A Critical Account of the Relationship between Institutional Trust, Risk Perception, and Technology Acceptance with an Application to Genetically Modified Foods

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Abstract

This article critically reflects on the widely held view of a causal chain with trust in public authorities impacting technology acceptance via perceived risk. It first puts forward conceptual reason against this view, as the presence of risk is a precondition for trust playing a role in decision making. Second, results from consumer surveys in Italy and Germany are presented that support the associationist model as counter hypothesis. In that view, trust and risk judgments are driven by and thus simply indicators of higher order attitudes toward a certain technology which determine acceptance instead. The implications of these findings are discussed.

Key words: consumer trust, risk perception, technology acceptance, genetic modification

Introduction

The typically held view on the relationship between trust, risk perception and acceptance of new food technologies is that of a causal chain: Low levels of trust in monitoring or regulatory bodies increase perceived risk, which in turn reduces acceptance (Siegrist 1999). For Europeans, this causal chain appears more than evident, after the BSE crises in 1996 and 2000 had eroded consumer trust in the food industry in general. In response to the public perception that both government and industry had failed in risk management and communication the EU funded a number of multi-disciplinary research projects to explore potential avenues for restoring consumer trust.

Furthermore, a general loss of trust in authorities' ability to regulate and monitor new technologies, as e.g. genetically modified (GM) foods, has been associated with the series of food scares in the EU in the 1990's (Bonnie 2003). In line with the causal chain perspective, this loss of trust has lead to increased perceived risk associated with GM foods and, consequently, to very low levels of GM food acceptance. A widely held opinion among political and business decision makers is thus that increasing trust in regulating authorities would counteract skepticism toward this technology in a straightforward way.

However, more recent empirical research suggests that such a causal chain may be too simplistic. As a counter hypothesis Eiser et al. (2002) put forward the 'associationist view' of trust, risk perception and technology acceptance. It states that more general evaluations drive specific risk and trust judgment, i.e. "...that both trust and risk perception could well be indicators or expressions of a more general attitude toward a certain activity or technology." (Poortinga & Pidgeon 2005: 200). Empirical evidence supporting the 'associationist view' would question efforts to increase acceptability of genetically modified (GM) foods through increasing trust in public bodies and industries.

With this paper we aim to contribute to resolving the dispute over the 'causal chain account' vs. the 'associationist view'. We do so in two steps, with GM foods chosen as the area of application. First, based on a thorough review of institutional trust research the fundamental relationships between trust, risk perception and technology acceptance are highlighted. A key consideration for deriving hypotheses is that risk is a primal condition for trust to evolve and to matter in the first place. Second, we present empirical results from recent surveys with two German and two Italian samples and report which hypotheses are supported most by the data.

The paper is organized according to these two steps. The review of trust research and outline of hypotheses is presented in the following section, followed by the section on empirical results. The paper concludes with a discussion of our findings' implications for political and business decision makers and for further research.

Theoretical part

In this section we first present the conceptual foundations for an investigation of the relationship between risk, trust and acceptance of technologies. We then present a set of hypotheses derived from these theoretical considerations and a discussion of the limitations of our framework.

Conditions of trust

Trust is an integral part of the interactions amongst individuals of any society, as can be seen by the large number of proverbs in any language that deal with trust. But which conditions must be satisfied for trust to play a role in human interaction? We start finding the answer by presenting a definition of trust by Mayer et al. (1995: 712):

> *Trust is the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party.*

Two elements of this definition form the fundamental condition of trust: the willingness to be vulnerable to another party's actions, irrespective of monitoring abilities. This condition certainly applies to a typical, i.e. average consumer: When confronted with the choice for or against a potentially risky technology, there is no way to monitor or control it from the individual's perspective. The literature on the psychometric approach to risk perception provides a large number of measurement dimensions on which individuals base their risk judgements (see e.g. Fife-Schaw & Rowe 1996).

The third element of the definition, i.e. the expectation that the other party will perform an important action addresses the measurement condition of trust. Previous research by Poortinga & Pidgeon (2003), Johnson (1999), Wicks et al. 1999, Earle and Cvetkovich (1995), and Mayer et al. (1995) identify three conditions on which the measurement of trustworthiness can then be based. As can be seen in Figure 1. From measurement conditions of trust to the measurement of trustworthiness1, one of them is based on cognitive reasoning, while the other two relate to more affective evaluations.

