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Exploring consumer purchase intentions towards traceable minced beef and beef steak using the Theory of Planned Behavior

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1 **Abstract**

2 Recently, traceability labels with a quick response (QR) code have been printed on product
3 packaging to help consumers easily access traceability information through their smart phones. We
4 analyzed consumer (n=616) attitudes and purchase intentions towards traceable minced beef/beef
5 steak in England, and identified psychosocial determinants of their purchase using the theory of
6 planned behavior (TPB). Respondents held a general favorable attitude with positive behavioral
7 beliefs and high trust towards the traceable product. In the TPB model, attitude was the main
8 determinant of intention to purchase each traceable product, followed by subjective norm and
9 perceived behavioral control (PBC). The predictive power of the TPB model increased marginally
10 for each sub-group when it was extended with habits, trust, and frequency of purchase. In the TPB-
11 extended minced beef model, PBC was no longer a significant driver, and trust replaced subjective
12 norm as the second most important predictor. In the TPB-extended beef steak model, attitude,
13 subjective norm and PBC were all still significant drivers of intention, however, in order of
14 importance, production process habits and origin habits were more important than PBC. These
15 findings have importance for those involved in the production and marketing of beef.

16
17 **Keywords:** Food traceability; Theory of planned behavior; Minced beef; Beef steak; Trust; Habits.

18 **Abbreviations:** CAPI, Computer Assisted Personal Interviewing; BSE, Bovine Spongiform
19 Encephalopathy; QR, quick response; TPB, theory of planned behavior; WTP, willingness to pay.

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27 1. Introduction

28 As a result of the globalization of the food supply chain, it has become increasingly difficult to
29 ensure the safety, quality and integrity of the food we eat. A number of food crises, such as the
30 occurrence of Bovine Spongiform Encephalopathy (BSE or mad cow disease) in cattle, dioxin in
31 chicken feed and horsemeat in beef products have threatened consumer confidence in the food
32 industry and provided the impetus for the progression of laws, policies and standards regarding food
33 safety and quality management (Hobbs, 2004). In Europe, the BSE crisis in the early- and mid-
34 1990's led to the implementation of a compulsory beef traceability and labelling system (which
35 enabled buyers to know where beef on sale originated) (EU, 2000) and to the introduction of a
36 mandatory "one step back"- "one step forward" traceability system in 2005 under General Food Law
37 Regulation (EC) No. 178/2002) (EU, 2002), which was made specific to food of animal origin from
38 2012 by Regulation (EC) No. 931/2011 (EU, 2011). Traces of undeclared horsemeat discovered in
39 products sold or labelled as beef in 2013 have also compelled food business operators to consider
40 how they can go beyond mandatory traceability requirements and develop systems which integrate
41 information at all stages of the supply chain. This has been encouraged by technological innovations
42 in relation to product traceability (reviewed by (Bosona & Gebresenbet, 2013)), for example,
43 DNA/RFID traceability solutions incorporating block chain technology (Tian, 2016) are being
44 applied in the UK pork industry (Cranswick, 2017). This type of control system could, once fully
45 implemented, provide both the opportunity for knowledge transfer within the supply chain and an
46 assurance of authenticity, due to the clear proof of provenance. Indeed, Mai and colleagues (Mai,
47 Bogason, Arason, Arnason & Matthiasson, 2010) offer empirical evidence that implementing RFID-
48 based traceability can bring quantifiable benefits at different steps in the supply chain.

49 Bosona and Gebresenbet (2013, p. 35) proposed a new comprehensive description of food
50 traceability in 2013, redefining it as "a part of logistics management that captures, stores and
51 transmits adequate information about a food, feed, food-producing animals or substances at all stages
52 in the food supply chain so that the product can be checked for safety and quality control, traced

53 upward, and tracked downward at any time”. Essentially there are three primary benefits of a
54 traceability system in the agricultural and food supply chain (Aung & Chang, 2014): (1) improved
55 food supply chain management (e.g., improved inventory management), (2) improved food crisis
56 management (e.g., reduced recall expenses), and (3) increased marketability of foods with verifiable
57 quality attributes which are unique or undetectable. Indeed, consumer demand for credence quality
58 attributes (e.g., organic production and fair trade) is encouraging firms to invest in traceability as a
59 means of product differentiation (Boecker, Hobbs, Kerr, & Yeung, 2013). Recently, QR (quick
60 response) codes have been printed on meat packaging (Huang, 2017) to offer consumers easy access
61 to meat traceability information through their smart phones.

62 Consumer research on food traceability has primarily focused on exploring consumer preferences
63 and willingness-to-pay (WTP) for labelling programs associated with the quality assurance attributes
64 of meat traceability systems (see for example, Cicia & Colantuoni, 2010; Dickinson & Von Bailey,
65 2005; Hobbs, Bailey, Dickinson, & Haghiri, 2005; Lim, Hu, Maynard, & Goddard, 2014), and to a
66 lesser extent, on consumers’ general perceptions of food traceability systems (Van Rijswijk &
67 Frewer, 2012; Van Rijswijk, Frewer, Menozzi, & Faioli, 2008; Wu, Xu & Gao, 2011) and traceable
68 food (Chen & Huang, 2013; Menozzi, Halawany-Darson, Mora, & Giraud, 2015; Song, Wang, &
69 Hu, 2017). While some early research indicated that consumers had little interest and understanding
70 of food traceability (Gellynck & Verbeke, 2001; Giraud & Amblard, 2003), collectively, the body of
71 literature suggests that safety and quality are linked to traceability in the mind of the consumer
72 (Giraud & Halawany, 2006; Van Rijswijk & Frewer, 2008; Van Rijswijk et al., 2008), and that
73 traceability may contribute to improving consumer confidence in the food system, especially if it is
74 used as a vehicle to deliver credible quality assurances (Hobbs et al., 2005; Verbeke & Ward, 2006).
75 Under the latter condition, traceability-related assurances about on-farm production methods, origin,
76 authenticity, and food safety tend to elicit a positive price premium across a number of countries
77 (Hobbs, 2016).

