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Published in:
Waste Management

DOI:
10.1016/j.wasman.2018.05.021

Print publication: 01/08/2018

Document Version
Peer reviewed version

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

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Abstract

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

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

1. Introduction

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

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

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

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

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

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

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

2. Background and hypotheses development

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

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

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

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

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

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

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

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

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

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

2.2 Date label knowledge

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

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

2.3 Risk perception

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

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

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

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

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

2.4 Trust

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

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

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

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

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

3. Method

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

3.1 Survey measures

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

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

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

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

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

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

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

3.2 Study design and analyses

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

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

4. Results

4.1 Relationship between product type and WTC

We tested four conditions where respondents saw two different product types with the 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

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

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

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

4.3. Relationship of reduced labelling and WTC

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

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.

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

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

5. Discussion

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6. Conclusion

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

Funding

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

Conflicts of interest: none

Table 1

Sample demographics (548 observations)

Household income	**%**	**Age**	**%**
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	**Education**	
		Less than high school	1
		High/secondary school	41
Gender		University degree	30
Male	49	Postgraduate degree	13
Female	51	Professional qualifications	14
		Other	1

Table 2

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							

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

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**

	Yoghurt best-before		Cheese best-before	
Item measures per latent factor	**Item loading (p-value)**	**AVE**	**Item loading (p-value)**	**AVE**
Risk Perception		**0.50**		**0.55**
If I consumed my usual dairy products, I believe they would pose a risk of food poisoning if I ate them:				
After the best-before date	0.64 (0.00)		0.65 (0.00)	
Scale: strongly disagree [1] strongly agree [7]				
How would you feel about eating cheese, yoghurt or butter past their best-before dates?				
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)	
Scale: Does not describe my feelings [1] clearly describes my feelings [5]				
Trust Label		**0.62**		**0.64**
Please indicate the extent to which you agree with the following statements about expiry dates on dairy products.				
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)	
Scale: strongly disagree [1] strongly agree [7]				
Calculative Trust		**0.54**		**0.57**
Please indicate the extent to which you agree with the following statements about expiry dates on dairy products.				
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)	
Scale: strongly disagree [1] strongly agree [7]				

532 Note. All factor loadings are reported as fully standardised.

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536 **Table 4**

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

Within subject	WTC							N	Chi square	DF	p value
	1	2	3	4	5	6	7				
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				
Between subject											
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	127			
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	140			
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	135			
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	122			

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Table 5

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				
Between subject											
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			