Level of evaluation	Measurement conditions…	…translate into…	…measurement dimensions for trustworthiness.
Cognitive	Element of rational prediction	⇒	Competence of trustee
Affective	Affect between trustee and trustor	⇒	Care/benevolence of trustee
	Moral character of affective element	⇒	Value similarity between parties

Figure 1. From measurement conditions of trust to the measurement of trustworthiness

In addition to the measurement of risk and of trust it is necessary to identify the perceived benefits of a new technology to arrive at a more complete picture of the factors determining acceptance. As with perceived risk, perceived benefits conditional upon another party's performance over which one has no control may be coined as the fundamental condition of trust, as one is vulnerable in the sense of not gaining the benefits, or profits from a business perspective. And again, psychometric research has provided a set of tools to measure perceived benefits. In any case, vulnerability combined with lacking ability to monitor the other party, implies to have something at risk. Consequently, as pictured in the decision tree in 2, only if this fundamental condition is satisfied, trust should play a roll at all in the consumer's decision to accept or refuse a technology.

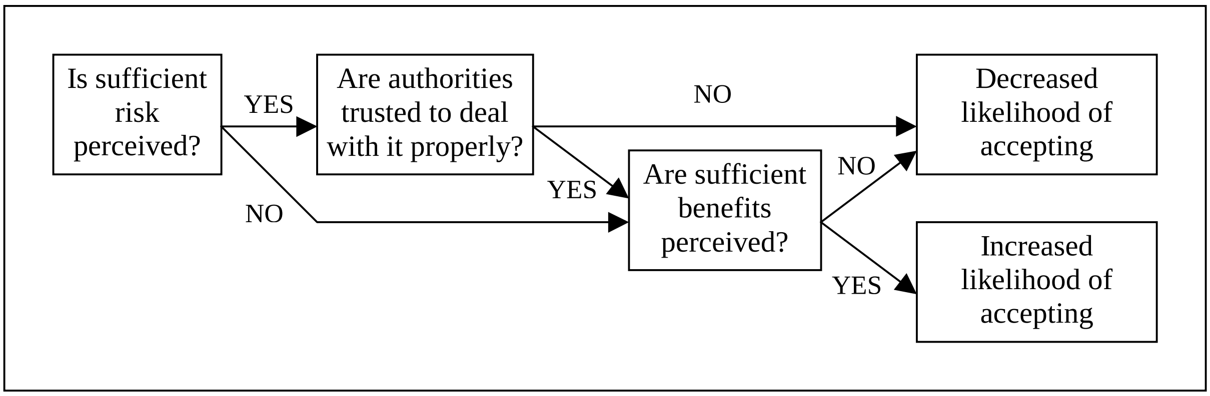

Figure 2. Acceptance decision tree based on perceived risk, trust and perceived benefits

Although there are many different ways of organizing the decision tree, e.g. starting with benefit evaluation, this fundamental argument is difficult to reconcile with the causal chain account in which the impact of trust on acceptability is mediated by perceived risks. It is also in contradiction with the associationist view which basically states that the acceptance decision is made based on more general attitudes and beliefs and risk, benefit, and trust judgements adjusted accordingly. Rather, the fundamental consideration would lead to the conjecture that sub-samples of consumers with high levels of perceived risk exhibit a stronger association between trust and technology acceptance than sub-samples with moderate or low levels of perceived risk.

Deriving hypotheses

In this section we present three hypotheses that will guide our empirical analysis. Starting point is the graphical presentation of the two different models in 3. The causal chain account of trust, risk and technology acceptance postulates that trust does not influence technology acceptance directly (dotted line) but instead via influencing perceived risk – and/or perceived benefits – which then determines acceptance. The intuition behind it is that trusting authorities to regulate and monitor properly leads to a reduced perceived risk, because they have it under control. Then the benefits can be reaped with less risk and the technology is more likely to be accepted. Not trusting authorities would lead to the opposite result.

Contrary to that, the associationist view basically reverses the above causal chain by postulating that higher order beliefs about and attitudes toward a certain technology drive trust, risk and benefit judgments. In that sense, someone who is opposed to GM food, e.g., will likely state to have no trust in authorities only regulating but not stopping the technology, emphasize the potential risks and downplay any claimed benefit. Vice versa, someone supports GM food will likely state to trust regulating bodies – unless they stop the technology – and downplay risks and emphasize benefits.