78 Although research has investigated consumers' perceptions of food traceability, relatively little is
79 known about consumers' purchase intentions toward traceable food or the main psychosocial
80 antecedents of these intentions (Menozzi et al., 2015). Therefore, the aim of this present study was to
81 explore consumer attitudes and purchase intentions towards traceable beef in England, and identify
82 psychosocial determinants of its purchase. Beef was selected as it has been the subject of a number
83 of high profile 'food scares' regarding its safety, quality and integrity, and consumers perceive that
84 traceability is of primary importance for this category of foods (Van Rijswijk & Frewer, 2012).
85 Specifically, two beef products were chosen – minced beef and whole muscle beef steak – as these
86 products tend to differ significantly in price and an unpublished focus group study (n=69
87 participants) conducted by the authors (Spence et al., Unpublished results), showed that UK
88 consumers viewed that minced beef was 'more easy to be made inauthentic' than whole muscle cuts
89 like beef steak. Given this, there may be differences in purchasing determinants between products.
90 As previously mentioned, traceability solutions incorporating block chain technology (Tian, 2016)
91 are currently being applied in the UK food industry (Cranswick, 2017). For this reason, we obtained
92 data from respondents living in England (the largest country in the UK).

93 We used the theory of planned behavior (TPB) (see Ajzen, 1991) as our conceptual framework,
94 which has proved to be successful in predicting and explaining human behavior in the area of health
95 and food choice (Dean, Raats, & Shepherd, 2008). The TPB postulates that attitudes (positive or
96 negative evaluations of the behavior), subjective norms (the influence of the thoughts and attitudes of
97 others towards the behavior), and perceived behavioral control (PBC; the extent to which an
98 individual feels able to perform a behavior) lead to the formation of a behavioral intention, which is a
99 precursor of behavior. Therefore, consistent with the theory, we suggest that the more favorable the
100 attitude and subjective norm, and the greater the PBC, the stronger the intention to purchase traceable
101 minced beef/beef steak.

102 In addition to the original constructs above, other constructs, such as past behavioral frequency,
103 habit strength and trust have been added to the TPB with both theoretical and empirical justifications

104 (Menozzi et al., 2015). Work undertaken with the addition of these variables has been shown to
105 increase the predictive power of the model in particularly relevant areas such as intention to purchase
106 traceable chicken and honey (Menozzi et al., 2015).

107 The present study attempts to first test the TPB model by measuring attitudes to traceable minced
108 beef/beef steak (vs. conventional beef), perceived social pressure pressure towards buying traceable
109 minced beef/beef steak (subjective norms), and perceived ability to find and understand additional
110 information about the origin and production process of traceable minced beef/beef steak (PBC) and
111 how they influence purchase intentions. Second, it tests an extended version of the TPB model
112 including habits, trust and frequency of minced beef/beef steak purchase which may explain more of
113 the variance in intention to purchase traceable minced beef/beef steak. Such research contributes to
114 the explanation of food-related behaviors, i.e., intention to purchase traceable food, by providing
115 evidence for the role of psychosocial variables.

116 **2. Material and Methods**

117 **2.1. Data collection and sample description**

118 A survey involving 616 respondents (male and female, aged 18-65 years) from the North and
119 South of England was conducted via in-home face-to-face Computer Assisted Personal Interviewing
120 (CAPI) in August 2016. To ensure sufficient variance in both the dependent and independent
121 variables under study, participants were selected using quota sampling to ensure that (a) each
122 respondent had some responsibility for buying minced beef/beef steak for their household; (b) at
123 least 40% of the respondents used food labels 'almost every time' (4) as a minimum on a scale of 1
124 ('never') to 5 ('every time') when buying a product for the first time and choosing between two or
125 more food products; and (c) there was roughly the same percentage of respondents from higher- and
126 lower-social class households. Approximately half of the respondents answered questions related to
127 traceable minced beef (n=313), and the other half (n=303) answered questions related to traceable
128 beef steak. On average, interviews lasted 25 minutes. The data were collected by a professional
129 interviewer from a marketing research agency who explained to respondents that there were 'no right

130 or wrong answers' and that their answers would be treated confidentially. The study was approved
131 by the Queen's University Belfast Ethical Committee and verbal consent was obtained from each
132 respondent. Demographic details and characteristics of the respondents are detailed in Table 1. 47%
133 of respondents stated that they used food labels 'almost every time/every time' when buying a
134 product for the first time, while 46% stated that they used food labels 'almost every time/every time'
135 when choosing between two or more products. Seventy-nine percent of respondents were smartphone
136 users and 37% had previously used their smartphone to scan a QR code. When respondents were
137 asked how much they trusted different individuals/organizations to provide them with accurate
138 information about food and drink on a 7-point Likert-type scale (1 = "strongly distrust", 7 =
139 "strongly trust"), they gave the highest trust ratings to an independent government body responsible
140 for food safety and hygiene (i.e., Food Standards Agency) (5.6 ± 1.5), followed by consumer
141 organizations (e.g., Which?, the largest independent consumer body in the UK) (5.5 ± 1.5), university
142 research scientists (5.2 ± 1.5), environmental organizations (5.1 ± 1.4), food and drink supermarkets
143 (4.7 ± 1.4), industry scientists (4.6 ± 1.5), food and drink manufacturers (4.6 ± 1.4), and the media
144 (3.1 ± 1.5).

145 **2.2. Questionnaire design and outline**

146 The questionnaire items were defined, drawing on guidelines for constructing a TPB based
147 questionnaire (Ajzen, 1991; Ajzen, 2006) and previous research on similar topics (Menozzi et al.,
148 2015; Van Rijswijk & Frewer, 2008; Van Rijswijk et al., 2008), including an unpublished focus
149 group study (n=69 participants) conducted by the authors (Spence et al., Unpublished results),
150 exploring consumer perceptions and attitudes towards food authenticity and traceability in beef
151 products. The questionnaire contained closed-ended questions, and was initially piloted among 20
152 individuals for understanding and technical functioning (question order, response categories, filters,
153 interviewer instructions, overall duration). At the outset, we obtained a measure of minced beef/beef
154 steak purchasing frequency (past behavior) and habits. Following this, participants were then
155 provided with a definition and example of traceable minced beef/beef steak (described below) before

156 completing items measuring behavioral beliefs, attitudes, subjective norms, PBC and intention.
157 Finally, trust, WTP, and socio-demographics (education, age, social class, gender, number of
158 children and adults in household) were recorded.

