should assume a more important role in decisions on science and technology"). Even so, almost a quarter (24 percent) rejects this idea. Another notable fact is that the neutral (21 percent) and "don't know" (14 percent) answers are significantly higher when asking for an increased role for the public, while they are lower (13 percent and 9 percent, respectively) when asking about leaving decisions with the experts. In other words: a significant minority of individuals (40 percent) approve of giving the public a larger role, while a large majority (70 percent) would entrust decisions to the experts. And while there is little disagreement or doubt about the experts' role, relatively more people are unsure about (or directly against) increased citizen participation.

Slightly more advocates of increased citizen participation can be found on the political

**Table 3.** Public participation in science and technology decision making

| | Complete or partial disagreement | Neither agreement nor disagreement | Complete or partial agreement | Don't know |
|---|---|---|---|---|
| Decisions on science and technology are best left with the experts | 7.1 | 13.3 | 70.1 | 9.4 |
| The citizens should assume a more important role in decisions on science and technology | 23.9 | 21.4 | 40.4 | 14.3 |

*Source*: our elaboration (data: FECYT). All data in percent.

left (about 5 percent above average). On the political right, we find about 10 percent less than average (on the extreme political right, however, we find more than average). The results do not vary according to level of education, except for the high percentage of "don't know" answers in the section of the population without a formal education. Among the non-religious, we find more in favor of participation (45 percent) than among practicing Catholics (35 percent).

The results with respect to participation bear a direct relation to the results about trust in scientists (Table 1). Given that in Table 3 the issue is decision making in relation to science and technology (and not its socioeconomic or environmental context), and scientists are generally trusted on such issues (while private enterprise, and even less so politicians, tend not to be trusted, as Table 2 shows), the responses to the first statement represented in Table 3 are not surprising. However, when directly asking for the *citizens'* role in decision making (second statement in Table 3), the individuals' opinion is somewhat different, though it does not necessarily contradict the previous result: a significant percentage of citizens (40 percent) demand their views to be considered. In the light of the already cited data, this has to be interpreted as a confirmation of *distrust in economic and political actors*, and not so much of distrust in actors from the scientific community.

### *Science and values in policy making*

The questions in this section were designed to measure the agreement with either a technocratic point of view on policy making, or a view critical of technocracy (Table 4). The technocratic approach is based on the idea that all social problems have an (optimal) technical solution (usually expressed as *the* one best way of doing something) and can be solved in an ideologically neutral fashion. The position criticizing technocracy emphasizes the value component of all policy, ultimately implying the need for citizen participation in decision making.

The questionnaire asked for agreement with two alternative statements: one affirming that scientific knowledge generally constitutes the best basis for drawing up laws and regulations, be they of scientific or non-scientific content (a position close to the technocratic view, even though it does not state that scientific knowledge is the *only* basis for policy), the other one expressing the idea that values and attitudes are at least as important as knowledge (a position close to a critique of technocracy). The results show that about half of the population (52 percent) considers values and attitudes to be at least as important for law making as scientific knowledge. For slightly more than a third (36 percent), scientific knowledge is the best basis for policy (though not necessarily the only

**Table 4.** Science and values in policy making

| | Complete or partial disagreement | Neither agreement nor disagreement | Complete or partial agreement | Don't know |
|---|---|---|---|---|
| Scientific knowledge is the best basis for drawing up laws and regulations | 22.0 | 20.6 | 35.8 | 21.6 |
| In drawing up of laws and regulations, values and attitudes are as important as scientific knowledge | 9.4 | 17.8 | 52.1 | 20.7 |

*Source*: our elaboration (data: FECYT). All data in percent.

one). However, almost one quarter (22 percent) rejects this point of view. In contrast, the alternative statement (that values are as important as knowledge in policy making) is rejected by fewer than 10 percent. In other words, not only does the anti-technocratic point of view dominate by a clear margin, it also encounters little rejection (whereas the technocratic point of view is clearly rejected by almost one quarter of the population). However, in the case of both alternative statements, the percentage of neutral and "don't know" answers is relatively high (between 18 percent and 22 percent each in both questions), if compared to the rest of the questions.

The position on the importance of values in policy making tends to be correlated with political ideology. Among those who situate themselves on the political left we find 8 percent more than on average who agree with the anti-technocratic view, while among those on the right, we find 8 percent less. With respect to religious sentiment, among the "non-religious" individuals, 59 percent agree with the importance of values, while among the practicing Catholics, this percentage is below average (46 percent).

