

Scotland's Rural College

## The effect of date labels on willingness to consume dairy products: implications for food waste reduction

Thompson, B; Toma, L; Barnes, AP; Revoredo-Giha, C

*Published in:*  
Waste Management

*DOI:*  
[10.1016/j.wasman.2018.05.021](https://doi.org/10.1016/j.wasman.2018.05.021)

First published: 28/05/2018

*Document Version*  
Peer reviewed version

[Link to publication](#)

### *Citation for pulished version (APA):*

Thompson, B., Toma, L., Barnes, AP., & Revoredo-Giha, C. (2018). The effect of date labels on willingness to consume dairy products: implications for food waste reduction. *Waste Management*, 78, 124 - 134. <https://doi.org/10.1016/j.wasman.2018.05.021>

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

1

2

3 **The Effect of Date Labels on Willingness to Consume Dairy Products: Implications for**  
4 **Food Waste Reduction**

5

6

7 Authors: Bethan Thompson<sup>a,b,\*</sup>, Luiza Toma<sup>b</sup>, Andrew Barnes<sup>b</sup>, Cesar Revoredo-Giha<sup>b</sup>

8 <sup>a</sup> School of Geosciences, University of Edinburgh, Peter Wilson Building, Edinburgh EH9  
9 3FH, UK

10 <sup>b</sup> Land Economy, Environment & Society, Scotland's Rural College (SRUC), West Mains  
11 Road, Edinburgh, EH9 3FH, UK

12 \* Corresponding author: Bethan Thompson, [bethan.thompson@sruc.ac.uk](mailto:bethan.thompson@sruc.ac.uk)

13 **Abstract**

14 In the context of national and cross-national efforts to reduce the quantity of food wasted by  
15 consumers, there is growing interest in the role of date labelling. Recent proposals by policy  
16 makers and the food industry to address food waste have included streamlining date-label  
17 application and encouraging the use of best-before dates where possible. In order for these  
18 measures to have a positive impact on food waste, consumers must not only know the  
19 difference between date types, but also be prepared to act on this information and consume  
20 products after the best-before date. Through a survey of 548 Scottish consumers we  
21 investigated the relationship between product type, date type, reduced labels and willingness  
22 to consume (WTC) dairy products in relation to the both the best-before date and the use-by  
23 date. We also examined the factors associated with different levels of WTC products after the  
24 best-before date including knowledge, risk perceptions and trust. Our results suggest that on  
25 their own, the effect on food waste of applying best-before dates to dairy is likely to be small.  
26 In order for such changes to be effective, consumer communication that goes beyond  
27 improving expiry-date knowledge and addresses the multifaceted nature of related risk  
28 perceptions and conceptions of date-label trust will be required.

29 **Keywords:** Consumer behaviour; Food waste; Date labels; Risk perception; Trust;  
30 Knowledge

31

## 32 1. Introduction

33 In the context of national and cross-national efforts to reduce the quantity of food  
34 wasted by consumers in developed countries (Gustavsson et al. 2011; High Level Panel of  
35 Experts (HLPE) 2014; Stenmarck et al. 2016), there is a growing interest in the role of date  
36 labelling (Milne 2012; Newsome et al. 2014; Wilson et al. 2017; WRAP 2011). Recent  
37 proposals to address food waste have included streamlining date-label application and  
38 encouraging the use of best-before dates where possible (The Consumer Goods Forum 2017;  
39 WRAP 2017a). Working with companies to increase the number of products with best-before  
40 dates could give, “consumers the confidence and option to make use of products after the  
41 best-before date” (WRAP 2017a, pp. 9), thereby helping to reduce household food waste. At  
42 present there is little evidence on the effectiveness of efforts to influence consumer behaviour  
43 and avoid unnecessary food waste through date labelling (European Commission 2018).

44 In the UK, dairy products, particularly yoghurt and cheese, have been identified as  
45 product categories which are often unnecessarily given a use-by rather than a best-before date  
46 (Better Regulation Delivery Office 2011). Date labelling in the UK is regulated at the EU  
47 level: all food must have either a minimum date of durability (translated as best-before date  
48 in the UK) or a use-by date, unless they are listed as one of the fresh or highly durable  
49 products that are exempt (Regulation (EU) No. 1169/(2011). The minimum date of durability  
50 is a measure of food quality, “the date until which the food retains its specific properties”  
51 (Regulation (EU) No. 1169/2011; p26); the use-by date is a measure of food safety, where  
52 “food shall be deemed to be unsafe in accordance with Article 14(2) to (5) of Regulation  
53 (EC) No 178/2002” (Regulation (EU) No. 1169/2011; p35). It should be also be noted that  
54 food safety is also dependent on compliance with specified storage conditions throughout the  
55 supply chain regardless of the date label applied (Newsome et al. 2014).

56 Determination of labelling requirements rests with food manufacturers (Department  
57 for the Environment, Food, and Rural Affairs (defra) 2011). As a consequence there is  
58 variation in how best-before and use-by date labels are applied (European Commission  
59 2018). Studies have found that some manufacturers of dairy products apply use-by dates for  
60 reasons broader than microbiological specifications outlined in EU regulation, including  
61 retailer specification, product quality deterioration, and desire for consistency across a range  
62 (Better Regulation Delivery Office 2011; European Commission 2018). This evidence  
63 suggests that date labelling decisions are not always made on the basis of food safety: use-by  
64 dates are the default position (WRAP 2017b). While the decision on labelling may have fine  
65 margins (Department for the Environment, Food, and Rural Affairs (defra) 2011), recent  
66 work on hard cheese with the dairy industry in the UK, has highlighted the opportunity for  
67 change: the proportion of products labelled with best-before dates increased from 75 per cent  
68 of products sold in the UK in 2009 to 97 per cent in 2015 (WRAP 2017a).

69 In the UK, dairy products represent about 10 per cent of avoidable household food  
70 waste (WRAP 2013). Equivalent estimates are not available for the EU as a whole, though  
71 Gustavsson et al. (2011) estimated that 7 per cent of dairy products were wasted by  
72 consumers in the wider Europe region. In the UK, 54 per cent of milk, 78 per cent of yoghurt  
73 and 79 per cent of cheese are reportedly wasted because they pass their expiry date, versus  
74 other reasons such as too much being served (WRAP 2013). Furthermore, the majority of  
75 yoghurts thrown away are unopened (WRAP 2010); for dairy products in general it has been  
76 suggested that the date label is key in making disposal decisions and that other methods of  
77 determining edibility, such as smelling or tasting the product, are rarely employed (WRAP  
78 2015).

79 Evidence of the role of date labels across the whole EU is not available at present  
80 (European Commission 2018), though household food waste studies from various Member

81 States indicate that date labels play an important role in the waste of dairy products and that  
82 misconception of the best-before date as an indicator of food safety is an issue. A summary of  
83 studies from the Netherlands found that dairy products made up 26 per cent of household  
84 food waste, with 61 per cent of people giving best-before date expiry as their reason for  
85 disposal (Netherlands Nutrition Centre 2014). A summary of studies from across the Nordic  
86 countries found that a lack of date label understanding contributed to food waste, in particular  
87 that products labelled with a best-before (such as yoghurt and sour cream) were most  
88 frequently reported as being thrown away because the expiry date had passed (Møller et al.  
89 2014). Overall these findings indicate that for the outlined date labelling changes to  
90 contribute to reducing household food waste, consumers must first know the difference  
91 between best-before and use-by dates, but must also act on this knowledge and be prepared to  
92 consume products after the best-before date.

93 A number of studies have highlighted consumer misunderstanding of date labels as an  
94 issue and have discussed the implications for household food waste (TNS European  
95 Behaviour Studies Consortium 2014; van Boxtael et al. 2014; Toma et al. 2017). However,  
96 few studies have investigated the association of factors beyond knowledge and use of date  
97 labels (European Commission 2018) and explored personal factors such as biospheric values  
98 associated with consuming products after the best-before date (Hooge et al. 2017). Studies  
99 have investigated the association of factors such as product type, expiry date based pricing,  
100 and other product characteristics on consumer interaction with date labels outside the home,  
101 in particular willingness to pay (WTP) (Tsiros and Heilman 2005; Theotokis et al. 2012) and  
102 willingness to waste (WTW) (Wilson et al. 2017). However, there are differences in how  
103 consumers consider suboptimal foods inside and outside the home, and further research is  
104 required to distinguish which factors are important in each context (Hooge et al. 2017).