159 **2.3. Definition and pictorial example of traceable minced beef/beef steak**

160 The interviewer read the following definition of traceable minced beef/beef steak to the
161 respondent: “traceable minced beef/beef steak is different to other minced beef/beef steak widely
162 available in stores because it has unique details by which you can trace it back to the specific farm or
163 farms on which it was raised. As a consumer, you can check the whole life story of traceable minced
164 beef/beef steak, from the farm on which it was bred - to the retailer, by entering a code online or by
165 scanning a QR code on the pack via your smart phone. You can obtain information about its farmer,
166 the production process of the beef steak/minced beef (e.g., feed, rearing conditions, transport,
167 slaughter and processing), country and region of origin, and an assurance from an independent body
168 that this information can be trusted”. A visual aid showing a traceable minced beef/beef steak
169 product was then shown to the respondent (Figure 1) to illustrate the concept.

170 **2.4. Measures**

171 Items (listed in Table 2) were scored on a 7-point Likert-type scale (1 = “strongly disagree”, 7 =
172 “strongly agree”, unless otherwise indicated).

173 *Habits*: The four-item self-behavioral automaticity index (Gardner, Abraham, Lally, & de Bruijn,
174 2012): (“[Behavior X is something...]” “I do automatically”, “I do without having to consciously
175 remember”, “I do without thinking”, “I start doing before I realize I’m doing it”) was used to
176 measure three types of habits (looking for information about the country or region of origin, looking
177 for information about the production process, and looking for information about food assurance
178 schemes).

179 *Behavioral beliefs*: To measure behavioral beliefs, participants responded to nine statements that
180 compared traceable minced beef/beef steak to that currently available in stores (e.g., traceable
181 minced beef/beef steak will more likely/likely be: healthier, tastier, more expensive, of known origin,

182 safer, of more satisfying quality, authentic, more environmentally friendly, have higher animal
183 welfare standards).

184 *Attitude:* Attitude towards purchasing traceable minced beef/beef steak in comparison to that
185 currently available in stores was measured by four semantic differential scales: two which tapped the
186 affective (bad-good, displeased-pleased) aspect of attitude and two which tapped the cognitive
187 (foolish-wise, harmful-beneficial) aspect of attitude.

188 *Subjective norm:* The perceived social pressure towards buying traceable minced beef/beef steak was
189 assessed as five social norms among family and friends, university scientists, the media, the food
190 industry, and other important people.

191 *Perceived behavioral control:* Respondent's perception of their ability to find and understand
192 additional information about the origin and production process of traceable minced beef/beef steak
193 was assessed by six items.

194 *Purchase intention:* Intention to purchase traceable minced beef/beef steak was assessed by three
195 items: "when traceable minced beef/beef steak becomes available I intend to buy it", "when traceable
196 minced beef/beef steak becomes available I will look for it", and "when traceable minced beef/beef
197 steak becomes available it will be important to me to buy it".

198 *Trust:* Trust in the traceability system was evaluated with three items: "I trust that traceable minced
199 beef/beef steak can be traced back to the actual farm", "I trust the information provided about the
200 production process and origin of the traceable minced beef/beef steak" and "I trust that traceable
201 minced beef/beef steak is authentic which means it has not been tampered with in any way and it is
202 what it says it is".

203 *WTP:* Respondents indicated how much more (as a percentage of the conventional products price)
204 they would pay for traceable minced beef/beef steak in response to the following item: "suppose the
205 price of minced beef/beef steak currently available in the supermarket is £4.00 for a 500g pack/£8.67
206 for two steaks. The price of the traced minced beef/beef steak with the unique identity details and the
207 additional available information will be higher but it is not determined yet. How much more would

208 you be willing to pay to purchase 500g of traceable minced beef/two traceable beef steaks?
209 Participants chose between the following options: 0%, 5%, 10%, 15%, 20%, 30% 40%, 50%, 60%,
210 70%, 80%, 90% and 100%. The price of the conventional minced beef/beef steak was based upon the
211 market price of the respective product sold in June 2016 by one leading UK supermarket.

212 **2.5. Data analysis**

213 All analyses were conducted using IBM SPSS Statistics for Windows version 21.0 (IBM
214 Corporation, Armonk, NY, USA), with a p-value $p < 0.05$ considered to be significant.

215 *Descriptive and factor analysis:* A descriptive sub-group (mean and SD) and sub-group analysis
216 (independent-samples *t*-tests for continuous variables and chi-square tests for categorical variables)
217 was first performed on the questionnaire items. Likert-type scale data for each of the 42 items (Table
218 2) was then entered into a maximum likelihood factor analysis with Direct Oblimin rotation. A nine-
219 factor solution was selected on the basis that this was in line with the theoretical expectations and
220 conceptualizations of the target constructs. Each variable loaded cleanly onto one factor above the
221 recommended level of 0.4 (Table 3). Internal reliabilities of all constructs (Table 3) were higher than
222 the recommended level of 0.70 (Eiser & Morse, 2001). The items within each construct were
223 averaged, thus the scores ranged from 1 to a maximum of 7, with higher values indicating stronger
224 (i.e., more positive) levels of the construct. Pearson correlations measured the strength of the
225 relationship between constructs within the models, behavioral beliefs and attitude, and behavioral
226 beliefs and intention.

227 *Regression analysis:* Initially, a hierarchical multiple regression examined the association between
228 TPB model constructs (attitude, subjective norm and PBC) and intention to purchase each traceable
229 product. Then, we tested an extended version of the TPB model including habits, trust, and frequency
230 of minced beef or beef steak purchase (0 less than four times per month/1 once or more weekly) as
231 predictors of the intention to purchase traceable minced beef/beef steak. In all regressions,
232 multicollinearity was not a concern (i.e., all correlation coefficients were less than 0.80, all tolerance
233 statistics were above 0.2).