## 3. The precautionary principle

Despite a lack of consensus about its definition and interpretation, the precautionary principle has been adopted over the past few years in several international treaties and pieces of legislation (Raffensperger and Tickner, 1999). The majority of its wordings present this principle as a demand for protective action with respect to the environment and human health, even if there is no conclusive scientific evidence on the relationship between causes and effects. In other words, the existence of doubts about possible harm is no excuse for not regulating.

The precautionary principle has been the object of numerous analyses in recent times. But there is relatively little information about its public acceptance. The already mentioned Norwegian perception study found that more than two-thirds (70 percent) of individuals showed (full or partial) agreement with a statement favoring precaution. Only 8 percent agreed with not applying precaution unless clear scientific proof of harm existed. In the Spanish study, the respective percentages are 73 percent and 41 percent. It is important to note that in the Norwegian study the interviewed individuals had to choose between the two alternative statements while in the Spanish one they were asked to declare their level of agreement with each of the statements, without obliging them to choose.[1]

### *The perception of the precautionary principle in Spain*

In spite of the higher percentage in Spain against restricting technologies whose potential for harm has not been proven (41 percent, compared to 8 percent in the Norwegian study), there is a clear tendency of favoring precaution (see Table 5). And this is even more so if we consider the percentages of disagreement with each of the two statements: only 6 percent of individuals are in *dis*agreement with the "precautionary" statement, while the alternative statement is (completely or partially) rejected by one quarter of individuals. Those figures are even more significant given the relatively low percentages of "don't know" answers (11 percent and 16 percent, respectively). The neutral and "don't know" answers are somewhat less (10–11 percent) in the case of the "precautionary" statement than in the case of its alternative (16–17 percent). These data indicate that even in a culture that tends to show one of the highest levels of trust in science in all of Europe (European Commission, 2001c), and even if individuals do not have to choose between the statement favoring precaution and its alternative, citizens clearly are inclined towards precaution.

**Table 5.** The precautionary principle

| | Complete or partial disagreement | Neither agreement nor disagreement | Complete or partial agreement | Don't know |
|---|---|---|---|---|
| If it has not been proven scientifically that new technologies can cause severe harm to humans or the environment, it is erroneous to impose restrictions on these technologies | 25.4 | 17.5 | 41.5 | 15.6 |
| While the consequences of a new technology are not well known, action should be guided by caution and the technology's use should be controlled in order to protect health and the environment | 5.9 | 10.2 | 73.1 | 10.8 |

*Source*: our elaboration (data: FECYT). All data in percent.

According to Table 6 (which was drawn up by crossing the results from the two statements presented in Table 5), 33 percent of individuals show agreement with *both* statements. In fact, this percentage is higher than the percentage (23 percent) of those who agree with the "precautionary" statement but disagree with its alternative. If we exclude the possibility of individuals not understanding well the questions nor having a clear position (which we can exclude because of the few "don't know" answers), we find that these results may reflect the ongoing policy debate on the precautionary principle's interpretation, just on the level of the individual citizens.

As we have seen, the different interpretations of the precautionary principle are related to different interpretations of (a) the uncertainty with respect to possible negative consequences of applying a technology, and (b) the supposed severity of such consequences. These doubts arise in situations in which there is a (perceived) lack of scientific knowledge about a technology's consequences, which gives rise to the question of which are the elements of a legitimate judgment about possible harm.

From the predominant wordings of the precautionary principle in the literature and in policy making we can deduce three different interpretations:

**Table 6.** The precautionary principle: comparison of the two alternative statements

| *If it has not been proven scientifically that new technologies can cause severe harm to humans or the environment, it is erroneous to impose restrictions on these technologies.* | *While the consequences of a new technology are not well known, action should be guided by caution and the technology's use should be controlled in order to protect health and the environment* | | | | |
|---|---|---|---|---|---|
| | Complete or partial disagreement | Neither agreement nor dis-agreement | Complete or partial agreement | Don't know | Total |
| Complete or partial disagreement | 1.2 | 1.4 | 22.7 | 0.2 | 25.4 |
| Neither agreement nor disagreement | 1.4 | 4.1 | 11.4 | 0.6 | 17.5 |
| Complete or partial agreement | 3.2 | 4.0 | 33.4 | 0.9 | 41.5 |
| Don't know | 0.1 | 0.7 | 5.6 | 9.1 | 15.6 |
| Total | 5.9 | 10.2 | 73.1 | 10.8 | 100.0 |

*Source*: our elaboration (data: FECYT). All data in percent.