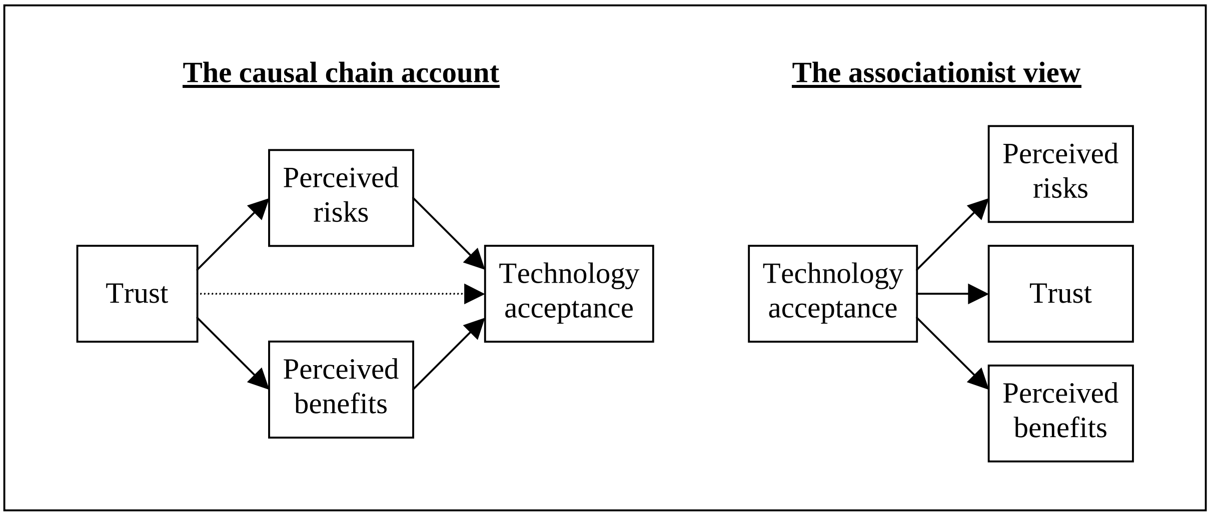

Figure 3. The causal chain account and the associationist view of trust

Source: Extended from Poortinga and Pidgeon (2005: 200).

For testing the two competing models we follow the methodology used by Eiser et al. (2002) and by Poortinga and Pidgeon (2005), as first described by De Vaus (2002). They base their analyses on correlations between the measured concepts. Although they ascertain that identification of causality is not possible with standard statistical techniques, the approach may very well indicate the direction of causal relationships. For that purpose, three basic relationships between two variables are discerned according to the role a third variable plays in that relationship:

a) In a direct causal relationship the two variables are directly related without mediation or interference from a third one.
b) In an indirect causal relationship the correlation between the two variables is mediated through the third one.
c) In a spurious relationship the correlation between the two variables is mainly or fully caused by the third variable.

The causal chain account represents an indirect relationship in so far as the impact of trust on acceptance is mediated through risk/benefit perception, while the associationist account represents the hypothesis of a spurious relationship between perceived risk/benefit and trust. According to Eiser et al. (2002) and Poortinga and Pidgeon (2005), the nature of relationships can be identified by comparing the bivariate (zero-order) correlation between two concepts with the partial (first-order) correlation when the third variable has been controlled for. From this consideration, three hypotheses can be derived that are phrased to reject the so far prevailing causal model.

$H_{trust\ x\ risk}$: The bivariate correlation between trust and risk perception is high, but is substantially reduced when acceptance of GM food is controlled for in a partial correlation.

$H_{accept\ x\ risk}$: The bivariate correlation between acceptance and risk perception is high and remains high when trust in regulating authorities is controlled for in a partial correlation.

$H_{trust\ x\ accept}$: The bivariate correlation between trust and acceptance is high and remains high when the perceived risk of GM food is controlled for in a partial correlation.

In the strictest form, only if all three of these hypotheses cannot be rejected, the data would provide clear evidence against the causal chain account. However, weaker results can still provide evidence against the causal chain account. We elaborate on this when presenting the results of our analysis in the next section.

Empirical part

In this section we will present empirical results from consumer surveys conducted in Germany and Italy between July 2004 and February 2005. First, the samples and measurement instruments will be briefly described. Then, the test will be performed between the two competing models of causal chain and associationist account of trust.