3. Results

3.1. Descriptive summary

Participants in each sub-group reported a general favorable attitude with positive behavioral beliefs and high trust towards the traceable product (Table 2). Participants viewed that buying traceable minced beef/beef steak, in comparison to the conventional product, would be wise/beneficial and make them feel good/pleased. Specifically, participants thought that the traceable product would more likely be of a known origin, authentic, safer and have higher welfare standards (all items scored above 5 in both sub-groups). Participants also thought that traceable minced beef/beef steak would be more expensive but have almost the same taste as the conventional product. With regard to the high score for the trust construct, participants trusted the traceability information, authenticity, and production procedures associated with minced beef/beef steak. At the same time, differences were found in these three constructs (attitude, behavioral beliefs, and trust) between sub-groups: those who answered questions on traceable beef steak (vs. minced beef) expressed a significantly more favorable attitude in three out of four items (good/pleased/wise), and significantly more favorable behavioral beliefs in five out of nine items (healthier, tastier, safer, of more satisfying quality, more environmentally friendly). Concurrently, those who answered questions on traceable beef steak (vs. minced beef), expressed significantly greater levels of trust that the product was authentic and could be traced back to the actual farm. The mean scores for these three constructs (attitude, behavioral beliefs, and trust) were significantly different between sub-groups.

With regard to the high score for the PBC construct, participants in each sub-group perceived that they had a similar ability to find and understand additional information about the production process and origin of traceable minced beef/beef steak. A slightly positive score was also registered on mean intention for the traceable minced beef and beef steak sub-group (4.56 and 4.78, respectively, $p = 0.28$); among participants, 61% of the minced beef sub-group and 66% of the beef steak sub-group agreed that they intended to purchase the traceable product once it becomes available, while others were either neutral (11% and 12% for the minced beef and beef steak sub-group, respectively) or in disagreement (28% and 22%, for the minced beef and beef steak sub-group, respectively).

261 Participants in each sub-group also reported similar low levels of subjective norms, production
262 process habits, and food assurance scheme habits (i.e., the sample means for each construct were
263 slightly below the mid-point, 4), and country or region of origin habits that centered around the mid-
264 point.

265 The mean percentage price premium above the base price that participants were willing to pay for
266 a traceable product was significantly lower in the beef steak sub-group compared to the minced beef
267 sub-group ($11\pm 14\%$ vs. $14\pm 17\%$, respectively; $p = 0.01$). In the beef steak sub-group, 25% of the
268 sample indicated that they would be unwilling to pay any price premium, while 70% would be
269 willing to pay a 5-30% premium. In the minced beef sub-group, 29% of the sample indicated that
270 they would be unwilling to pay any price premium, while 57% would be willing to pay a 5-30%
271 premium.

272 3.2. Predicting intentions

273 Correlations between the TPB and the TPB-extended constructs for each sub-group are shown in
274 Table 4. All constructs, with the exception of frequency of purchase, correlated significantly with
275 intention to purchase traceable minced beef/beef steak. Attitude had the strongest relationship with
276 intention, indicating that those with a more positive attitude towards the traceable product in each
277 sub-group were more likely to intend to purchase it. There were also moderate positive correlations
278 between intentions and each of the following constructs: subjective norm (both sub-groups), PBC
279 (both sub-groups), trust (both sub-groups), country of origin habits (both sub-groups) and food
280 assurance habits (minced beef sub-group only).

281 The TPB model explained (based on R^2_{adj}) 57% of the variance in intention to purchase traceable
282 minced beef and 51% of the variance in intention to purchase traceable beef steak (Table 5). Attitude
283 was the main determinant of intention to purchase the traceable product in each sub-group, followed
284 by subjective norm, and PBC. Therefore, having a more favorable attitude towards the traceable
285 product ($\beta = 0.60$ and $\beta = 0.49$ for the minced beef and beef steak sub-group, respectively), a higher
286 level of subjective norm supportive of its purchase ($\beta = 0.20$ and $\beta = 0.26$ for the minced beef and

287 beef steak sub-group, respectively), and a higher PBC regarding finding and understanding its
288 traceability information ($\beta = 0.11$ and $\beta = 0.16$ for the minced beef and beef steak sub-group,
289 respectively) were associated with a greater intention to purchase it.

290 The explained variance (based on R^2_{adj}) in intention to purchase traceable beef increased
291 marginally to 62% for the minced beef sub-group ($p < 0.001$) and 53% for the beef steak sub-group
292 ($p = 0.008$) when the TPB model was extended with country of origin habits, production process
293 habits, food assurance habits, trust and frequency of purchase. Attitude ($\beta = 0.48$) and subjective
294 norm ($\beta = 0.20$) were both still significant drivers of intention to purchase traceable minced beef,
295 however, trust ($\beta = 0.22$) was a greater significant predictor of intention than subjective norm, and
296 PBC was no longer a predictor. Country of origin habits and food assurance habits did not emerge as
297 significant predictors ($p = 0.06$ and $p = 0.05$, respectively) within the traceable minced beef model.
298 In comparison, attitude ($\beta = 0.41$), subjective norm ($\beta = 0.27$) and PBC ($\beta = 0.12$) were all still
299 significant drivers of intention to purchase traceable beef steak, however, production process habits
300 ($\beta = 0.16$) and origin habits ($\beta = 0.13$) were greater significant predictors of intention than PBC, and
301 trust did not emerge as a significant predictor ($\beta = 0.12$, $p = 0.06$).

302 3.3. Explaining intentions

303 To gain further understanding of the reasons influencing the intention to purchase traceable minced
304 beef/beef steak, the behavioral beliefs were correlated with attitude and intention. Table 6 shows that
305 all behavioral beliefs correlated significantly ($p < 0.001$) with attitude within each sub-group.
306 Additionally, all behavioral beliefs, with the exception of 'traceable beef steak will likely be more
307 expensive', correlated significantly ($p < 0.001$) with intention within each sub-group.

308 4. Discussion

309 Food traceability systems aim to improve food supply chain management, especially in relation to
310 the control of a food crisis, and enable producers to deliver verifiable product information regarding
311 credence quality attributes (e.g., organic production and fair trade). The objectives of this survey
312 study were to explore consumer attitudes and purchase intentions towards traceable minced beef and

313 beef steak in England, and to identify psychosocial determinants of their purchase intentions using
314 both the TPB model and the TPB- extended model.