1. A *moderate* one, defended mostly by scientists and public administration officials, which considers that any judgment about possible harm has to be based on existing scientific knowledge. This is the definition put forward by the European Commission which states that there must be indications of possibly dangerous or unacceptable levels of harm (European Commission, 2000). In other words, the Commission demands a risk assessment previous to any application of the precautionary principle in policy making. The existing knowledge, despite it being insufficient, has to serve for identifying possible harmful effects. Invoking precaution is only legitimate if there is a *scientific basis* for suspecting negative consequences.
2. A *stringent* one, put forward by many environmentalist movements, as well as scientists close to them, which is based on the idea that risk assessment and precaution are two alternative approaches to policy making, whose main difference lies in how to apply scientific evidence to decision making. This position defends the precautionary principle as a principle for *selecting technologies* (risk assessment as a criterion for selecting). A technology's "inherent possibility for harm" is sufficient basis for action (in terms of reducing, preventing or avoiding the possible negative effects) (Santillo et al., 1999).
3. An *intermediate* position which accepts the need for scientific analysis, without restricting it to risk assessment procedures, but also points to the general existence of uncertainties or even ignorance which limit the use of science in decision making (Stirling, 1999). Von Schomberg (1996) speaks of the criterion of "acceptable uncertainty" which may substitute in such instances for "acceptable risk."

On the basis of these different interpretations of the precautionary principle we can interpret the data from Table 6 in the following way: the 33 percent of the population who agree at the same time with the "precautionary" statement as well as the statement that no restrictions should be imposed on technology unless there is evidence of harm tend to be in agreement with the *moderate* interpretation of the precautionary principle. The 23 percent who agree with precaution and reject the alternative statement can be considered to agree with the *stringent* interpretation of the principle. This section of the population would accept the use of elements of judgment different from risk assessment.

*Precaution and policy making*

Tables 7 and 8 show the attitudes of those who are in favor of the precautionary statement towards each of the two statements about policy making (respective importance of science and values for decision making), split into the two subgroups we identified from Table 6 (the "moderate" and the "stringent" supporters of precaution). As we can observe from Table 7, the two groups of supporters of precaution differ slightly about the importance of science for policy (in fact, within the "moderate" group more individuals tend to agree with the preeminent role of science in law making). However, when it comes to the importance of values and attitudes, both groups show the same levels of agreement and disagreement (Table 8). This means that, independent of their specific interpretation of the precautionary principle, its supporters consider values and attitudes as important as science in policy making.

As we saw in Table 4, more than half of the Spanish population agrees with the statement that values and attitudes are equally important as science in policy making, while fewer than 10 percent disagree. And, according to Table 9 (which represents the crossing of the data from the two respective questions about the role of values and precaution), 45 percent of all citizens agree with both precaution and the importance of values. Almost all those who agree with the "precautionary" statement also agree with the relevance of values

**Table 7.** Attitude of the different supporters of precaution with respect to science for policy making

| *Scientific knowledge is the best basis for drawing up laws and regulations* | "Moderate" supporters of precaution | "Stringent" supporters of precaution | Total of sample |
|---|---|---|---|
| Complete or partial disagreement | 21.6 | 31.1 | 22.0 |
| Neither agreement nor disagreement | 17.5 | 22.7 | 20.6 |
| Complete or partial agreement | 46.7 | 35.8 | 35.8 |
| Don't know | 14.2 | 10.5 | 21.6 |
| Total | 100.0 | 100.0 | 100.0 |

*Source*: our elaboration (data: FECYT). All data in percent.

in policy making (or at least do not disagree). Only 6 percent of the Spanish population supports precaution but at the same time rejects the role of values. In other words, for a large majority of citizens, values and attitudes—alongside science—are a factor of transversal importance in policy making.

### *The social uniformity of the perception of precaution*

The sociodemographic variables do not significantly influence the support for or rejection of the precautionary principle among the Spanish population. Political ideology does not exert

**Table 8.** Attitude of the different supporters of precaution with respect to values in policy making

| *In drawing up of laws and regulations, values and attitudes are as important as scientific knowledge* | "Moderate" supporters of precaution | "Stringent" supporters of precaution | Total of sample |
|---|---|---|---|
| Complete or partial disagreement | 6.9 | 9.7 | 9.4 |
| Neither agreement nor disagreement | 14.6 | 17.1 | 17.8 |
| Complete or partial agreement | 66.0 | 64.2 | 52.1 |
| Don't know | 12.5 | 8.9 | 20.7 |
| Total | 100.0 | 100.0 | 100.0 |

*Source*: our elaboration (data: FECYT). All data in percent.