Table 6

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			

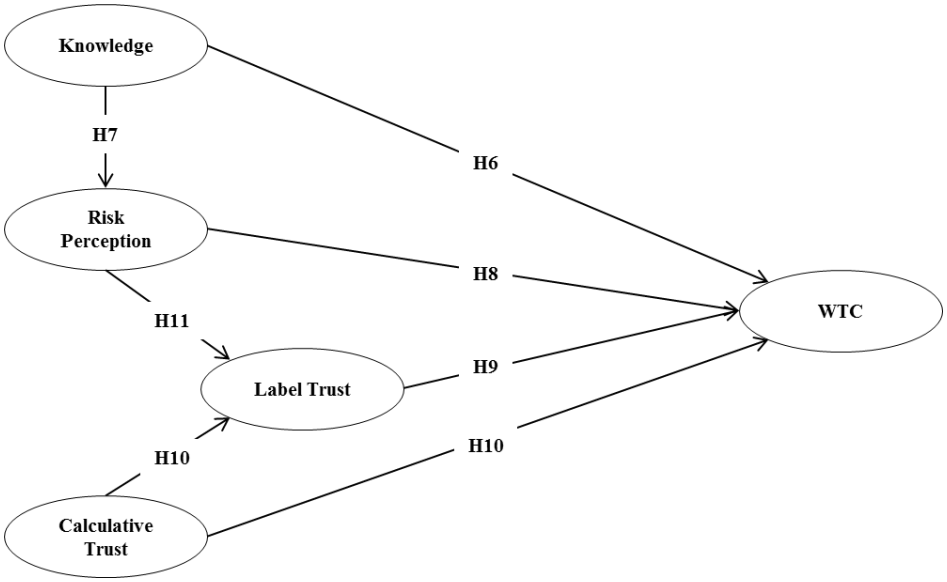

Figure 1

Outline of structural model

Table 7

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

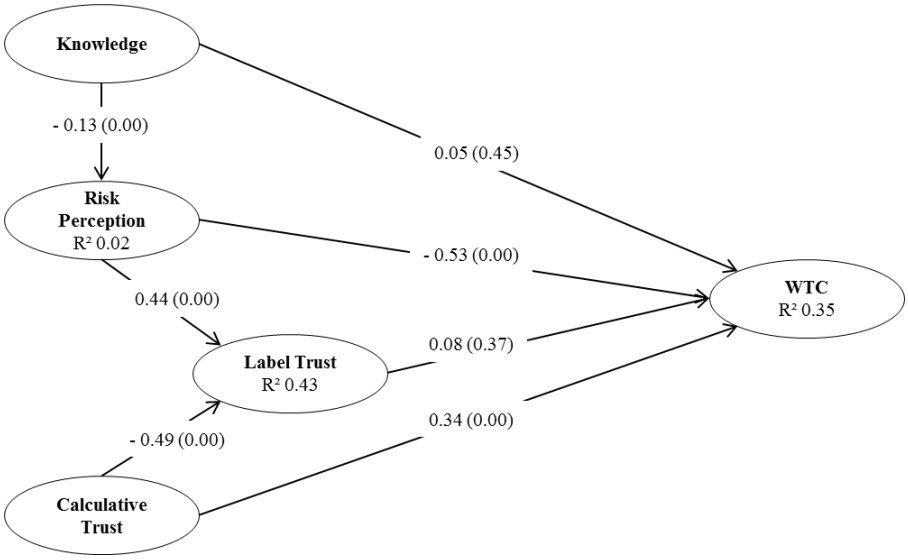

Figure 2

Results of the structural model for best-before date yoghurt

* Standardised coefficients and p-values are reported e.g. 0.36 (0.00) and R^2 are reported within endogenous latent variables

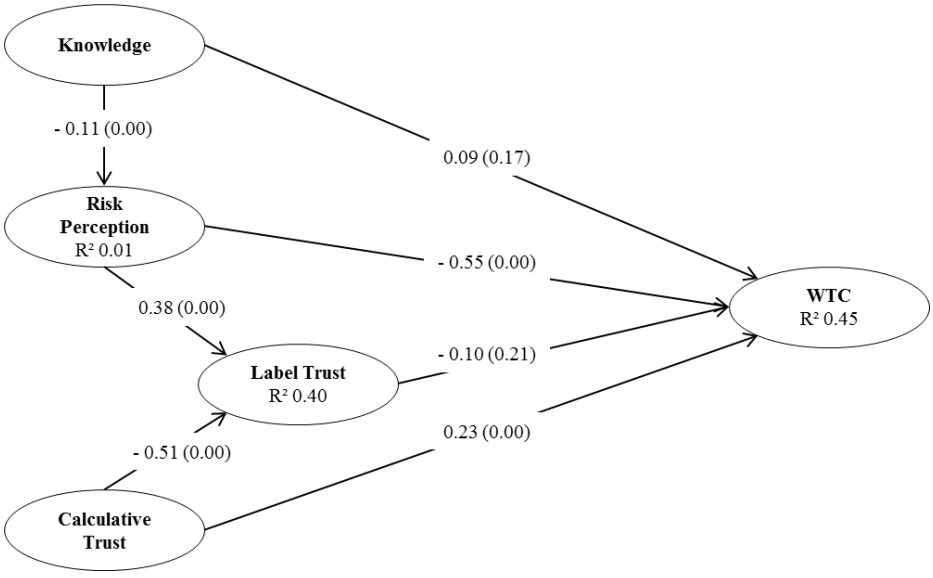

Figure 3

Results of the structural model for best-before date cheese

* Standardised coefficients and p-values are reported e.g. 0.22 (0.01) and R^2 are reported within endogenous latent variables

Appendix

Table A

Demographics of subsamples for best-before cheese (n = 286) and best-before yoghurt (n = 270) structural models

	Model			Model	
	Cheese	**Yoghurt**		**Cheese**	**Yoghurt**
Household income	**%**	**%**	**Age**	**%**	**%**
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	**Education**		
			Less than high school	1	1
			High/secondary school	41	37
Gender			University degree	28	30
Male	50	45	Postgraduate degree	12	16
Female	50	55	Professional qualifications	16	16
			Other	1	1

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