315 Our study has shown that the most positive item connected with traceable minced beef and beef
316 steak is the belief that it will more likely be of a known origin, followed closely by trust that the
317 traceable product can be traced back to the actual farm. The crucial role of origin in the consumer
318 decision making process has been demonstrated in previous studies. For example, Menozzi et al.
319 (2015) showed that knowing the origin of chicken was the item with the highest connection to
320 traceable chicken in both France and Italy. As shown by DEFRA (Department for Environment,
321 Food & Rural Affairs, 2015), the value that UK consumers place on country of origin labelling
322 appears to have increased as a result of the horsemeat adulteration scandal in 2013, indicating that
323 origin, for many consumers, might be a cue for authenticity. Indeed, in the present study, the third
324 most positive belief connected with traceable beef in each sub-group is the belief that it will more
325 likely be authentic. Similarly, Van Rijswijk et al. 2008, who investigated consumer perceptions of
326 traceability by means-end-chain laddering in four European countries, found that origin was an
327 important attribute for a consumer that was linked to products being controlled/“guaranteed”, which
328 in turn was linked to both trust/confidence and food quality and that food quality was linked with
329 food safety and finally health.

330 Given UK focus group discussions (Spence et al., Unpublished results) revealed that consumers
331 view conventional minced beef as being ‘more easy to be made inauthentic’ than beef steak, we had
332 anticipated that traceable minced beef would score more favorably than traceable beef steak in
333 comparison to the conventional product with regard to single attitude and belief items. However,
334 those who answered questions on traceable beef steak expressed a significantly more favorable score
335 in three out of four attitude items and five out of nine belief items. While we are unsure of the
336 reasons for this finding we would suggest that it merits further investigation. Differences in product
337 trust where, however, as expected; those who answered questions on traceable beef steak expressed
338 significantly greater levels of traceable product trust which is unsurprising given that beef steak is a

339 whole-muscle cut derived from one source, providing easier traceability. Despite these differences
340 between sub-groups, intention to buy traceable mince was the same as intention to buy traceable beef
341 steak, however, traceable beef steak (vs. traceable minced beef) obtained a significantly lower price
342 premium. This is may be because beef steak has a higher base price than minced steak.

343 The predictive power of the TPB model increased marginally from 57 to 62% ($p < 0.001$) for the
344 traceable minced beef sub-group and from 51% to 53% ($p = 0.008$) for the traceable beef steak sub-
345 group when the model was extended with country of origin habits, production process habits, food
346 assurance habits, trust, and frequency of purchase constructs. These results on the TPB model
347 compare favorably with findings from a meta-analysis (Armitage & Conner, 2001) looking at data
348 from 258 different studies which showed that the TPB accounted for 39% of the variance in
349 intention. Comparing the R^2_{adj} statistics from the TPB and TPB-extended models, the addition of the
350 five extra constructs added 5% explained variance to the TPB minced meat model and only 2%
351 explained variance to the TPB beef steak model. While the former finding is consistent with a
352 previous study (Menozzi et al., 2015) which demonstrated a 5% boost in explained variance for
353 traceable chicken in France (from 60% to 65%, using TPB and TPB-extended models, respectively),
354 our findings indicate that the extended models were, in this study and especially for beef steak, less
355 parsimonious to a model comprised solely of TPB constructs. These preliminary findings, however,
356 should be replicated before a definitive conclusion is reached as to the potential role of these
357 additional constructs in the TPB model of purchase intentions towards traceable food.

358 In the TPB model, attitude was the main determinant of intention to purchase each traceable
359 product, followed by subjective norm and PBC which contributed comparatively less. In the
360 extended TPB model for the minced beef sub-group, PBC was no longer a significant driver, and
361 trust replaced subjective norm as the second most important predictor. In the extended TPB model
362 for the beef steak sub-group, attitude, subjective norm and PBC were all still significant drivers of
363 intention, however, in order of importance, production process habits and origin habits were more
364 important than PBC. In line with findings reported in Menozzi's study (2015), which showed that

365 attitudes (assessed by seven belief items) drive the intention to purchase traceable chicken in France,
366 it would therefore seem reasonable that those wishing to promote traceable beef purchase in England
367 should start designing interventions (e.g., public information campaigns) which enable consumers to
368 not only recognize, but appreciate the increased value of traceable beef. The present study shows
369 that, with the exception of the belief that the traceable product will likely be more expensive, all
370 behavioral beliefs should be incorporated into any campaigns. For those wishing to market traceable
371 minced beef, beliefs about its quality, authenticity, safety, tastefulness and healthfulness appear to be
372 most important, whereas quality, healthfulness and environmental friendliness are most important for
373 beef steak. This, however, is only a starting point for influencing intentions (and consequently
374 behavior) as many other factors need also to be considered.

375 Although meta-analysis (Armitage & Conner, 2001) has shown that the subjective norm is a
376 weak predictor of intentions, this study, similar to Menozzi et al. (2015), demonstrated that
377 subjective norm is an important positive antecedent of purchase intention. Specifically, the opinion
378 of family, university scientists, the media, the food industry/supermarkets and other people important
379 to the respondents had a significant effect on intention to buy traceable beef. Therefore, marketing
380 campaigns may also need to be targeted specifically to these people of influence. Interestingly, when
381 the TPB model was extended, trust became significant in the minced beef sub-group and replaced
382 subjective norm as the second most important predictor. The finding that participants' intention to
383 purchase traceable minced beef is driven by trust in the effectiveness of the traceability system (i.e.,
384 the belief that beef can be traced back to the actual farm, and information about it can be trusted to be
385 genuine) is in line with other studies who have explored this construct on consumer outcomes within
386 the context of the TPB (Lobb, Mazzocchi, & Traill, 2007; Menozzi et al., 2015). For example,
387 Menozzi et al. (2015) showed that trust in the effectiveness of the traceability system was the main
388 determinant of traceable chicken/honey purchase in Italy. Similarly, Stefani, Cavicchi, Romano &
389 Lobb (2008) found that trust in food-chain actors (from farmers through retailers) reduces the level
390 of perceived risk and plays an indirect role in explaining intention to purchase. Thus, in addition to

391 improving attitudes towards traceable beef, we must also try to build and maintain trust in the
392 traceability system itself. In relation to this, it is worth considering the sources (Mazzocchi, Lobb,
393 Bruce Traill, & Cavicchi, 2008) that might play a key role in the system and in the communication of
394 messages related to it. For instance, we found that respondents placed most trust in an independent
395 government body responsible for food safety and hygiene (i.e., Food Standards Agency) to provide
396 them with accurate information about food and drink, suggesting that the involvement of this body in
397 the traceability system would likely increase trust in the effectiveness of the traceability system. The
398 fact that trust in the traceability system was only a significant predictor of intention in the minced
399 beef sub-group and not in the beef steak sub-group is noteworthy – perhaps this finding is due to the
400 fact that conventional minced beef is ‘more easy to be made inauthentic’ than whole muscle cuts like
401 beef steak (Spence et al., Unpublished results).