105           This study adds to the existing literature by investigating how consumers interact with  
106 date labels at home when making a decision whether to consume a product. First, it explores  
107 whether WTC dairy products varies by date type (best-before or use-by) as well as product  
108 type (milk, cheese and yoghurt), and whether the presence of a reduced label affects WTC.  
109 Second, it differentiates itself from previous literature by investigating factors associated with  
110 consumers' WTC dairy products in relation to the best-before date, using yoghurt and cheese  
111 as examples: in addition to knowledge of the best-before date, it explores how consumers'  
112 perception of food-related risk and trust in date labels are associated with their WTC yoghurt  
113 in relation to its best-before date. These factors were chosen because the wider literature on  
114 the use of food labels and food-safety information highlights the importance of perceived  
115 risk, trust in information and labels, as well as food system actors (Frewer et al. 1996; Hobbs  
116 and Goddard 2015; Lobb et al. 2007; Tonkin et al. 2016a; Tonkin et al. 2016b). We hope our  
117 findings will contribute to building the evidence base on consumer engagement with date  
118 labels, and on efforts towards food waste reduction (European Commission, 2018).

119

120 **2. Background and hypotheses development**

121 **2.1 Association between product type, date type, reduced labels, and WTC**

122 A number of studies have explored the association of product type on WTC a range of  
123 products, including dairy products, on or after the expiry date (Broad Leib et al. 2016; WRAP  
124 2011; van Boxstael et al. 2014). As the results reported by these studies were descriptive in  
125 nature, tested a number of variants of date label phrasing e.g. “use-by end of” (WRAP 2011)  
126 and Broad Leib et al.’s (2016) study was US based it is valuable to test whether willingness  
127 to consume for our respondents were significantly different by date or product type.

128 First we compare products holding the date type constant. Milk is not included in the  
129 best-before condition because the majority of milk sold in the UK is fresh and currently  
130 carries only use-by dates.

131 H1: in the use-by date condition we hypothesise that respondents’ WTC yoghurt will be  
132 lower than respondents’ WTC milk and WTC cheese will be higher than both WTC both  
133 milk and yoghurt.

134 H2: in the best-before date condition we hypothesise that respondents’ WTC yoghurt will be  
135 lower than respondents’ WTC cheese.

136 Second we compare WTC for different date types holding the product type constant.  
137 Again milk is not included because the condition of milk with a best-before date would not be  
138 realistic for consumers in the UK.

139 H3: in the yoghurt condition we hypothesise that WTC yoghurt with a use-by date will be  
140 lower than respondents’ WTC yoghurt with a best-before date.



141 H4: in the cheese condition we hypothesise that WTC cheese with a use-by date will be lower  
142 than WTC cheese with a best-before date.

143 Expiry-date-based pricing, and the use of a reduced label to indicate this, is a common  
144 approach used by food retailers (Aschemann-Witzel 2018; Tsiros and Heilman 2005;  
145 Theotokis et al. 2012). Willingness to pay (WTP) for a product has been shown to decrease as  
146 the expiry date approaches (Tsiros and Heilman 2005), since estimated likelihood of  
147 consumption (as well as perceived quality) is an important factor in consumers' decisions to  
148 purchase food close to the expiry date (Aschemann-Witzel 2018). It is therefore of interest to  
149 test whether, once reduced items are brought into the home, the presence of the reduced label  
150 is still pertinent (e.g. it prompts them to think about its approaching sub-optimality). If it is,  
151 we hypothesise that a product with a reduced label would be associated with a lower WTC  
152 compared to the same product without the reduced label. This would not have the desired  
153 effect on household food waste. We therefore compare WTC for products with a reduced  
154 label holding both the product type and date type constant.

155 H5: in the reduced condition we hypothesise that WTC products with a reduced label will be  
156 lower than for products without a reduced label for all product/date type combinations.

157

## 158 **2.2 Date label knowledge**

159 A number of studies have assessed consumer knowledge about expiry dates and  
160 discussed the implications for household food waste (Broad Leib et al. 2016; van Boxtael et  
161 al. 2014; Toma et al. 2017; TNS European Behaviour Studies Consortium 2014; Visschers et  
162 al. 2016). Three of these studies go beyond assessing knowledge alone and explore the  
163 relationship between knowledge and date label use or food waste (Toma et al. 2017; TNS  
164 European Behaviour Studies Consortium 2014; Visschers et al. 2016). Their results are  
165 mixed: Visschers et al. (2016) found no link between expiry-date knowledge and self-  
166 reported food waste outcomes; Toma et al. (2017) found that consumers who had better  
167 knowledge of expiry dates were actually less likely to engage in waste-reducing behaviours  
168 (such as willingness to consume dry products such as rice and pasta without a best-before  
169 date). On the other hand, TNS found that “misconception of the ‘best-before’ date as a safety  
170 limit is one of the strongest factors which drives consumers to throw away outdated food”  
171 (2014, pp.156). The use of different measures of outcomes by these three studies is likely to  
172 explain their different conclusions about knowledge’s relationship to food waste;  
173 nevertheless, the relationship between expiry date knowledge and WTC is not clear. In light  
174 of these findings, we develop a further hypothesis to test whether the relationship between  
175 expiry date knowledge and WTC differs by product type.

176 H6: consumers with better expiry date knowledge will have a higher WTC a product in  
177 relation to the best-before date.

## 178 **2.3 Risk perception**

179 Despite knowing the meaning of best-before dates, consumers may still perceive a  
180 risk in consuming products after the best-before date has passed. As has been found with  
181 regard to educating consumers about biotechnology, improving knowledge alone is unlikely

182 to be sufficient to overcome perceived risks; social norms, amongst other factors, are likely to  
183 be important (Lusk & McCluskey 2018). We are nevertheless interested in testing whether  
184 there is an association between knowledge and risk perception, and therefore develop a  
185 seventh hypothesis:

186 H7: respondents with better knowledge of best-before dates will have lower perceived risk  
187 with regard to consuming products after the best-before date

188 Risk perceptions are known to affect consumer preferences for food, including their  
189 WTP (Lobenitz and Grunert 2018; Tsiros and Heilman 2005). Risk perception with regard to  
190 food products is not simply about food safety: in the minds of consumers, food safety, food  
191 quality, freshness and healthiness are interlinked (van Rijswijk and Frewer 2008; Wansink  
192 and Wright 2006). More broadly, consumers do not tend to differentiate between different  
193 types of hazards, which can make assuaging concerns about food safety challenging (Verbeke  
194 et al. 2007), though consumers have been found to judge product risk differently depending  
195 on the context (Sen and Block 2009; Redmond and Griffith 2004; Arkes 1996). Hooge et al.  
196 (2017) emphasised that different factors are associated with sub-optimal product preferences  
197 in shops and at home. We therefore develop an eighth hypothesis to test whether higher risk  
198 perceptions are associated with lower WTC products in relation to the best-before date in the  
199 context of home, or if the context of home means that risk perceptions have a negligible  
200 association with WTC.

201 H8: respondents with higher perceptions of risk will report lower willingness to consume  
202 products in relation to the best-before date.

## 203 **2.4 Trust**

204           The degree of trust that consumers have in information provision, including the  
205 providers of that information, is one factor that has been found to affect risk perceptions of  
206 food products (Frewer et al. 1996; Tonsor et al. 2009). As with risk perception, trust has been  
207 shown to be a multi-dimensional concept: a number of different types and sources of trust  
208 have been identified in relation to food (Hobbs and Goddard 2015; Lobb et al. 2007).  
209 Concepts of trust in relation to date labels appear from this review to be under-researched,  
210 with most studies focussing on trust in food safety information relating to food scares (e.g.  
211 Lobb et al., 2007) or trust in other types of labels such as sustainability claims (e.g. Sirieix et  
212 al. 2013), or brand (e.g. Lassoued and Hobbs 2015).