Descriptions of samples and measurement instruments

Between July 2004 and February 2005 we conducted four consumer surveys in Germany and Italy. In each country there was one online survey that was announced through consumer newsletters and on websites that are heavily frequented by consumers. In addition to these, personal interviews were gathered in Italy through the mall intercept sampling method, while a mail survey was conducted among consumers in Northern Germany. All four surveys used the same questionnaire, with only one variation in the measurement of acceptance through stated likelihood of purchasing GM food for the online surveys. There, subjects were randomly assigned to either a discrete, five-point scale or a continuous scale to be operated by mouse click between 0 and 400 pixels. Since we noticed that subjects on the continuous scale were more often using the extremes of the scale than those on the discrete scale, we decided to separate the online samples further according to the scale used. This produced another two sub-samples totaling six, for each of which the statistical tests have to be performed. But first the sub-samples are described in 1.

The online samples do not vary very much in their socio-demographic characteristics across countries or type of scale. However, the intercept and mail survey samples in Italy and Germany respectively differ considerably from both one another and from the online samples. Should considerable differences in the correlations between the online and the traditional survey samples be observed, these can thus be attributed to differences in the socio-demographic compositions.

The relevant concepts for testing the two models were measured as follows. First, acceptance of GM food was elicited through the one-item scale described above , i.e. subjects stated on five-point or continuous scales how likely they were to purchase GM food, should it become available in the future.

Table 1. Descriptive statistics for sub-samples

	Italy			Germany		
	I) Online metric	**II) Online non-metric**	**III) Inter-views**	**IV) Online metric**	**V) Online non-metric**	**VI) Mail survey**
N	186	169	168	270	270	222
Female (share)	41%	38%	67%	41%	46%	35%
Age (mean)	40.9	42.8	46.9	41.6	41.0	54.2
Household size (mean)	2.96	2.86	3.34	2.69	2.72	2.19
Children at home (mean)	0.28	0.26	0.35	0.33	0.34	0.10
Trust[b] (mean)	3.02	3.05	3.12	3.74	3.61	3.47
Perceived risk[b] (mean)	-35.7	-31.4	-21.4	-36.5	-36.3	-37.0
Perceived benefits[b] (mean)	7.0	11.3	16.4	12.2	10.8	11.8
Acceptance[a] (mean)	104 / 1.98	2.34	2.74	157 / 2.56	2.48	2.39

[a] *Stated likelihood to buy GM food measured on metric scale ranging from 0 (very low) to 400 pixels (very high), or on 5-point scale (1: very low, 5: very high).*

[b] *For details of measurement see the following two paragraphs below.*

Second, perceived risk and benefit were measured according to the theory of planned behaviour (Ajzen 1991). Three risk items (reduced biodiversity, personal health risks, risks to future generations) were first rated on a seven point scale ranging from -3 (totally undesirable) to +3 (totally desirable) with a zero midpoint indicating indifference. Then their likelihood was assessed on a seven-point scale ranging from 1 (very unlikely) to 7 (very likely). Both scores were multiplied for each item and than added across items, yielding possible overall scores between -63 (high risk) and +63 (no risk). The same was done for three benefit items (reduced use of pesticides and chemicals; improved nutrition in developing countries; foods with specific health effects). Again, individual results range from -63 (no benefits) to +63 (huge benefits).

Finally, trust in public authorities regulating and monitoring the authorization and marketing of GM foods was measured with four items to be rated on seven-point scales. Capturing competence, the first asked about EU and national government's past performance to keep unauthorized GM foods from the domestic market (1: very poor…7: very good). The second through fourth captured the dimension of care, in particular EU/national government: taking consumer concerns not at all seriously (1) to very seriously (7); being truthful in their communication to the public: not at all (1) to completely (7); being independent in their decision making from industry: not at all (1) to fully (7). After reliability tests had shown sufficient levels of correlations between these four scales for each sub-sample – with Cronbach's alpha ranging from 0.65 to 0.83 – they were collapsed into one scale by calculating their mean for each individual.

Hypotheses testing

We now proceed as in Poortinga and Pidgeon (2005) and calculate the bivariate and partial correlations for the three variables trust, perceived risk and acceptance. In extension of their work we also calculate the correlations for trust, perceived benefits and acceptance. The results are shown in c Sub-samples are I) Italy, online, metric scale for accept: II) Italy, online, non-metric scale or accept; III) Italy, intercept interviews; IV) Germany, online, metric scale for accept; V) Germany, online, non-metric scale for accept; VI) Germany, mail survey. d Bivariate correlation coefficients (Pearson) apply to corresponding variables in first column with error levels in italics below.2.