402 Whilst habit has been found to be a predictor of consumer outcomes within the context of the
403 TPB (de Bruijn, 2010; Menozzi et al., 2015; Norman & Conner, 2006), this study has demonstrated
404 that production process habits (i.e., looking for information about the production process) and origin
405 habits (i.e., looking for information about the country or region of origin) only positively predict
406 intention to buy traceable beef steak. Perhaps this finding reflects the fact that beef steak is a high-
407 end beef product (in comparison to minced beef) with a higher base price.

408 With respect to the findings discussed above, it is important that the limitations of the study are
409 considered. Specifically, face-to-face CAPI is open to social desirability bias and techniques such as
410 computer-assisted self-interviewing (CASI) may obtain different answers. Furthermore, behavioral
411 intention rather than actual behavior is reported here and while intentional behavior may account for
412 considerable variance in actual behavior (Ajzen, 1991), follow-up studies may investigate actual in-
413 store purchase of traceable beef products. As traceability perception is country- and product-specific
414 (Menozzi et al., 2015), future studies may also wish to explore purchasing intentions in different
415 countries and towards different beef products. Indeed, with regard to product type and akin to the
416 products affected by the horsemeat scandal, it would be interesting to see if these results would be

417 replicable with beef products which are more highly processed i.e., ready meals containing processed
418 meat. Finally, as there has been little consideration given (e.g., Chrysochou, Chrysochoidid & Olga,
419 2009) to how consumers perceive and accept technologies that provide traceability information,
420 future research in this area could provide a better understanding of the potential success of the QR
421 code to convey traceability information to the final consumer.

422 **5. Conclusion**

423 Respondents held a general favorable attitude with positive behavioral beliefs and high trust
424 towards traceable beef. In the TPB model, attitude was the main determinant of intention to purchase
425 each traceable product, followed by subjective norm and PBC. The predictive power of the TPB
426 model for the minced beef and beef steak sub-group increased marginally by 5% and 2%
427 (respectively) when the model was extended with habits, trust, and frequency of purchase. In the
428 extended TPB model for the minced beef sub-group, PBC was no longer a significant driver, and
429 trust replaced subjective norm as the second most important predictor. In the extended TPB model
430 for the beef steak sub-group, attitude, subjective norm and PBC were all still significant drivers of
431 intention, however, in order of importance, production process habits and origin habits were more
432 important than PBC. These findings have importance for beef producers, beef labelling, and those
433 involved in the marketing and sales of beef products.

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568 **Table 1**
 569 Demographic details and characteristics of the total study sample and according to whether they completed questions
 570 relating to traceable minced beef or beef steak.

		Total n = 616 %	Minced beef n = 313 %	Beef steak n = 303 %
Gender	Male	42	44	40
	Female	58	56	60
Age	18-29 yrs	22	23	21
	30-49 yrs	42	42	43
	50-64 yrs	36	36	37
Social class*	ABC ₁ ^a	51	55	47
	C ₂ DE ^b	49	45	53
Highest education level	No qualifications or compulsory level	27	28	26
	Secondary/further education (e.g., NVQ)	39	37	42
	University level	34	36	32
Occupation status	Employed full-time (>30h per week)	49	51	48
	Employed part-time (≤29h per week)	20	18	21
	Full-time homemaker	5	5	5
	Unemployed	12	10	13
	Student	4	5	2
	Retired	11	11	11
Household size	1	13	12	15
	2	36	36	36
	3	17	16	19
	4	21	25	16
	5+	13	11	15
Number of children under 16 in household	0	60	60	59
	1	16	17	16
	2	17	16	17
	3+	7	7	8
Frequency of minced beef or beef steak purchase for household	Everyday or almost everyday	0.3	1	1
	Several times a week	10	8	5
	Once a week	36	39	33
	Several times a month	21	23	21
	Once a month	18	16	23
	Every two months	8	5	5
	Every three/four months	3	4	2
	Twice per year	4	4	3
	Once per year	1	1	2
Changed beef shopping behavior immediately after the 2013 horsemeat adulteration scandal*	No	79	82	76
	Yes	21	18	24

571 ^a High social class; includes professional, managerial, technical, and skilled non-manual occupations in addition to
 572 farmers with 50+ acres.

573 ^b Low social class; includes skilled manual, partly skilled and unskilled occupations in addition to farmers with less than
 574 50 acres.

575 *There was a significant association between sub-group (i.e., those who completed questions on traceable minced beef
 576 vs. those who completed questions on traceable beef steak) and (a) whether social class was high or low $\chi^2(1) = 4.36, p$
 577 < 0.05 and (b) whether or not participants had changed their beef shopping behavior immediately after the 2013
 578 horsemeat adulteration scandal $\chi^2(1) = 3.94, p < 0.05$.

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Fig. 1. Respondents were shown a visual aid, specific to minced beef or beef steak, depicting the type of traceability information which could be retrieved upon scanning the package QR code.

629
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631**Table 2**

Mean (SD) of questionnaire items which were scored on a 7-point Likert-type scale (1 = “strongly disagree”, 7 = “strongly agree”, unless otherwise indicated) for each sub-group (minced beef and beef steak).