213           We explore two concepts of trust and their association with risk perceptions and  
214 willingness to consume. The first concept measures trust in expiry-date labels as conveyers of  
215 information. This comes under the category of system trust, where people base their trust on  
216 established rules (such as food safety guidelines) and the enforcement of those rules  
217 (Lindgreen 2003). The second type of trust is described as calculative trust, defined as the  
218 “rational evaluation that others are likely to behave in a way that does not harm their own  
219 interests” (Hobbs and Goddard 2015, pp. 71). This concept evokes the constraints on future  
220 behaviour that Earle (2010) uses to define this concept: we interpret that consumers may  
221 perceive food manufacturers to be constrained by their need to avoid prosecution and/or to  
222 gain repeat business; by extension they trust date labels and may also perceive them to have a  
223 buffer built in. This can also be seen as the food industry needing to protect itself from  
224 economic losses, and by proxy it is trusted to protect the interests of consumers (Frewer et al.  
225 1996). We therefore developed the following hypotheses:

226 H9: consumers with greater trust in the label will have a higher WTC with respect to the best-  
227 before date

228 H10: consumers with stronger sense of calculative trust will have a higher WTC with respect  
229 to the best-before date although potentially lower trust in the label (as they may perceive it to  
230 be set conservatively)

231 H11: consumers with higher risk perception will have lower trust in the label

232

233

234

### 235 **3. Method**

236 We created a survey which was administered online between October 2016 and  
237 December 2016. Respondents were recruited through an online panel to create a sample of  
238 the Scottish population stratified by age, income and gender. They confirmed that they were  
239 regular consumers of dairy products and that they were wholly or partly responsible for  
240 purchasing and disposal decisions in their household. We received 548 responses; the  
241 characteristics of the sample are outline in Table 1.

#### 242 **3.1 Survey measures**

243 *Willingness to consume (WTC)* was measured by a series of questions that asked  
244 respondents when in relation to the expiry date they would be happy to consume a product.  
245 This was based on an approach used by WRAP (2011), though the response scale was  
246 adapted as respondents had already been screened as consumers of dairy products. Different  
247 products were used for the use-by and best-before conditions in each case, such that  
248 product/expiry date combinations were realistic and could be found in a UK shop. The item  
249 was coded with 1, if they were only willing to consume the product prior to the best-before  
250 date, and 7 if they would be willing to consume the product any time after the best-before  
251 date. The exact wording of the questions and an example is displayed in Table 2.

252 *Knowledge* of the best-before date was measured by two statements adapted from the  
253 text of Regulation (EU) No. 1169/2011 as well as WRAP (2011) and TNS (2014). They read:  
254 “The date after which food may not retain specific properties” and “The date that is an  
255 indicator of food quality”. We chose to include these two statements as best-before dates are  
256 described in different ways by different sources: best-before dates are both described as a  
257 general quality label (WRAP 2011; TNS 2014) and in terms of deterioration of certain  
258 properties such as taste (Regulation (EU) No. 1169/2011). Respondents selected a radio

259 button next to each statement to indicate which date they understood it to refer to.  
260 Respondents were given the option to choose either best-before, use-by or sell-by/display-  
261 until. Knowledge was coded as a single item measure: 0 if they did not identify any best-  
262 before statement correctly, 1 if they answered one correctly and 2 if they answered both  
263 correctly.

264 **Risk perception** was measured as a multi-dimensional concept, drawing on Tsiros and  
265 Heilman's (2005) two risk constructs: product quality risk and personal risk. The wording of  
266 Tsiros and Heilman's (2005) measures were adapted to the home and best-before date  
267 context. For example, one of Tsiros and Heliman's measures of personal risk asked about  
268 "guests in your home thinking less of you for serving them a poor quality product" (pp. 120);  
269 we adapted this to date-label situation and asked whether it would be "appropriate to serve  
270 others dairy products after the best-before date". The wordings of our adapted measures are  
271 outlined in Table 3.

272 **Label trust** was one of two concepts of trust drawing on the food-labelling literature.  
273 It was measured by a series of statements that asked respondents the extent to which expiry  
274 dates were credible, meaningful and protected their interests. These measures were developed  
275 by the authors but were based on the concepts described by (Tonkin et al., 2016a; Tonkin et  
276 al., 2016b) and partly adapted from the measures used by (Lassoued and Hobbs, 2015; Lobb  
277 et al. 2007). The wordings of the measures used are outlined in Table 3.

278 **Calculative trust** was the second of two concepts of trust, and captures the idea  
279 articulated by Frewer et al. (1996) and Hobbs and Goddard (2015) that we trust date labels  
280 because we believe that food system actors wish to protect their own interests. The measures  
281 themselves were adapted from some of the questions used in Frewer et al. (1996), including  
282 whether food system actors seek to protect their own interests. We developed additional

283 measures to test the idea that by extension, respondents may perceive dates to be set earlier  
284 than necessary to encourage the purchase of more products, or believe that food companies  
285 are cautious in setting dates because they prioritise safety over waste. The wordings of the  
286 measures used are outlined in Table 3.

## 287 **3.2 Study design and analyses**

288 Hypotheses H1 – H5 were tested using a simple Chi-square test. The WTC question  
289 was constructed as a mixed design that facilitated both within and between subject tests for  
290 H1-H4 (Charness et al. 2012). Only between subject tests were conducted for H5, which  
291 facilitated counterbalancing of order effects since respondents were randomly allocated to  
292 either the reduced or non-reduced condition for every product/date type combination. This  
293 resulted in 32 possible permutations of question order; on average, 17 respondents will have  
294 had the same question order. The number of respondents per test is described in Tables 4, 5,  
295 and 6.

296 Hypotheses H6 – H11 were tested by means of a structural equation model outlined in  
297 Figure 1. The lavaan package (Rosseel 2012) in R was used for analysis. The model was run  
298 twice: once for the subsample of respondents who were assigned to the non-reduced best-  
299 before yoghurt condition (n = 270); and once for the subsample of respondents who were  
300 assigned to the non-reduced best-before yoghurt condition (n = 286). Characteristics of these  
301 subsamples are reported in Appendix Table A.

## 302 **4. Results**

### 303 **4.1 Relationship between product type and WTC**

304 We tested four conditions where respondents saw two different product types with the  
305 same date type. We tested these conditions both within and between subjects. The results of



306 the within subject and between subject comparisons are outlined in Table 4. Where response  
307 categories 6 and 7 were low we also ran the Chi-squared test by merging these categories;  
308 this did not change which comparisons were significant. Both within and between subjects  
309 we found the same pattern emerged. We found evidence that WTC is different between milk  
310 and cheese, as well as between yoghurt and cheese, where both products have a use-by date.  
311 We did not find evidence of a difference when the products were yoghurt and milk, or when  
312 both products (yoghurt and cheese) had a best-before date. The largest amount of variance  
313 observed was in the between subject yoghurt and cheese use-by date comparison; the smallest  
314 was in the within subject yoghurt and milk use-by date comparison. These findings suggest  
315 that some product differences were pertinent to respondents' WTC, whether we compared the  
316 same people or different people. However, these product differences were only pertinent  
317 when the use-by date was present and not when the best-before date was present. These  
318 results partly support H1, as we find that WTC cheese is higher than WTC milk and yoghurt  
319 where use-by dates are present. However, WTC yoghurt does not appear to be different to  
320 WTC milk where both have a use-by date. We do not find evidence to support H2 as WTC  
321 cheese and yoghurt with a best-before date appear to be similar.

## 322 **4.2 Relationship between date type and WTC**

323 We tested conditions where respondents saw the same type of products with a  
324 different date type. We tested these conditions both within and between subjects. The results  
325 of the within subject and between subject comparisons are outlined in Table 5. As above,  
326 where response categories 6 and 7 were low we also ran the Chi-squared test by merging  
327 these categories; this did not change which responses were significant. We found evidence  
328 that date type was pertinent to respondents' WTC yoghurt with a use-by date and yoghurt  
329 with a best-before date; this was only found in the between subject comparison. We found no  
330 evidence to suggest that respondents' WTC cheese was associated with a difference in date

331 type; the variance was slightly higher between responses in the comparison made between  
332 subjects but it was not significant.

333 Our observation of a different result for the within and between subject conditions  
334 could indicate that personal factors are important in determining a respondents' WTC, with  
335 the same person responding similarly regardless of the date type. To see if these differences  
336 could be linked to the socio-demographic profile of the samples, we checked using a Chi-  
337 squared test to see how similar randomly-allocated subject samples were for the between  
338 subject yoghurt use-by/best-before comparison. We found that while they were similar in  
339 terms of age and income, there were significantly more women in the yoghurt best-before  
340 condition. Across all other between subject comparisons the two randomly allocated subject  
341 samples were not significantly different in terms of age, income or gender.

342 These results partly support H3, as we find that WTC yoghurt with a use-by date is  
343 lower than WTC yoghurt with a best-before, but only in the between subject condition and  
344 cannot rule out that this could be linked to the female-dominant sub-sample. We find no  
345 evidence to support H4 and instead find that WTC cheese is similar regardless of the date  
346 type.