**Table 9.** The precautionary principle and public values

| | *While the consequences of a new technology are not well known, action should be guided by caution and the technology's use should be controlled in order to protect health and the environment* | | | | |
|---|---|---|---|---|---|
| *In drawing up of laws and regulations, values and attitudes are as important as scientific knowledge* | Complete or partial disagreement | Neither agreement nor disagreement | Complete or partial agreement | Don't know | Total |
| Complete or partial disagreement | 1.7 | 1.4 | 6.1 | 0.2 | 9.4 |
| Neither agreement nor disagreement | 1.5 | 3.5 | 12.1 | 0.6 | 17.8 |
| Complete or partial agreement | 2.3 | 4.0 | 44.9 | 0.9 | 52.1 |
| Don't know | 0.4 | 1.3 | 9.9 | 9.1 | 20.7 |
| Total | 5.9 | 10.2 | 73.1 | 10.8 | 100.0 |

*Source*: our elaboration (data: FECYT). All data in percent.

**Table 10.** Agreement with precaution according to level of education.

| *While the consequences of a new technology are not well known, action should be guided by caution and the technology's use should be controlled in order to protect health and the environment* | Less than primary or no education | Pre-high-school diploma | High-school diploma | 1st-level university diploma | 2nd-level university diploma | Total of sample |
|---|---|---|---|---|---|---|
| Complete or partial disagreement | 4.2 | 6.5 | 6.4 | 5.3 | 4.4 | 5.9 |
| Neither agreement nor disagreement | 8.1 | 10.8 | 11.8 | 7.3 | 7.7 | 10.2 |
| Complete or partial agreement | 54.4 | 70.4 | 78.4 | 85.4 | 84.7 | 73.1 |
| Don't know | 33.3 | 12.3 | 3.4 | 2.0 | 3.3 | 10.8 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

*Source*: our elaboration (data: FECYT). All data in percent.

a notable influence, except among those self-positioned on the extreme left (only 7 percent of the total of individuals): 89 percent of this group supports the precautionary statement, 16 percent above the average support (again, this is mainly due to the lower than average percentage of "don't know" answers).

Religious sentiment shows some influence. While among non-believers (14 percent of the population) and non-practicing Catholics (51 percent of the population) the support for precaution is somewhat higher than average (79 percent and 75 percent, respectively, as compared to the average of 73 percent), it is among practicing Catholics (29 percent of the population) where we find less support (65 percent, 8 percent below average).

The only sociodemographic variable that shows an important difference with relation to precaution is educational background. Table 10 shows that among those with a university degree (first and second level university diploma, roughly equivalent to graduate and postgraduate), agreement with the precautionary principle is above average, while among those with less than primary or no education it is below average. However, this is mainly due to the fact that among the latter group, the "don't know" answers are significantly higher than for the rest of the population. If we were to eliminate the "don't know" answers, there would be no significant differences across the population. Even so, we can observe a tendency of the "don't know" answers diminishing and agreement with the precautionary principle increasing with increasing education level.

## 4. Conclusions

The perception study shows that—basically independent of sociodemographical variables—an important part of the Spanish population

1. supports the precautionary principle in the sense that if the consequences of a new technology are not well known, action has to be guided by caution,
2. considers that values and attitudes are as important as scientific knowledge in policy making,
3. considers that scientists can be influenced in their work by economic interests, and
4. agrees to leaving decision making on science and technology with the experts.

The first two points can be summed up in that Spaniards clearly prefer policy to err on the side of precaution. Despite the generally high support for science, the acceptance of science by 40 percent of the population as the best basis for policy, as well as a clear majority for

leaving decision making in the hands of experts, the Spanish population shows similar views about precaution as the Norwegian one: almost three-quarters of Spaniards support the "precautionary" statement, while only 6 percent reject it.

This position on precaution can be considered to be well established among Spanish citizens. Neither while conducting this survey nor in the preceding months was there any important crisis, industrial accident or any similar event which might have strongly influenced public perception at the moment the study was completed. Nor were there any wide-ranging public debates in Spain, especially in the media, related to science and technology (as there had been at the end of the 1990s, for instance, on the issue of genetically modified foods). Considering precaution a well established value and wide-ranging social demand in Spain is backed by the fact that in the present study people did not even have to chose among statements favoring or rejecting precaution (like in the Norwegian study).