Variables (number of items) <i>Items</i>	Code	Minced beef n = 313	Beef steak n = 303
Attitude (4 items)		5.33 (0.07)	5.56 (0.07)*
<i>Buying traceable minced beef/beef steak instead of minced beef/beef steak now available in supermarkets would make me feel:</i>			
Scale: bad (1) - good (7)	att 1	5.26 (1.35)	5.51 (1.33)*
Scale: displeased (1) - pleased (7)	att 2	5.29 (1.36)	5.52 (1.30)*
<i>I think that buying traceable minced beef/beef steak instead of conventional minced beef/beef steak is:</i>			
Scale: foolish (1) - wise (7)	att 3	5.33 (1.40)	5.57 (1.27)*
Scale: harmful (1) - beneficial (7)	att 4	5.46 (1.29)	5.61 (1.26)
Subjective Norm (5 items)		3.58 (1.49)	3.55 (1.59)
<i>I would buy traceable minced beef/beef steak because:</i>			
my family, partner and friends approve	sn 1	3.91 (1.94)	3.99 (2.02)
university scientists are in favor of it	sn 2	3.73 (1.78)	3.68 (1.91)
the media (TV, radio) are in favor of it	sn 3	2.97 (1.69)	2.89 (1.77)
the food industry and/or food supermarkets promote it	sn 4	3.64 (1.75)	3.52 (1.81)
people important to me buy this type of beef	sn 5	3.62 (1.89)	3.68 (1.99)
Perceived Behavioral Control (6 items)		5.26 (1.48)	5.38 (1.43)
<i>Regarding the additional information about the production process and origin of traceable minced beef/beef steak (obtained via the code)</i>			
it will be easy to find the additional information	pbc 1	5.17 (1.68)	5.33 (1.64)
I will be confident that I'll find the additional information	pbc 2	5.15 (1.74)	5.31 (1.61)
I will be able to find the additional information without help from others	pbc 3	5.18 (1.76)	5.34 (1.64)
It will be easy to understand the additional information	pbc 4	5.31 (1.57)	5.42 (1.55)
I will be confident that I'll understand the additional information	pbc 5	5.37 (1.57)	5.48 (1.56)
I will be able to understand the additional information without help from others	pbc 6	5.37 (1.67)	5.42 (1.60)
Intention (3 items)		4.56 (1.73)	4.78 (1.72)
<i>When traceable minced beef/beef steak becomes available:</i>			
I intend to buy it	int 1	4.69 (1.78)	4.84 (1.78)
I will look for it	int 2	4.66 (1.90)	4.92 (1.81)
it will be important to me to buy it	int 3	4.34 (1.88)	4.57 (1.88)
Trust (3 items)		5.33 (1.43)	5.57 (1.33)*
<i>I trust:</i>			
that traceable minced beef/beef steak can be traced back to the actual farm	tru 1	5.44 (1.53)	5.72 (1.36)*
the information provided about the production process and origin of the traceable minced beef/beef steak	tru 2	5.27 (1.52)	5.49 (1.43)
traceable minced beef/beef steak is authentic which means it has not been tampered with in any way and is what it says it is	tru 3	5.28 (1.53)	5.51 (1.4)*
Habits (country of origin; 4 items)		3.98 (2.06)	4.15 (2.02)
<i>When I buy minced beef/beef steak, looking for information about the country or region of origin is something:</i>			
I do automatically	hab 1	4.12 (2.20)	4.30 (2.14)
I do without having to consciously remember	hab 2	4.03 (2.17)	4.16 (2.11)
I start doing before I realize I'm doing it	hab 3	3.86 (2.18)	4.04 (2.14)
I do without thinking	hab 4	3.91 (2.23)	4.10 (2.15)
Habits (production process; 4 items)		3.49 (2.05)	3.53 (1.97)
<i>When I buy minced beef/beef steak, looking for information about the production process that is needed to make the beef (e.g., feed, rearing conditions, transport, slaughter and processing) is something:</i>			
I do automatically	hab 5	3.51 (2.10)	3.59 (2.03)

I do without having to consciously remember	hab 6	3.51 (2.12)	3.55 (2.05)
I start doing before I realize I'm doing it	hab 7	3.45 (2.10)	3.50 (2.06)
I do without thinking	hab 8	3.48 (2.17)	3.50 (2.05)
Habits (food assurance; 4 items)		3.67 (1.97)	3.68 (1.94)
<i>When I buy minced beef/beef steak, looking for food assurance schemes such as red tractor, or smaller 'niche' schemes that aim to meet particular consumer demands such as higher welfare, environmental or organic standards, is something:</i>			
I do automatically	hab 9	3.72 (2.06)	3.77 (2.02)
I something I do without having to consciously remember	hab 10	3.69 (2.03)	3.66 (1.99)
is something I start doing before I realize I'm doing it	hab 11	3.65 (2.04)	3.68 (2.00)
is something I do without thinking	hab 12	3.61 (2.08)	3.62 (2.02)
Behavioral beliefs (9 items)		4.97 (1.2)	5.19 (1.14)*
<i>Regarding traceable minced beef/beef steak, in comparison to conventional beef now available in supermarkets:</i>			
Traceable minced beef/beef steak will likely be healthier	bel 1	4.58 (1.77)	4.95 (1.73)**
Traceable minced beef/beef steak will likely be tastier	bel 2	4.18 (1.72)	4.50 (1.71)*
Traceable minced beef/beef steak will likely be more expensive	bel 3	5.38 (1.34)	5.27 (1.44)
Traceable minced beef/beef steak will more likely be of known origin	bel 4	5.83 (1.39)	5.88 (1.30)
Traceable minced beef/beef steak will likely be safer	bel 5	5.19 (1.64)	5.49 (1.46)*
Traceable minced beef/beef steak will likely be of more satisfying quality	bel 6	4.71 (1.74)	4.97 (1.56)*
Traceable minced beef/beef steak will more likely be authentic which means it has not been tampered with in any way and it is what it says it is	bel 7	5.24 (1.63)	5.47 (1.38)
Traceable minced beef/beef steak will likely be more environmentally friendly	bel 8	4.61 (1.71)	4.98 (1.53)*
Traceable minced beef/beef steak will likely have higher animal welfare standards	bel 9	5.04 (1.65)	5.24 (1.52)

632 Significantly different from those who completed questions on traceable minced beef ($p < 0.05^*$; $< 0.01^{**}$; bold numbers
633 highlights significance).

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651**Table 3**
Standardized factor loadings and Cronbach's alpha.