### 347 **4.3. Relationship of reduced labelling and WTC**

348 The reduced comparison was only made between subjects. The results of the  
349 comparisons are outlined in Table 6. For each product type/date type combination we found  
350 no difference in respondents' willingness to pay. These results provide no evidence to support  
351 H5 that respondents would have a lower WTC products with a reduced label.

### 352 **4.4. Relationship between knowledge, risk perceptions, trust, and WTC**

353 The latent constructs of risk perception, label trust and calculative trust were tested  
354 by means of confirmatory factor analysis. The standardised loadings of the latent variable  
355 item measures were above .50 and statistically significant when the model was run for both  
356 the yoghurt best-before and the cheese best-before subsamples (see Table 3). We used  
357 (Fornell and Larcker 1981) measures of convergent and discriminant validity to assess our  
358 measurement model, and found that the Average Variance Extracted (AVE) was at or above  
359 the recommended .50 for each latent variable, and the square of the correlations between  
360 different latent variables was lower than either of their respective AVE scores.

361 Goodness of fit for the whole model was judged against a range of statistics including  
362 the Comparative Fit Index (CFI) and the Root Mean Square Error Approximation (RMSEA).  
363 Both of these items indicated a good fit as the CFI was over the recommended threshold of  
364 .95 and the RMSEA was under the threshold of .08 (Hu and Bentler 1999). Table 7 outlines  
365 these and other commonly reported measures of model fit.

366 The results of the structural models are described in Figure 2 and Figure 3. Their  
367 results are broadly the same, though the magnitude of the coefficients and  $R^2$  vary slightly.  
368 They indicate that perceived risk was negatively associated with WTC. This suggests that  
369 those who reported higher levels of perceived risk were less likely to be willing to consume  
370 yoghurt or cheese after the best-before date, supporting H8. There was a positive association  
371 between those with better knowledge of best-before dates and WTC, though this relationship  
372 was not statistically significant in both models, and therefore H6 is not supported. Knowledge  
373 was found to have a negative association with risk perceptions, providing evidence to support  
374 H7. Label trust did not have a significant relationship with WTC, meaning H9 is not  
375 supported. On the other hand, we found that calculative trust has a direct, positive  
376 relationship with WTC and a negative relationship with label trust, supporting H10. Lastly,  
377 risk perception and label trust are positively related, providing evidence contrary to H11.

378 Those that have stronger risk perceptions appear more likely to perceive date labels as  
379 meaningful, credible and protecting their interests.

380 The R-squared values indicate that 35 per cent of the variance in WTC yoghurt with a  
381 best-before date, and 45 per cent of the variance of WTC cheese, was accounted for by the  
382 models. The R-squared value for risk was extremely low, providing evidence that knowledge  
383 has a very weak association with risk perception. On the other hand, risk perceptions and  
384 calculative trust account for nearly half the variance observed in label trust.

## 385 **5. Discussion**

386 The first objective of this study was to assess the relations between product type, date  
387 type, and the presence of a reduced label on WTC dairy products. We found no difference in  
388 WTC for products with a reduced label compared to identical products without a reduced  
389 label. This is positive for expiry-date-based pricing as these results suggest that consumers'  
390 WTC is not affected by the awareness that a product was purchased when it was already  
391 approaching the end of its shelf life. We found that product type did make some difference to  
392 WTC: where date labels were held constant, respondents' WTC cheese was greater than  
393 respondents' WTC yoghurt or milk, but only where both products had use-by dates. Where  
394 cheese and yoghurt had best-before dates we did not observe WTC responses that were  
395 significantly different from one another; neither did we observe WTC responses that were  
396 significantly different between yoghurt and milk with use-by dates. These findings indicate  
397 that only some product differences are pertinent, and consumers take into account  
398 product/date combinations.

399 Physical differences between these products could be relevant to consumer responses,  
400 for example cheese being relatively hard and dry compared to yoghurt and milk. We may be  
401 able to hypothesise, therefore, that WTC bread would be higher than WTC juice. On the other

402 hand, factors such as consumers' previous experience of how edible they have found these  
403 products after the expiry date might be driving these observations. In terms of understanding  
404 why product type seems to matter, future research should also include qualitative work to  
405 draw out the reasoning behind these responses.

406 Our comparison of date types where product type was held constant found that date  
407 type mattered for yoghurt but not for cheese. Furthermore, we found that date type was only  
408 significant in the between subject comparison for yoghurt, suggesting that a change from a  
409 use-by to a best-before date on its own is unlikely to change behaviour. Instead, personal  
410 differences matter when it comes to how we interpret date labels.

411 These findings imply that increasing the proportion of cheese or yoghurts with a best-  
412 before rather than a use-by date, as proposed (WRAP 2017), is on its own unlikely to have a  
413 large effect on consumption beyond the best-before label and consequently reduce food  
414 waste. Given this and evidence of the anchoring effects of date labels (Elsen et al. 2015), a  
415 more effective approach might be to encourage companies to give the maximum amount of  
416 shelf life to products and challenge any dates which may be unnecessarily cautious (WRAP  
417 2017a). Options such as intelligent food packaging might also be considered, though these  
418 may also present issues around initial consumer acceptance and longer-term behaviour as  
419 discussed by Raak et al. (2017); personal differences in terms of how we interpret these new  
420 types of indicators are still likely to matter.

421 The second objective of this study was to understand the relationship between best-  
422 before date knowledge, risk perceptions, and trust on WTC, and how these factors are  
423 associated with WTC. We found that respondents who reported higher risk perceptions were  
424 more likely to report lower WTC. This is consistent with Tsiros and Heliman's (2005) results  
425 where they found that higher perceived product quality risk was related to lower WTP. While

426 the concepts of WTC and WTP are relevant to different contexts, the home and shopping  
427 contexts respectively, it appears that risk perception plays a role in both. We found that all  
428 risk perception item measures loaded onto a single latent factor. These item measures  
429 encompassed aspects of product quality risk and personal risk which were distinguished by  
430 Tsiros and Heilman (2005). This could indicate that in the home context these aspects of risk  
431 are not differentiated by consumers, not just across safety and quality aspects encompassed  
432 by product quality risk but also social aspects encompassed by personal risk. This has  
433 important implications for communicating with consumers alongside the proposed expiry-  
434 date streamlining (The Consumer Goods Forum 2017). If these changes are to be effective,  
435 communications need to go beyond stating that products are safe to eat after the best-before  
436 date and address concerns about taste, quality, freshness, and social acceptability.

437         This recommendation is further supported by our finding with regard to best-before-  
438 date knowledge. We tested the extent to which best-before-date knowledge was associated  
439 with risk perceptions and WTC and found that it had limited-to-no association. Specifically,  
440 it had no direct association with WTC; there was an indirect relationship through risk  
441 perceptions, although its association with risk perceptions was small. It will be important to  
442 understand more about the formation of risk perceptions with regard to best-before dates in  
443 order to ensure that consumer education and communication is effective.

444         Higher risk perception was notably associated with higher levels of label trust. This  
445 finding ran counter to our hypothesis but could be understood as label use being driven by a  
446 particular need or interest: Grunert et al. (2010) for example, found that having an interest in  
447 healthy eating was associated with nutrition information use. Therefore we can interpret our  
448 findings as indicating that those with higher perceived risks tend to find date labels more  
449 trustworthy and salient.

450 We also explored the association of trust with WTC: trust in date labels' credibility,  
451 and calculative trust related to the food system actors which set date labels. We found that  
452 only calculative trust had a direct, positive association with WTC; trust in date labels had a  
453 weak, negative relationship with WTC, but this was not statistically significant. Respondents  
454 with higher levels of calculative trust were also less likely to have high levels of trust in the  
455 label itself.

456 The implications of these findings for expiry-date policy are challenging. On the one  
457 hand, it is desirable for consumers to trust the information they are presented with on a date  
458 label and perceive it as credible, reliable and meaningful; these labels are not otherwise  
459 fulfilling their traditional economic role in reducing quality uncertainties and information  
460 asymmetries (Lusk 2013). It appears that in this model, the extent to which consumers trust  
461 labels does not have a direct impact on WTC, and is instead strongly associated with  
462 perceived risk: trying to improve consumer trust and confidence in labels alone may not  
463 result in lower food waste. On the other hand, it seems that the more consumers perceive food  
464 companies to be protecting their own interests with regard to setting the expiry date, the more  
465 willing they are to consume products after the best-before date. Companies are now being  
466 urged to ensure they give the absolute maximum shelf-life to products (WRAP 2017b), which  
467 we also highlighted as being potentially effective in reducing food waste. The challenge may  
468 be that if companies provide the absolute maximum shelf-life, individuals with high  
469 calculative trust may still be willing to exceed the date and be disappointed with a product's  
470 quality, which companies may wish to avoid. If the same were found to apply to use-by dates  
471 then this could also result in food safety issues.

