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Research report

Public attitudes to GM foods. The balancing of risks and gains ☆

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ABSTRACT

In the paper we study the variables influencing attitudes to the use of two biotechnologies related to gene transfer within apples. Using Eurobarometer 73.1 survey data on biotechnology, science and technology, with 15,650 respondents, we study the extent these attitudes are determined by socio-economic and other variables. We found that attitudes to the risks and gains are determined by socio-economic variables and also by the individual's knowledge, scientific background, their parent's education in science and their religion. Perceptions of naturalness and of environmental impact combined with perceived risks and gains in determining overall approval, proxied by views on whether the technologies should be encouraged, for GMTs. However there are substantial differences in attitudes to transgenesis and cisgenesis.

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Introduction

Interest in transgenic foods has grown rapidly in recent decades. But their use has nonetheless been limited by both technical problems and a substantial scepticism among the general public. One of the public's major concerns is the artificial combination of genetic elements derived from different organisms that cannot be crossed by natural means (Holme, Wendt, & Holm, 2013). Partially because of this scepticism, cisgenesis was developed as an alternative to transgenic crop development. Initially the main principle was that the genes or gene elements should be derived from the species itself (Jochemsen & Schouten, 2000). But this was later extended to include the gene pool of sexually compatible species. There is indeed evidence that the public view cisgenesis more favourably than transgenesis (McComas, Besley, & Steinhardt, 2014). This is part of a literature which has shown that consumers' risk perceptions of food innovations play a major role in their acceptance (Cardello, 2003).

The relative hostility to GM foods in the EU has meant that their development in Europe has been much more limited than in the USA (Ceccoli & Hixon, 2012). According to Ammann (2014) EU legislation for the approval of GM crops is one of the most restrictive in the world. Some countries, such as Switzerland (Siegrist, 2000), have actually banned aspects of GM technologies on the basis of public concern. In addition to regulatory issues, the success of GM products on the market depends upon public acceptance (Moschini, Bulut, & Cembalo, 2005). If this hostility is based on uninformed prejudice, it can be considered as blocking the development of potentially important technologies. Thus, an understanding of the determinants of perceptions of GM technologies is important.

The standard economic approach to analysing individual attitudes and actions tends to assume that people will support an action if it is in their perceived self-interest to do so, i.e. if the gains are greater than the costs, including the risks. The literature on GM foods tends to extend these costs and gains away from the individual and their family, to the wider community (Umberger, Thilmany McFadden, & Smith, 2009). Boxall and Adamowicz (2002) developed the traditional model to include psychological factors. Also from a psychological perspective, Siegrist (2000) concluded that perceived benefit and risk determined the acceptance of gene technology in Switzerland.

Three meta studies on attitudes to GM foods (Dannenberg, 2009; Frewer et al., 2013; Lusk, Jamal, Kurlander, Roucan, & Taulman, 2005) all conclude that there are substantial differences between European and American consumers, with the latter more hostile than the former. There has been some work done on contrasting attitudes to perceived risk. Grunert et al. (2000) found British consumers to be more negative to genetic modifications related to animals than to plants. Burton, Rigby, Young, and James (2001) found significant differences in consumer attitudes to cisgenesis and transgenesis, and that women were significantly more averse to both

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technologies than men. Similarly, both Baker and Burnham (2001) and Siegrist (2000) suggested that women are more risk averse than men, and more concerned with food safety. Barrena and Sanchez (2010) found that risk perceptions in food products, the health impact of foods, and individual age and income, were the main variables in explaining consumers' decisions. The importance of socio-economic variables in explaining risk and benefit perceptions to GM foods was further confirmed by Bredahl (2001) and Schläpfer (2008). Both Flynn, Slovic, and Mertz (1994) and Grimsrud et al. (2004) also found socio-economic characteristics to be important, with positive attitudes towards GM food being linked to the young.

The results on the impact of education and scientific knowledge have been mixed. Grimsrud et al. (2004) concluded that both self-reported knowledge about biotechnology and higher levels of formal general education, increased acceptance of GM food in Norway. Ceccoli and Hixon (2012) also emphasised the importance of scientific knowledge in looking at attitudes towards GM foods in 15 EU member states and Flynn et al. (1994) concluded that scientific understanding influenced individual risk perception. However, Schläpfer (2008) found no evidence linking education and positive attitudes to GM crops.

There has been considerable work done on the impact of religion on attitudes. Costa-Font and Mossialos (2006) found religiosity to be significant in determining attitudes to cisgenesis. Myskja (2006) observed that religious groups emphasise that crossing species was unnatural. He also emphasised that there have been a lot of religious pronouncements on GM foods. More generally Wilkes, Burnett, and Howell (1986) found religiosity to impact on consumer behaviour and Brossard, Scheufele, Kim, and Lewenstein (2009) argued that life styles and knowledge about technology tend to be interpreted through the 'lens of religious beliefs'. Biel and Nilsson (2005) found a significant impact of religion on attitudes to GM, but not on other environmental issues.