Among those who agree with the precautionary principle (almost three-quarters of the Spanish population), somewhat less than half (one third of the total population) would defend a moderate interpretation, in the sense that in order to impose restrictions on new technologies some scientific evidence of their potential for causing harm would be necessary. A third of those who support precaution (about one quarter of the total population) would agree with a more stringent (radical) definition, given that they consider that scientific evidence of harm is not needed for initiating precautionary measures.

From the literature, three different interpretations of the precautionary principle could be extracted. However, the way the present study was designed, it can only offer results with respect to the dichotomy between the moderate and stringent interpretations, which are the ones most relevant in public debate and political discourse. In addition, the difference between these two groups, especially when it comes to their assessing the role of values and science for policy, is relatively small. The intermediate interpretation is mostly present in academic and policy-making analysis (and approaches). In order to obtain a better characterization of the public perception of the precautionary principle, more detailed studies, among them qualitative ones, would have to be conducted.

The results from this study have consequences for policy making. On the one hand, they show that positions like the one defended by the European Commission can find substantial support among the Spanish population. However, the percentage of those who agree with the more stringent interpretation is sufficiently large (23 percent of citizens) as to make impossible a wide-reaching consensus based solely on the European Commission's position. Another point to take into account is that while only 6 percent reject precaution, more than one quarter of the population rejects the position contrary to precaution. Further, most of the citizens in favor of precaution also consider that in decision making values are as important as scientific knowledge, independently of their concrete interpretation (moderate or stringent) of the precautionary principle.

Citizens in Spain generally hold a positive view of science and its role in policy making (which contrasts with relatively lower levels of trust when it comes to private companies or politicians). But more than half consider that scientific expert knowledge cannot be the exclusive base for policy making (only slightly more than one third do), and must be complemented by values and attitudes.

In other words, any policy approach to science and technology which does not take account of precaution (at least in the sense of the moderate interpretation) is likely to fail. Furthermore, a policy process based exclusively on scientific knowledge and experts will tend to encounter resistance: other, different criteria and sources of information have to

become integral parts of any such decision-making process in order to generate widespread social acceptance.

And even then, a part of the population may reject such moderately precautionary policy. In fact, the social conflict in relation to agricultural biotechnology in Spain in recent years (Todt and Luján, 2000; Todt, 2004) proves this: the ambivalences with regard to precaution shown by the regulators over a time span of almost 15 years go a long way to explaining public resistance to the technology. For future technology development and regulation, policy has to respond clearly and unambiguously to social demands for precaution.

The recent changes in European policy (see Introduction) can be interpreted as a direct response to public perception regarding precaution and policy making. In fact, the results presented here show that those policy innovations have already been socially integrated by the citizens because they are in accord with their demands and values. Up to a point, these policy changes could even be considered too little to satisfy that quarter of the Spanish population that tends to agree with the stringent point of view on precaution. Current and future European policy initiatives will have to respond to such public demands in order to find acceptance and create trust.

## Acknowledgements

The work presented in this paper was carried out as part of the projects *Ciencia reguladora y riesgos tecnológicos* (Ref. BFF2001-0377) of the Spanish Ministry for Science and Technology, *La función de los valores en la ciencia reguladora* (Ref. HUM2005-07168) of the Spanish Ministry of Science and Education, and *La gobernanza de la ciencia y la tecnología en España* of the Spanish Foundation for Science and Technology (FECYT). The authors are grateful to the FECYT for the data from the survey and would like to express their gratitude to Ana Arriba, Santiago Lorente and Carolina Moreno for their helpful comments.

## Note

1 It has to be taken into account that the questions in the Spanish and Norwegian questionnaires were originally formulated in the respective languages of the two countries. In the Spanish questionnaire, the questions were formulated to parallel the Norwegian ones. However, the differences in language made necessary certain adaptations, which are also reflected in the questions' translation into English, as presented in this paper.

## References

De Marchi, B. and Funtowicz, S. (2004) "La gobernabilidad del riesgo en la Unión Europea," in J.L. Luján and J. Echeverría (eds) *Gobernar los riesgos*, pp. 153–65. Madrid: Biblioteca Nueva.