472 This study limited itself to two concepts of trust, calculative trust and trust in the  
473 labels themselves, as a measure of system trust, since the wider food safety and labelling  
474 literature indicated they were relevant to consumer interactions with labelling and perceptions

475 of food safety. Future research could benefit from exploring other trust concepts identified in  
476 the literature (Hobbs and Goddard 2015), that go beyond the rational concepts of trust and  
477 include social and emotional aspects which have been shown to be influential (Dunning et al.  
478 2012). This could form an interesting counterpoint to social and psychological aspects of risk  
479 that were found to be relevant alongside safety and quality aspects within our model. From  
480 the point of view of developing effective communications, further research into trusted  
481 sources of information with regard to date label interpretation would also be beneficial.

482         Our findings suggest that food manufacturers should weigh carefully the costs and  
483 benefits of investing in the tests required to move products from a use-by to a best-before  
484 date. For cheese, it appears that – at least for our respondents – that whether a product has a  
485 use-by date or a best-before date matters very little to their consumption and (by extension)  
486 waste decisions. For yoghurt, it appears that the date label may make some difference to  
487 some people. If date label changes are to be effective in contributing to food waste reduction,  
488 they will need to be combined with campaigns that address the range of perceived risks  
489 associated with products consumed beyond their best-before dates. From the perspective of  
490 retailers, having a greater volume of products on their shelves that have best-before rather  
491 than use-by dates is likely to increase opportunities for sales and/or redistribution, potentially  
492 reducing waste at the retail level; retail food waste aspects in relation to date labels are  
493 discussed more extensively by Aschemann-Witzel (2018). From the perspective of  
494 consumers, we agree that moving products to best-before dates does provide an opportunity  
495 to reduce food waste. Combined with effective communication over the long term, more  
496 people could be persuaded to eat products which have passed their best-before date, though  
497 encouraging people to eat (and consider socially acceptable) products which look or even  
498 taste slightly unpleasant, even though safe, will be challenging.

499



## 500 **6. Conclusion**

501 Our results suggest that on its own, the effect on food waste reduction of moving  
502 more dairy products to best-before dates is likely to be small. In order for such changes to be  
503 effective, consumer communication that goes beyond improving expiry-date knowledge to  
504 address the multifaceted nature of related risk perceptions and conceptions of date-label trust  
505 will be required. Communication will need to go beyond providing information to the effect  
506 that it is safe to eat products beyond the best-before date, and acknowledge that there is a  
507 difference between knowing a product is safe to eat and acting on that knowledge. Knowing  
508 the difference between date labels only goes so far in addressing these risk perceptions.  
509 Changes to date labelling and communication around those changes will need to take into  
510 account the interactions between consumer risk perceptions, trust in labels, and calculative  
511 trust in order to develop approaches that are effective for food waste reduction.

## 512 **Funding**

513 The PhD research project of the first author is funded by a Scottish Government Rural  
514 Affairs and Environment Portfolio Underpinning Capacity Studentship. Data collection was  
515 funded by the Scottish Government Rural Affairs, Food and the Environment Strategic  
516 Research Programme 2016-2021 Theme 3 RD3.1.4 'Preventing food waste'.

517 **Conflicts of interest:** none

518

519 **Table 1**

520 **Sample demographics (548 observations)**

<b>Household income</b>	<b>%</b>	<b>Age</b>	<b>%</b>
Less than £14,000	14	18-24	7
£14,000 - £20,999	20	25-34	14
£21,000 - £27,000	13	35-44	13
£28,000 - £34,999	12	45-54	15
£35,000 - £41,999	11	55-64	26
£42,000 - £49,999	10	65+	25
£50,000 - £65,999	9		
£66,000 - or more	11		
		<b>Education</b>	
		Less than high school	1
		High/secondary school	41
<b>Gender</b>		University degree	30
Male	49	Postgraduate degree	13
Female	51	Professional qualifications	14
		Other	1

521

522 **Table 2**

523 **Willingness to consume (WTC) example question**

Please look at the pictures of the products that follow. Indicated until when you would be happy to consume each product, relative to the date shown.

	Before the date shown (1)	One the date shown (2)	1 day after the date shown (3)	2 days after the date shown (4)	3 days after the date shown (5)	Up to a week after the date shown (6)	Any time after the date shown (7)
--	---------------------------	------------------------	--------------------------------	---------------------------------	---------------------------------	---------------------------------------	-----------------------------------

Yoghurt with this expiry date:



Condition A



Condition B

524 Note. For each product/expiry date combination the respondent would either see the normal condition A or the  
525 reduced condition B.

526

527

528

529 **Table 3**  
 530 **Item measures for latent variables: risk perception, label trust and calculative trust**  
 531 **including the item loadings, and average variance (AVE) extracted per factor**

Item measures per latent factor	Yoghurt best-before		Cheese best-before	
	Item loading (p-value)	AVE	Item loading (p-value)	AVE
<b>Risk Perception</b>		<b>0.50</b>		<b>0.55</b>
<i>If I consumed my usual dairy products, I believe they would pose a risk of food poisoning if I ate them:</i>				
After the best-before date	0.64 (0.00)		0.65 (0.00)	
<i>Scale: strongly disagree [1] strongly agree [7]</i>				
<i>How would you feel about eating cheese, yoghurt or butter past their best-before dates?</i>				
It would be embarrassing if people knew I ate these dairy products past their best-before date	0.69 (0.00)		0.72 (0.00)	
	0.79 (0.00)		0.823 (0.00)	
I would feel I was not providing well for myself/my family	0.73 (0.00)		0.80 (0.00)	
I would worry they wouldn't taste very good				
Even if I'd eat it myself, it would not be appropriate to serve others dairy products after the best-before date	0.62 (0.00)		0.70 (0.00)	
<i>Scale: Does not describe my feelings [1] clearly describes my feelings [5]</i>				
<b>Trust Label</b>		<b>0.62</b>		<b>0.64</b>
<i>Please indicate the extent to which you agree with the following statements about expiry dates on dairy products.</i>				
Expiry date labels protect the interests of consumers	0.76 (0.00)		0.72 (0.00)	
Expiry dates on the dairy products I buy (use-by and best-before) are credible	0.76 (0.00)		0.82 (0.00)	
Expiry date labels on dairy products are meaningful	0.81 (0.00)		0.86 (0.00)	
<i>Scale: strongly disagree [1] strongly agree [7]</i>				
<b>Calculative Trust</b>		<b>0.54</b>		<b>0.57</b>
<i>Please indicate the extent to which you agree with the following statements about expiry dates on dairy products.</i>				
Expiry dates are set earlier than necessary to encourage us to buy more	0.82 (0.00)		0.81 (0.00)	
Food companies are too cautious in setting expiry dates, they focus on safety at the expense of creating waste	0.76 (0.00)		0.78 (0.00)	
It is in the interests of food companies to set expiry dates earlier than necessary	0.61 (0.00)		0.67 (0.00)	
<i>Scale: strongly disagree [1] strongly agree [7]</i>				

Note. All factor loadings are reported as fully standardised.