Table 2. Bivariate and partial correlations between a) trust, perceived risk and acceptance, and

b) trust, perceived benefits and acceptance

Sub-sample[c]	I)		II)		III)		IV)		V)		VI)	
a)	Biv.	Part.	Biv.	Part.	Biv.	Part.	Biv.	Part.	Biv.	Part.	Biv.	Part.
Trust x Risk	.263	.109	.350	.171	.161	.044	.701	.393	.663	.226	.316	.133
	.000	*.141*	*.000*	*.026*	*.037*	*.572*	*.000*	*.000*	*.000*	*.000*	*.000*	*.048*
Risk x Accept	.671	.645	.641	.590	.534	.517	.787	.606	.824	.676	.584	.530
	.000	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*
Trust x Accept	.276	.140	.354	.180	.233	.117	.659	.244	.692	.343	.370	.240
	.000	*.058*	*.000*	*.019*	*.002*	*.023*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*
b)												
Trust x Benefits	.291	.140	.315	.069	.020	-.009	.668	.326	.572	.083	.314	.140
	.000	*.057*	*.000*	*.373*	*.801*	*.233*	*.000*	*.000*	*.000*	*.175*	*.000*	*.038*
Benefits x Accept	.708	.682	.774	.746	.433	.440	.782	.610	.772	.635	.559	.530
	.000	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*
Trust x Accept	.276	.105	.354	.183	.233	.249	.659	.295	.692	.480	.370	.246
	.000	*.157*	*.000*	*.017*	*.002*	*.001*	*.000*	*.000*	*.000*	*.000*	*.000*	*.000*

[c] *Sub-samples are I) Italy, online, metric scale for accept: II) Italy, online, non-metric scale or accept; III) Italy, intercept interviews; IV) Germany, online, metric scale for accept; V) Germany, online, non-metric scale for accept; VI) Germany, mail survey.*

[d] *Bivariate correlation coefficients (Pearson) apply to corresponding variables in first column with error levels in italics below.*

[e] *Partial correlation coefficients (Pearson) apply to corresponding variables in first column with the one not listed there being controlled for. Error levels are in italics below.*

We impose the following rule for our hypotheses tests to decide when a correlation coefficient is sufficiently reduced. Only if the error probability shifts to a lower level of convention (i.e. from 0.01 to 0.05 or beyond) from bivariate to partial correlation, the reduction is sufficient. So for the first hypothesis about the relationship between trust and risk, in eight out of twelve cases the condition is met. And in three cases the decrease in the coefficients' magnitudes is considerable. As outlined in the *Deriving hypotheses* section, we rate this as evidence in favor of the associationist view and against the causal chain account, as the relationship between trust and risk/benefit perception is rather weak, once acceptance has been accounted of.

The second hypothesis is directed at identifying whether there is an impact of trust on acceptance that is mediated through risk/benefit perception, as the causal chain account postulates. The empirical results in clearly do not support this relationship. In all 12 cases the correlation coefficient between perceived risk/benefit and acceptance changes only slightly or hardly at all, when trust is controlled for. This finding of low indirect effects between trust and acceptance does not support the causal chain account but instead the associationist view.

The third hypothesis investigates the strength of the direct relationship between trust and acceptance, when perceived risk/benefits are controlled for. In seven out of 12 cases the coefficients' significance levels are not affected, according to the above definition. But in all but one case the coefficients' magnitude is considerably reduced. This finding is not in support of the associationist view. However, the overall direct effect between trust and acceptance remains rather strong and significant at the 0.05 error level in 10 out of 12 cases. When weighing these rather large direct effects against the small indirect effects between trust and acceptance identified in the previous paragraph, the causal chain account which postulates that the effect of trust is mediated through risk perception is not supported either.

Summing up, the empirical evidence supports the associationist view in two out of three hypotheses, while it is inconclusive in the third. This leads over to a brief discussion of the findings' implications for political decision makers and further research.

Concluding remarks

There are only a few studies testing the two models discussed here. Therefore, empirical evidence as to which of the two is more appropriate is basically inconclusive. In this paper we present conceptual reason and empirical evidence against the causal chain account of trust, risk perception and technology acceptance. This questions whether efforts to restore consumer trust in public authorities will have an impact on risk perception and acceptance of new food technologies. If, on the contrary, further evidence in support of the associationist view as counter hypothesis is obtained in future research, decision makers will want to know what the dimensions and determinants of these higher order attitudes toward new technologies are that drive trust, risk and benefit judgments. Very likely, further research in that area will have to draw a more differentiated picture of the consumer side, taking into account further factors, such as motivation (Slaby & Urban 2002), or the co-existence of different "best" explanatory models for different consumer segments or societal groups.

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