Code	Minced meat		Beef steak	
	Alpha	Factor loadings	Alpha	Factor loadings
Attitude	0.93		0.94	
att 1		0.83		0.85
att 2		0.89		0.93
att 3		0.74		0.79
att 4		0.58		0.67
Subjective Norm	0.88		0.89	
sn 1		0.57		0.71
sn 2		0.72		0.82
sn 3		0.85		0.78
sn 4		0.84		0.71
sn 5		0.67		0.78
Perceived Behavioral Control	0.95		0.95	
pbc 1		-0.71		-0.77
pbc 2		-0.73		-0.75
pbc 3		-0.81		-0.86
pbc 4		-0.93		-0.94
pbc 5		-0.93		-0.88
pbc 6		-0.94		-0.89
Intention	0.93		0.94	
int 1		-0.68		-0.79
int 2		-0.74		-0.83
int 3		-0.81		-0.84
Trust	0.93		0.95	
tru 1		-0.87		-0.88
tru 2		-0.86		-0.95
tru 3		-0.82		-0.88
Habits (country of origin)	0.95		0.96	
hab 1		-0.91		0.89
hab 2		-0.94		0.94
hab 3		-0.83		0.89
hab 4		-0.74		0.86
Habits (production process)	0.98		0.97	
hab 5		0.87		-0.75
hab 6		0.90		-0.89
hab 7		0.92		-0.91
hab 8		0.83		-0.87
Habits (food assurance)	0.97		0.98	
hab 9		-0.87		0.88
hab 10		-0.97		0.87
hab 11		-0.85		0.88
hab 12		-0.85		0.90
Behavioral beliefs	0.91		0.90	
bel 1		0.68		0.54
bel 2		0.71		0.57
bel 3		0.42		0.52
bel 4		0.45		0.50
bel 5		0.68		0.64
bel 6		0.75		0.64
bel 7		0.58		0.52

bel 8		0.69			0.59
bel 9		0.63			0.50

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697**Table 4**

Correlations between intention and other constructs contained within the minced meat and beef steak TPB- and TPB-extended models.

Minced meat constructs	1	2	3	4	5	6	7	8	9
1. Intention	-								
2. Attitude	0.73***	-							
3. Subjective norm	0.47***	0.42***	-						
4. PBC	0.41***	0.45***	0.18**	-					
5. Trust	0.56***	0.52***	0.22***	0.52***	-				
6. Habits (country of origin)	0.35***	0.33***	0.10	0.11	0.24***	-			
7. Habits (production process)	0.25***	0.24***	0.17**	0.08	0.13*	0.69***	-		
8. Habits (food assurance)	0.30***	0.22***	0.14*	0.07	0.20***	0.66***	0.72***	-	
9. Frequency of purchase	0.02	-0.02	0.03	0.09	0.12*	0.08	0.08	0.09	-
Beef steak constructs									
1. Intention	-								
2. Attitude	0.66***	-							
3. Subjective norm	0.48***	0.39***	-						
4. PBC	0.41***	0.41***	0.19**	-					
5. Trust	0.46***	0.54***	0.23***	0.48***	-				
6. Habits (country of origin)	0.33***	0.29***	0.11	0.19**	0.14*	-			
7. Habits (production process)	0.21***	0.13*	0.16**	0.12*	0.06	0.65***	-		
8. Habits (food assurance)	0.19**	0.14*	0.16**	0.11	0.42	0.68***	0.77***	-	-
9. Frequency of purchase	0.03	0.01	0.000	0.03	0.56	0.18**	0.18	0.11	-

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PBC, perceived behavioral control.

 $p < 0.05^*$; $< 0.01^{**}$; $< 0.001^{***}$; bold numbers highlights significance.

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Table 5

Standardized regression coefficients (β) for both the theory of planned behavior (TPB) constructs and the TPB-extended constructs from regression analysis predicting consumers' intention to buy traceable minced beef and beef steak.

Independent constructs	TPB		TPB-extended	
	Minced beef	Beef steak	Minced beef	Beef steak
Attitude ^a	0.60***	0.49***	0.48***	0.41***
Subjective norm ^a	0.20***	0.26***	0.20***	0.27***
Perceived behavioral control ^a	0.11**	0.16***	0.04	0.12*
Trust ^a			0.22***	0.10
Habits (country of origin) ^a			0.10	0.13**
Habits (production process) ^a			-0.07	0.16**
Habits (food assurance) ^a			0.11	-0.05
Frequency of minced beef or steak mince purchase ^b			-0.02	0.00
R^2_{adj}	0.57	0.51	0.62	0.53
Model F	140.07***	105.89***	64.46***	43.15**
ΔR^2	-	-	0.05	0.02
df	3,309	3,299	8,304	8,294

* $p \leq 0.05$; ** $p < 0.01$, *** $p < 0.001$; bold text highlights significance.

^a Mean of variable items measured on a 7-point Likert scale; higher scores indicative of stronger (i.e., more positive) levels of the construct.

^b 0 = less than four times per month, 1 = once or more weekly.

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773**Table 6**Correlations of behavioral beliefs with attitude and intention for the minced beef and beef steak (*italic*) sub-groups.

Behavioral beliefs	Correlation (r) with attitude	Correlation (r) with intention
Traceable minced beef/ <i>beef steak</i> will likely be healthier	0.53*** / 0.53***	0.50*** / 0.49***
Traceable minced beef/ <i>beef steak</i> will likely be tastier	0.51*** / 0.46***	0.54*** / 0.47***
Traceable minced beef/ <i>beef steak</i> will likely be more expensive	0.25*** / 0.18**	0.17** / 0.11
Traceable minced beef/ <i>beef steak</i> will more likely be of known origin	0.48*** / 0.47***	0.37*** / 0.35***
Traceable minced beef/ <i>beef steak</i> will likely be safer	0.56*** / 0.56***	0.49*** / 0.44***
Traceable minced beef/ <i>beef steak</i> will likely be of more satisfying quality	0.56*** / 0.51***	0.54*** / 0.51***
Traceable minced beef/ <i>beef steak</i> will more likely be authentic which means it has not been tampered with in any way and it is what it says it is	0.55*** / 0.60***	0.52*** / 0.44***
Traceable minced beef/ <i>beef steak</i> will likely be more environmentally friendly	0.49*** / 0.54***	0.45*** / 0.50***
Traceable minced beef/ <i>beef steak</i> will likely have higher animal welfare standards	0.52*** / 0.53***	0.44*** / 0.43***

774 $p < 0.01^{**}$; $<0.001^{**}$.

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- Respondents reported favorable attitudes and beliefs towards traceable beef.
- Purchase intentions for minced beef and beef steak were similar.
- Attitude is the main driver of behavioral intention.
- In the extended model, trust predicts the intention to buy minced beef.
- In the extended model, habits predict the intention to buy beef steak.

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