532

533

534

535

536 **Table 4**

537 **Comparison of WTC responses by product type, total subjects (n = 548)**

<b>Within subject</b>	<b>WTC</b>							<b>N</b>	<b>Chi square</b>	<b>DF</b>	<b>p value</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>				
Milk use-by	17	52	26	20	14	10	5	144	17.32	6	0.01
Cheese use-by	16	41	15	15	16	25	16				
Milk use-by	20	53	26	21	9	6	3	138	3.48	6	0.75
Yoghurt use-by	19	58	20	17	8	11	5				
Cheese use-by	18	46	17	16	12	25	9	143	13.57	6	0.03
Yoghurt use-by	22	61	26	10	9	11	4				
Cheese best-before	20	37	13	18	12	28	20	148	7.67	6	0.26
Yoghurt best-before	22	43	21	19	14	19	10				
<b>Between subject</b>											
Milk use-by	21	47	18	16	7	9	1	119	12.34	6	0.05
Cheese use-by	23	36	17	16	6	19	10				
Milk use-by	18	46	18	15	12	13	3	125	5.96	6	0.43
Yoghurt use-by	26	50	31	13	10	8	2				
Cheese use-by	21	31	15	15	10	19	17	128	20.75	6	0.00
Yoghurt use-by	23	47	25	20	9	8	3				
Cheese best-before	14	31	17	20	18	24	14	138	9.60	6	0.14
Yoghurt best-before	19	39	16	19	9	14	6				

538

539

540 **Table 5**

541 **Comparison of WTC by date type – total subjects (n=548)**

Within subject	WTC							N	Chi square	DF	p value
	1	2	3	4	5	6	7				
Cheese use-by	17	45	14	16	13	20	10	135	2.7	6	0.85
Cheese best-before	19	34	14	17	13	24	14				
Yoghurt use-by	18	53	26	20	7	9	3	136	3.74	6	0.7
Yoghurt best-before	19	45	23	19	9	17	4				
<b>Between subject</b>											
Cheese use-by	22	32	18	15	9	24	16	136	4.95	6	0.55
Cheese best-before	15	34	16	21	17	28	20	151			
Yoghurt use-by	27	55	25	10	11	10	4	142	15.45	6	0.02
Yoghurt best-before	22	37	14	19	14	16	12	134			

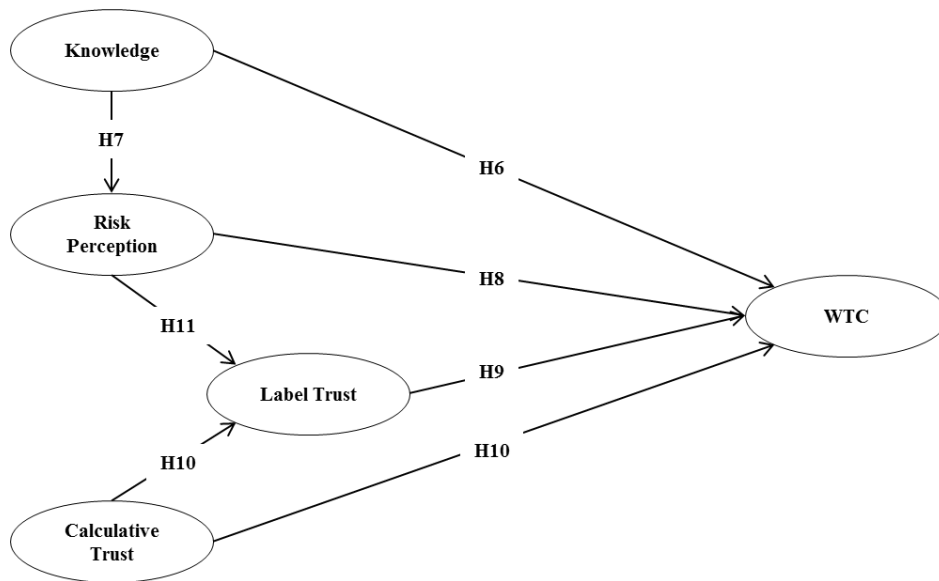
542

543 **Table 6**

544 **Comparison of WTC responses by reduced condition, total subjects (n = 548)**

Between subject	WTC							N	Chi square	DF	p value
	1	2	3	4	5	6	7				
Milk use-by	38	99	44	36	21	19	6	263	10.24	6	0.11
Milk use-by reduced	46	105	70	25	21	16	2	285			
Cheese use-by	39	77	32	31	22	44	26	271	5.14	6	0.92
Cheese use-by reduced	33	96	42	27	19	38	22	277			
Cheese best-before	34	68	30	38	30	52	34	286	1.89	6	0.93
Cheese best-before reduced	36	59	34	33	22	48	30	262			
Yoghurt use-by	45	108	51	30	18	19	7	278	2.88	6	0.82
Yoghurt use-by reduced	44	106	38	30	23	23	6	270			
Yoghurt best-before	41	82	37	38	23	33	16	270	7.05	6	0.32
Yoghurt best-before reduced	55	74	53	36	22	28	10	278			

545



546

547 **Figure 1**

548 **Outline of structural model**

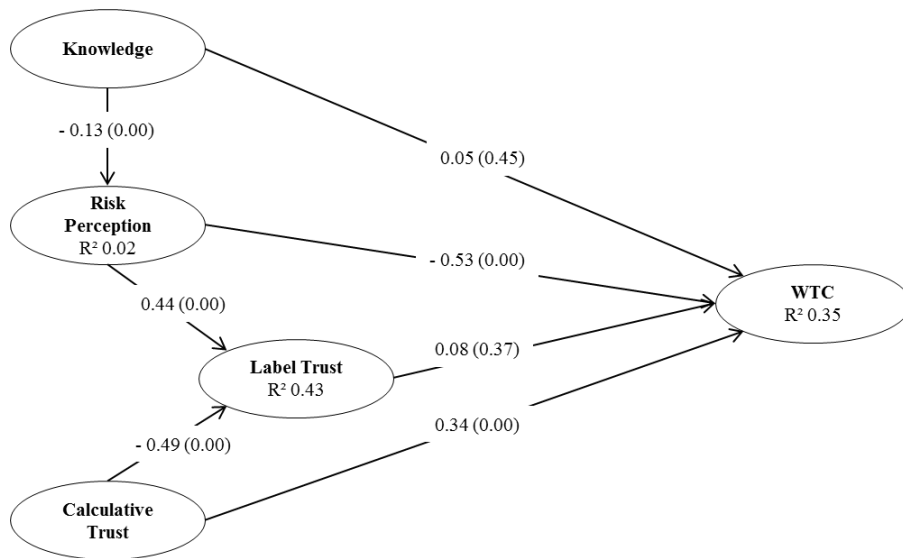
549 **Table 7**

550 **Goodness of fit indicators for best-before cheese (n = 286) and best-before yoghurt (n =**

551 **270) structural models**

	Model	
	Yoghurt best-before	Cheese best-before
Chi-squared	130.59	113.98
D.F.	60	60
Chi-squared p value	0.00	0.00
Root Mean Square Error of Approximation (RMSEA)	0.07	0.06
90% Conf	0.05 – 0.08	0.04 – 0.07
RMSEA p value	0.04	0.25
Comparative Fit Index (CFI)	0.98	0.99
Normed Fit Index (NFI)	0.96	0.98
Non-Normed Fit Index (NNFI)	0.97	0.99
Relative Fit Index (RFI)	0.95	0.97
Standardized Root Mean Square Residual (SRMR)	0.06	0.06
Adjusted Goodness of Fit Index (AGFI)	0.95	0.96
Incremental Fit Index (IFI)	0.98	0.99

552



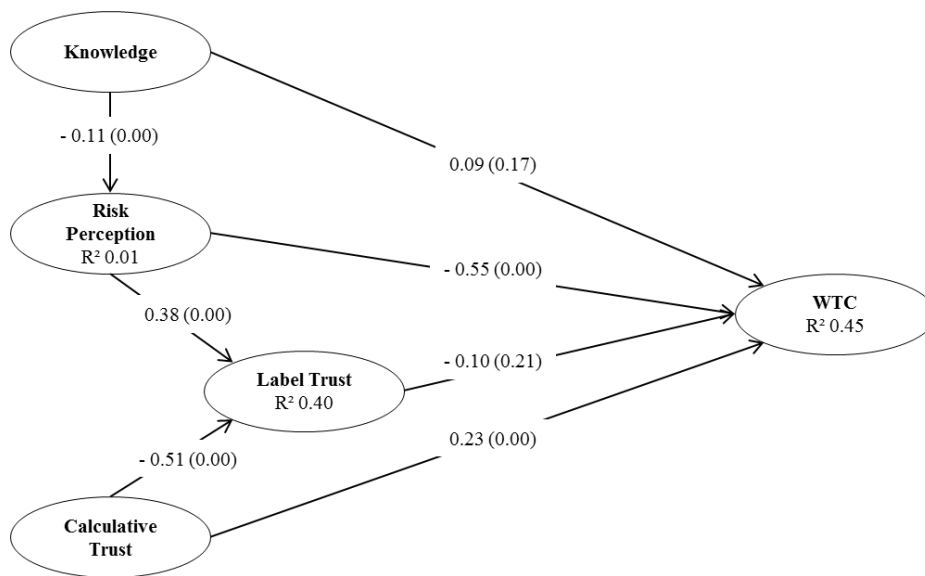
553

554 **Figure 2**

555 **Results of the structural model for best-before date yoghurt**

556 \* Standardised coefficients and p-values are reported e.g. 0.36 (0.00) and R<sup>2</sup> are reported within endogenous  
 557 latent variables