Several studies have analysed the impact of perceived risks and gains on overall attitudes and decisions. Mazzocchi, Lobb, Traill, and Cavicchi (2008) found that food scare risk perceptions and trust were important determinants of food purchases in several EU countries. Hu, Hunnemeyer, Veeman, Adamowicz, and Srivastava (2004) linked consumers' preferences for GM food to risk attitudes. The literature on attitudes to biotechnology in general and GM foods in particular also encompasses environmental concerns (Lockie, Lawrence, Lyons, & Grice, 2005; Moon & Balasubramanian, 2001) and concerns about 'the naturalness' of the technology (Nistor, 2012; Umberger et al., 2009). More generally, naturalness, or rather loss of naturalness, as an element of risk perception, has been central in the risk field since the 1970s (see e.g. Slovic, 1986). Building upon this, in the general context of food safety including GM foods, Fife-Schaw and Rowe (1996) noted people's frequent reliance on a "natural-is-good" heuristic. Rozin, Fischler, and Shields-Argeles (2012) suggested that naturalness may appeal to those who resent the intrusion of technology into basic traditions. Finally, Kontoleon and Yabe (2006) emphasised the importance of ethical concerns, environmental concerns, trust and education in the demand for GM derived animal foods in the UK. Trust does appear to be an important concept and Siegrist (2000) found it to impact on perceptions of risks, benefits and the overall acceptance of gene technology.

There has also been some work done on the specific attitudes of farmers to GM foods. Areal, Riesgo, and Rodriguez-Cerezo (2011) concluded that, for EU farmers, the potential financial gains were important in the decision to adopt GM herbicide-tolerant crops, as did Breustedt, Muller-Scheeßel, and Latacz-Lohmann (2008) for German arable farmers adopting GM oilseed. However, Guehlstorf (2008) in a study in the USA, concluded that farmers were influenced by environmental considerations and social impact, as well as financial gains.

In this paper we examine the determinants of attitudes to GM foods in more depth than has been done previously, focusing on the extent to which they are linked to socio-economic and demographic characteristics as well as on the impact of both the individual's religion and scientific background. The study is done within the context of two different biotechnologies related to gene transfer in apples. The production of a new apple cultivar normally takes at least 15–20 years and costs €400,000 (Fenning & Gershenzon, 2002) and even longer if a trait, such as disease resistance, is introduced from wild apple species. Thus, 50 years or more are necessary to obtain a new apple cultivar expressing a trait originally present in a wild apple (Flachowsky et al., 2011). Gene transfer technologies can significantly shorten this time. There has been relatively little work specifically relating to people's attitudes to GM apples. However, Schenk et al. (2008) studied consumer risk and benefit perception of GM applied to apple cultivars, within the context of allergies. They conclude that acceptance of GM products is primarily a function of perceived personal benefit as opposed to personal or environmental risk perceptions per se.

Thus the existing literature indicates that people appear to be weighing up the advantages and disadvantages of GM food, with these extending beyond a simple comparison of individual based risks and benefits. One question is whether concepts of perceived naturalness and environmental impact are separate from risks and benefits? We shall assume that this is the case, but also go some way to testing this assumption. Although it is often not treated as such, the process can be interpreted as a mediation model, where concepts such as risk and benefits determine overall attitudes, and the former are in turn determined by a number of socio-economic and country specific factors.

Figure 1, which adapts the figure found in Costa-Font, Gil, and Traill (2008), captures the essential features of our model. Perceived risk, benefits etc. are a function of socio-economic and other variables, and overall attitudes are determined, as in a mediation model, by these perceived impacts. There is still a role for socio-economic variables to have an independent impact on overall attitudes, e.g. through their impact on trust, which is not explicitly included in the empirical analysis. Scientific knowledge is reflected in an individual's education and their family background. We model the latter by the scientific background of the respondent's parents. Knowledge may also be linked to age, since with age individuals accumulate knowledge (Costa-Font & Mossialos, 2006), but, on the other hand, formal knowledge learned at school may become obsolete.

Not all of the variables in Fig. 1 are included in the empirical model. This is the case for the regulatory institutions in the top row and trust in the third row. They are included in Fig. 1 because they are important aspects of the process, but it is not always possible to include every theoretical variable in an empirical model as we are restricted by data availability. Thus, in the empirical analysis the actions of the countries' regulatory institutions are captured by the country dummy variables, which of course also reflect other country characteristics. Trust will also be captured by these variables and in addition, as indicated in Fig. 1, by socio-economic variables (Schoon & Cheng, 2011). Nor are the variables in the second row explicitly captured in the model. They are the implicit route by which the socio-economic, demographic, educational and religious and scientific background variables impact upon the attitudinal variables. In further research it would be valuable to model this process by explicitly including the second row variables in the empirical analysis, provided they can be satisfactorily measured, which may not always be the case.

Combining both the literature review and the model presented above, we argue that socio-economic and demographic variables impact on underlying attitudes to perceived risk, benefits, environmental impact and naturalness. These underlying