Elzinga, A. and Jamison, A. (1995) "Changing Policy Agendas in Science and Technology," in S. Jasanoff, G.E. Markle, J.C. Petersen and T. Pinch (eds) *Handbook of Science and Technology Studies*, pp. 572–97. London: SAGE.

European Commission (1999) *White Paper on Food Safety, COM (1999) 719 final*. Brussels: European Commission.

European Commission (2000) *Communication from the Commission on the Precautionary Principle, COM 1 (2000).* Brussels: European Commission.

European Commission (2001a) *Science and Society Action Plan, COM 714 final (4/12/2001).* Brussels: European Commission.

European Commission (2001b) *European Governance: a White Paper, COM 428 (25/07/2001)*. Brussels: European Commission.

European Commission (2001c) *Eurobarometer 55.2: Europeans, Science and Technology.* Luxembourg: European Commission.

European Commission (2002) *On the Collection and Use of Expertise by the Commission: Principles and Guidelines, COM 713 final (11/12/2002).* Brussels: European Commission.

European Parliament and Council (2002) "Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28/1/2002, Laying Down the General Principles and Requirements of Food Law, Establishing the European Food Safety Authority and Laying Down Procedures in Matters of Food Safety," *Official Journal of the European Communities* 45: 1–24.

FECYT (2005) *Percepción social de la ciencia y la tecnología en España—2005*. Madrid: FECYT.

Jasanoff, J. (1990) *The Fifth Branch*. Cambridge, MA: Harvard University Press.

Kallerund, E. and Ramberg, I. (2002) "The Order of Discourse in Surveys of Public Understanding of Science," *Public Understanding of Science* 11: 213–24.

Luján, J.L. and Todt, O. (2000) "Perceptions, Attitudes and Ethical Valuations: the Ambivalences of the Public Image of Biotechnology in Spain," *Public Understanding of Science* 9: 383–92.

National Research Council (1996) *Understanding Risk: Informing Decisions in a Democratic Society*. Washington, DC: National Academy of Sciences.

OECD (2001) *Social Sciences and Innovation, Information Society*. Paris: OECD.

Raffensperger, C. and Tickner, J., eds (1999) *Protecting Public Health and the Environment: Implementing the Precautionary Principle*. Washington, DC: Island Press.

Santillo, D., Johnston, P. and Stringer, R. (1999) "The Precautionary Principle in Practice: a Mandate for Anticipatory Preventive Action," in C. Raffensperger and J. Tickner (eds) *Protecting Public Health and the Environment: Implementing the Precautionary Principle*, pp. 36–50. Washington, DC: Island Press.

Sarewitz, D. (1996) *Frontiers of Illusion: Science, Technology and the Politics of Progress*. Philadelphia, PA: Temple University Press.

Slovic, P. (1997) "Risk Perception and Trust," in V. Molak (ed.) *Fundamentals of Risk Analysis and Risk Management*, pp. 233–45. Boca Raton, FL: CRC Lewis Publishers.

Stirling, A. (1999) *On Science and Precaution in the Management of Technological Risk: Vol. 1*. Brussels: EC Joint Research Center.

Tesh, S.N. (2000) *Uncertain Hazards: Environmental Activists and Scientific Proof*. Ithaca, NY: Cornell University Press.

Todt, O. (2003) "Designing Trust," *Futures* 35: 239–51.

Todt, O. (2004) "Regulating Agricultural Biotechnology under Uncertainty," *Safety Science* 42: 143–58.

Todt, O. and Luján, J.L. (2000) "Spain: Commercialization Drives Public Debate and Precaution," *Journal of Risk Research* 3(3): 237–45.

Von Schomberg, R. (1996) "The Laborious Transition to a Discursive Policy Process on the Release of Genetically Modified Organisms," in A. van Dommelen (ed.) *Coping with Deliberate Release*, pp. 147–56. Tilburg: ICHPA (International Centre for Human and Public Affairs).

## Authors

José Luis Luján is Professor for Philosophy of Science at the Department of Philosophy, University of the Balearic Islands. His research interests include public perception of science and the philosophical analysis of risk assessment and regulation. **Correspondence:** Department of Philosophy, University of the Balearic Islands, Crta. Valldemossa km 7.5, E-07071 Palma de Mallorca, Spain, e-mail: jl.lujan@uib.es

Oliver Todt is Professor for Philosophy of Science at the Department of Philosophy, University of the Balearic Islands. His research focuses on social conflict in relation to science and technology regulation, as well as multi-actor governance of technology.