558



559

560 **Figure 3**

561 **Results of the structural model for best-before date cheese**

562 \* Standardised coefficients and p-values are reported e.g. 0.22 (0.01) and R<sup>2</sup> are reported within endogenous  
 563 latent variables

564

565

## Appendix

566 **Table A**567 **Demographics of subsamples for best-before cheese (n = 286) and best-before yoghurt**568 **(n = 270) structural models**

	Model			Model	
	Cheese %	Yoghurt %		Cheese %	Yoghurt %
<b>Household income</b>			<b>Age</b>		
Less than £14,000	13	12	18-24	6	7
£14,000 - £20,999	22	21	25-34	14	14
£21,000 - £27,000	14	14	35-44	13	13
£28,000 - £34,999	11	11	45-54	15	16
£35,000 - £41,999	12	12	55-64	27	26
£42,000 - £49,999	8	10	65+	25	24
£50,000 - £65,999	8	9			
£66,000 - or more	12	10	<b>Education</b>		
			Less than high school	1	1
			High/secondary school	41	37
<b>Gender</b>			University degree	28	30
Male	50	45	Postgraduate degree	12	16
			Professional		
Female	50	55	qualifications	16	16
			Other	1	1

569

570

571



574 Arkes, Hal R. (1996): The Psychology of Waste. In *Journal of Behavioral Decision Making* 9,  
575 pp. 213–224.

576 Aschemann-Witzel, Jessica (2018): Consumer perception and preference for suboptimal food under  
577 the emerging practice of expiration date based pricing in supermarkets. In *Food Quality and*  
578 *Preference* 63, pp. 119–128. DOI: 10.1016/j.foodqual.2017.08.007.

579 Better Regulation Delivery Office (2011): Better Regulation of 'Use By' Date Labelled Foods: A  
580 Business View. Better Regulation Delivery Office (BIS/11/1474). Available online at  
581 <https://www.gov.uk/government/publications/business-regulation-use-by-dates>.

582 Broad Leib, Emily; Rice, Christina; Neff, Roni; Spiker, marie; Schklair, Ali; Greenberg, Sally (2016):  
583 Consumer Perceptions of Date Labels: National Survey. Available online at  
584 <https://www.chlpi.org/>.

585 Charness, Gary; Gneezy, Uri; Kuhn, Michael A. (2012): Experimental methods. Between-subject and  
586 within-subject design. In *Journal of Economic Behavior & Organization* 81 (1), pp. 1–8. DOI:  
587 10.1016/j.jebo.2011.08.009.

588 Department for the Environment, Food, and Rural Affairs (defra) (2011): Guidance on the application  
589 of date labels to food. Available online at  
590 [http://webarchive.nationalarchives.gov.uk/20130403125104/http://www.defra.gov.uk/food-](http://webarchive.nationalarchives.gov.uk/20130403125104/http://www.defra.gov.uk/food-farm/food/labelling/)  
591 [farm/food/labelling/](http://webarchive.nationalarchives.gov.uk/20130403125104/http://www.defra.gov.uk/food-farm/food/labelling/).

592 Dunning, David; Fetchenhauer, Detlef; Schlösser, Thomas M. (2012): Trust as a social and emotional  
593 act. Noneconomic considerations in trust behavior. In *Journal of Economic Psychology* 33 (3),  
594 pp. 686–694. DOI: 10.1016/j.joep.2011.09.005.

595 Earle, Timothy C. (2010): Trust in risk management. A model-based review of empirical research. In  
596 *Risk analysis : an official publication of the Society for Risk Analysis* 30 (4), pp. 541–574. DOI:  
597 10.1111/j.1539-6924.2010.01398.x.

598 Elsen, Millie; van Giesen, Roxanne; Leenheer, Jorna (2015): Milan BExpo 2015: A behavioural study  
599 on food choices and eating habits. Produced by Consumers, Health, Agriculture and Food  
600 Executive Agency (Chafea) on behalf of Directorate-General for Justice and Consumers. Brussels,  
601 Belgium (Specific Contract n° 2014 85 09). Available online at <https://publications.europa.eu/en>.

602 European Commission (2018): Market study on date marking and other information provided on food  
603 labels and food waste prevention. European Commission Directorate-General for Health and Food  
604 Safety. Brussels, Belgium. Available online at <https://publications.europa.eu/en/home>.

605 European Parliament and Council (2011): Regulation (EU) No 1169/2011 of the European Parliament  
606 and of the Council of 25 October 2011 on the provision of food information to consumers,  
607 amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament  
608 and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive  
609 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European  
610 Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and  
611 Commission Regulation (EC) No 608/2004Text with EEA relevance. 1169/2011.

- 612 Fornell, Claes; Larcker, David F. (1981): Evaluating Structural Equation Models with Unobservable  
613 Variables and Measurement Error 18, pp. 39–50.
- 614 Frewer, L.; Hedderley, D.; Howard, C.; Shepherd, R. (1996): What Determines Trust in Information  
615 About Food-Related Risks? Underlying Psychological Constructs. In *Risk Analysis* 16 (4),  
616 pp. 473–486.
- 617 Grunert, Klaus G.; Fernández-Celemín, Laura; Wills, Josephine M.; Storcksdieck Genannt  
618 Bonsmann, Stefan; Nureeva, Liliya (2010): Use and understanding of nutrition information on  
619 food labels in six European countries. In *Zeitschrift für Gesundheitswissenschaften = Journal of*  
620 *public health* 18 (3), pp. 261–277. DOI: 10.1007/s10389-009-0307-0.
- 621 Gustavsson, Jenny; Cederberg, Christel; Sonesson, Ulf (2011): Global food losses and food waste.  
622 Extent, causes and prevention ; study conducted for the International Congress Save Food! at  
623 Interpack 2011, [16 - 17 May], Düsseldorf, Germany. Rome: Food and Agriculture Organization  
624 of the United Nations. Available online at <http://www.fao.org/home/en/>.
- 625 High Level Panel of Experts (HLPE) (2014): Food losses and waste in the context of sustainable food  
626 systems. A report by The High Level Panel of Experts on Food Security and Nutrition of the  
627 Committee on World Food Security. Rome, Italy. Available online at [www.fao.org/cfs/cfs-hlpe](http://www.fao.org/cfs/cfs-hlpe).
- 628 Hobbs, Jill E.; Goddard, Ellen (2015): Consumers and trust. In *Food Policy* 52, pp. 71–74. DOI:  
629 10.1016/j.foodpol.2014.10.017.
- 630 Hooge, Ilona. E. de; Oostindjer, Marije; Aschemann-Witzel, Jessica; Normann, Anne; Loose, Simone  
631 Mueller; Almli, Valérie Lengard (2017): This apple is too ugly for me! In *Food Quality and*  
632 *Preference* 56, pp. 80–92. DOI: 10.1016/j.foodqual.2016.09.012.
- 633 Lassoued, R.; Hobbs, J. E. (2015): Consumer confidence in credence attributes. The role of brand  
634 trust. In *Food Policy* 52, pp. 99–107. DOI: 10.1016/j.foodpol.2014.12.003.
- 635 Lindgreen, Adam (2003): Trust as a valuable strategic variable in the food industry. In *British Food*  
636 *Journal* 105 (6), pp. 310–327. DOI: 10.1108/00070700310481694.
- 637 Lobb, A. E.; Mazzocchi, M.; Traill, W. B. (2007): Modelling risk perception and trust in food safety  
638 information within the theory of planned behaviour. In *Food Quality and Preference* 18 (2),  
639 pp. 384–395. DOI: 10.1016/j.foodqual.2006.04.004.
- 640 Loebnitz, Natascha; Grunert, Klaus.K. (2018): The impact of abnormally shaped vegetables on  
641 consumers' risk perception. In *Food Quality and Preference* 63, pp. 80-87. DOI:  
642 10.1016/j.foodqual.2017.08.004
- 643 Lusk, Jayson L. (2013): Consumer Information and Labeling. In Walter J. Armbruster, Ronald D.  
644 Knutson (Eds.): *US Programs Affecting Food and Agricultural Marketing*. New York, NY:  
645 Springer New York, pp. 349–373.
- 646 Lusk, Jayson L.; McCluskey, Jill (2018): Understanding the Impacts of Food Consumer Choice and  
647 Food Policy Outcomes. In *Applied Economic Perspectives and Policy* 40 (1), pp. 5–21. DOI:  
648 10.1093/aapp/ppx054.
- 649 Milne, Richard (2012): Arbiters of Waste. Date Labels, the Consumer and Knowing Good, Safe Food.  
650 In *The Sociological Review* 60 (2\_suppl), pp. 84–101. DOI: 10.1111/1467-954X.12039.
- 651 Møller, Hanne; Lødrup, Nina; Lundquist Madsen, Pernille; Rosengren, Åsa; Nurttilla, Annika (2014):  
652 Date labelling in the Nordic countries. Practice of legislation. Nordic Council of Ministers 2014.  
653 Available online at [www.norden.org/en/publications](http://www.norden.org/en/publications).

654 Netherlands Nutrition Centre (2014): Consumer food waste. Fact sheet. Netherlands Nutrition Centre.  
655 Available online at <https://ec.europa.eu/food/>.

656 Newsome, Rosetta; Balestrini, Chris G.; Baum, Mitzi D.; Corby, Joseph; Fisher, William; Goodburn,  
657 Kaarin et al. (2014): Applications and Perceptions of Date Labeling of Food. In *Comprehensive*  
658 *Reviews in Food Science and Food Safety* 13 (4), pp. 745–769. DOI: 10.1111/1541-4337.12086.

659 Raak, Norbert; Symmank, Claudia; Zahn, Susann; Aschemann-Witzel, Jessica; Rohm, Harald (2017):  
660 Processing- and product-related causes for food waste and implications for the food supply chain.  
661 In *Waste management* 61, pp. 461–472. DOI: 10.1016/j.wasman.2016.12.027.

662 Redmond, Elizabeth C.; Griffith, Christopher J. (2004): Consumer perceptions of food safety risk,  
663 control and responsibility. In *Appetite* 43 (3), pp. 309–313. DOI: 10.1016/j.appet.2004.05.003.

664 Rosseel, Yves (2012): lavaan. An R Package for Structural Equation Modeling. In *Journal of*  
665 *Statistical Software* 48 (2), pp. 1–36. Available online at <http://www.jstatsoft.org/v48/i02/>.

666 Sen, Sankar; Block, Lauren G. (2009): “Why My Mother Never Threw Anything Out”. The Effect of  
667 Product Freshness on Consumption. In *J Consum Res* 36 (1), pp. 47–55. DOI: 10.1086/596027.

668 Sirieix, Lucie; Delanchy, Marion; Remaud, Hervé; Zepeda, Lydia; Gurviez, Patricia (2013):  
669 Consumers' perceptions of individual and combined sustainable food labels. A UK pilot  
670 investigation. In *International Journal of Consumer Studies* 37 (2), pp. 143–151. DOI:  
671 10.1111/j.1470-6431.2012.01109.x.

672 Stenmarck, Åsa; Jensen, Carl; Quedsted, Tom; Moates, Graham (2016): Estimates of European food  
673 waste levels. Available online at [www.eu-fusions.org](http://www.eu-fusions.org).

674 The Consumer Goods Forum (2017): The Consumer Goods Forum and Champions 12.3 issue  
675 landmark call to use two simple date labels by 2020. Lee Green. Available online at  
676 [https://www.theconsumergoodsforum.com/press\\_releases/companies-commit-to-simplify-food-](https://www.theconsumergoodsforum.com/press_releases/companies-commit-to-simplify-food-date-labels-worldwide-by-2020-reducing-food-waste/)  
677 [date-labels-worldwide-by-2020-reducing-food-waste/](https://www.theconsumergoodsforum.com/press_releases/companies-commit-to-simplify-food-date-labels-worldwide-by-2020-reducing-food-waste/).

678 Theotokis, Aristeidis; Pramataris, Katerina; Tsiros, Michael (2012): Effects of Expiration Date-Based  
679 Pricing on Brand Image Perceptions. In *Journal of Retailing* 88 (1), pp. 72–87. DOI:  
680 10.1016/j.jretai.2011.06.003.

681 TNS European Behaviour Studies Consortium (2014): Study on the Impact of Food Information on  
682 Consumers' Decision Making (No EAHC/2011/CP/01). Available online at  
683 [https://ec.europa.eu/food/overview\\_en](https://ec.europa.eu/food/overview_en).

684 Toma, Luiza; Costa Font, Montserrat; Thompson, Bethan (2017): Impact of consumers'  
685 understanding of date labelling on food waste behaviour. In *Operational Research*, pp. 1–18. DOI:  
686 10.1007/s12351-017-0352-3.

687 Tonkin, Emma; Meyer, Samantha B.; Coveney, John; Webb, Trevor; Wilson, Annabelle M. (2016a):  
688 The process of making trust related judgements through interaction with food labelling. In *Food*  
689 *Policy* 63, pp. 1–11. DOI: 10.1016/j.foodpol.2016.06.007.

690 Tonkin, Emma; Webb, Trevor; Coveney, John; Meyer, Samantha B.; Wilson, Annabelle M. (2016b):  
691 Consumer trust in the Australian food system - The everyday erosive impact of food labelling. In  
692 *Appetite* 103, pp. 118–127. DOI: 10.1016/j.appet.2016.04.004.

693 Tonsor, Glynn T.; Schroeder, Ted C.; Pennings, Joost M. E. (2009): Factors Impacting Food Safety  
694 Risk Perceptions. In *Journal of Agricultural Economics* 60 (3), pp. 625–644. DOI: 10.1111/j.1477-  
695 9552.2009.00209.x.

696 van Boxstael, S.; Devlieghere, F.; Berkvens, D.; Vermeulen, A.; Uyttendaele, M. (2014):  
697 Understanding and attitude regarding the shelf life labels and dates on pre-packed food products by  
698 Belgian consumers. In *Food Control* 37, pp. 85–92. DOI: 10.1016/j.foodcont.2013.08.043.

699 van Rijswijk, Wendy; Frewer, Lynn J. (2008): Consumer perceptions of food quality and safety and  
700 their relation to traceability. In *British Food Journal* 110 (10), pp. 1034–1046. DOI:  
701 10.1108/00070700810906642.

702 Verbeke, Wim; Frewer, Lynn J.; Scholderer, Joachim; Brabander, Hubert F. de (2007): Why  
703 consumers behave as they do with respect to food safety and risk information. In *Analytica*  
704 *chimica acta* 586 (1-2), pp. 2–7. DOI: 10.1016/j.aca.2006.07.065.

705 Visschers, Vivianne H.M.; Wickli, Nadine; Siegrist, Michael (2016): Sorting out food waste  
706 behaviour. A survey on the motivators and barriers of self-reported amounts of food waste in  
707 households. In *Journal of Environmental Psychology* 45, pp. 66–78. DOI:  
708 10.1016/j.jenvp.2015.11.007.

709 Wansink, Brian; Wright, Alan O. (2006): "Best if Used By? " How Freshness Dating Influences Food  
710 Acceptance. In *J Food Science* 71 (4), S354-S357. DOI: 10.1111/j.1750-3841.2006.00011.x.

711 Wilson, Norbert L.W.; Rickard, Bradley J.; Saputo, Rachel; Ho, Shuay-Tsyr (2017): Food waste. The  
712 role of date labels, package size, and product category. In *Food Quality and Preference* 55, pp. 35–  
713 44. DOI: 10.1016/j.foodqual.2016.08.004.

714 WRAP (2010): Preventing household dairy waste. Available online at [www.wrap.org.uk](http://www.wrap.org.uk).

715 WRAP (2011): Consumer insight: date labels and storage guidance. WRAP. Available online at  
716 <http://www.wrap.org.uk/>.

717 WRAP (2013): Household Food and Drink Waste in the United Kingdom 2012. With assistance of  
718 Tom Quested (WRAP), Robert Ingle (support to WRAP from SKM Enviros), Andrew Parry  
719 (WRAP). WRAP. Available online at [www.wrap.org.uk](http://www.wrap.org.uk).

720 WRAP (2015): Reducing food waste by extending product life. With assistance of Peter Lee  
721 (Oakdene Hollins), Steve Osborn (Leatherhead Food Research), Peter Whitehead (WRAP).  
722 WRAP. Available online at [www.wrap.org.uk](http://www.wrap.org.uk).

723 WRAP (2017a): Guidance on application of date labels and related advice. WRAP; Food Standards  
724 Agency; Defra Labelling. Available online at [www.wrap.org.uk](http://www.wrap.org.uk).

725 WRAP (2017b): Helping Consumers Reduce Food Waste – Retail Survey 2015. With assistance of  
726 Marcel Arsand and Andrew Parry (WRAP), Katherine Page, Nia Owen, Tim Lineham, and Adam  
727 Read (Ricardo Energy & Environment). WRAP. Available online at [www.wrap.org.uk](http://www.wrap.org.uk).

728