Adopting waste-prevention routines: the role of consumer concern for food waste

Guillaume Le Borgne, Lucie Sirieix, Pierre Valette-Florence, Sandrine Costa

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Food waste is a burning issue, one that is both local and global. Although most consumers hate wasting and do not intend to waste, they still end up wasting food. By focusing on routines that prevent waste rather than on waste behaviours, and by defining and measuring consumer concern for food waste (CFW), this study seeks to address this apparent contradiction. A follow-up to three preliminary studies, this quantitative study proposes a valid and reliable measure of CFW, and examines the links between CFW, the antecedents of this concern, and seven waste-prevention routines. Empirical data reveals two dimensions of CFW that have a very distinct influence on food-related and waste-prevention routines. The first, "individual/interpersonal concern", has a strong relationship with these routines, whereas the second, "global concern", has no significant relationship with them. For researchers, the authors provide a model integrating the antecedents and behavioural consequences of CFW. For both policy makers and managers seeking to reduce food waste at the household level, this research provides recommendations to have an impact on food-waste-related behaviours through individual/interpersonal CFW and its proven antecedents (economic concerns, food involvement, food education).

Keywords: food waste, concern, sustainability, environmental concern, consumer behaviour.

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1. Introduction

A strong reduction of food waste (FW) is a public goal in many places of the world (see for instance Europe or United States of America) through prevention, food donation, or re-use (composting, biogas, etc.).[1] Most research on consumer behaviour has aimed to explain the high share of FW at the household level and to provide solutions to diminish the amounts of food wasted by consumers. Part of this research focuses on direct causes of wastage at all stages of food consumption, generally presented as biases in consumer decisions (Block et al., 2016). However, although most consumers hate wasting and do not intend to waste (Evans, 2011), they nevertheless still end up wasting food. This 'paradox' (or gap) arises particularly from the wide diversity of food-related actions, ranging from the purchase of food items to their consumption or disposal. Such actions (or non-actions – for instance, forgetting a food product deep in the fridge) can combine and lead consumers to waste food without intending to do so. Other studies have shown the effect of routines on the amount of food wasted by households (Stancu et al., 2016). Indeed, several planning routines and storing routines have been proven to help households significantly reduce FW (Hoj, 2011; Quested et al., 2013; Stancu et al., 2016; Romani et al., 2018).

High amounts of FW at the household level do not necessarily indicate 'ignorance' or lack of responsibility on the part of consumers (Meah, 2014). Consumers show a high level of concern about FW (Authors, 2015), especially as this issue is widely discussed in the media, yet thus far no research has been devoted to the subject of consumer concern. In contrast, research on environmental concern has been developed extensively over recent decades to understand how concern for the environment and other factors explain environmental behaviour (Farjam et al., 2019). Environmental concern can at times include concern for FW. However, given the specificity of food consumption, the great diversity of goals involving food, and the strong and complex relationship developed by human beings with food, a specific concept of concern for FW is needed. Concern for FW may indeed play a central role in influencing the adoption of FW-reduction routines.

This work is the latest step of a wider research project on household FW (Authors, 2013, 2015, 2016) encompassing two quantitative and two qualitative studies, which we describe in Section 2.3. In the present article, we investigate the antecedents of seven food-related routines that have been proven to have a negative influence on household FW. For this purpose, we conceptualize consumer concern for food waste (CFW), and study the impact of CFW and its own antecedents on the adoption of these routines. We investigate the following questions: How may CFW be defined, and what are its dimensions? What are its main antecedents? How do CFW and its antecedents influence recourse to food-related routines which, in turn, influence the amount of food wasted in a household?

To answer these research questions, the remainder of this paper is structured as follows. Section 2 offers a theoretical framework with a review of the literature on FW at the consumer level and a conceptualization of CFW. It then discusses the relevance and conceptualizes the CFW, and presents the conceptual development of the model and the hypotheses for the study. Section 3 presents the global research project and the methodology of the quantitative study, relying on

[1] https://ec.europa.eu/food/safety/food_waste/eu_actions_en and https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy

structural equations modelling, and Section 4 presents analyses and results. Finally, Section 5 presents a general discussion followed by our recommendations and conclusions.

2. Literature review, theoretical framework and development of hypotheses

The literature has demonstrated the importance of routines in waste prevention (Stefan, 2013). To better understand these routines, this article focuses on the individual factors that may influence the adoption of these routines. Several studies have shown that motivations can be intrinsic (Cecere et al., 2014), and can be part of environmental or sustainability concerns (Grunert et al., 2014). However, food consumption - and thus FW - is a very specific subject with intimate, social and societal dimensions (e.g., Rozin, 1999). Consequently, explaining FW using a general concept of environmental concern does not seem satisfactory. In the following, after presenting studies on FW determinants and the role of routines in FW prevention, we show why the conceptualization of *food waste concern* is necessary.

2.1. Determinants of household food waste

FW has received increasing attention over the past few years. Studies aiming to explain variation in quantities of household FW mainly focus on two areas: 1) socio-demographic factors, and 2) psychosocial processes related to FW behaviour, FW management, and barriers to FW management. Among the socio-demographic factors influencing household FW, household size and composition are the most commonly cited (Koivupuro et al., 2012; Tucker and Farrelly, 2016). However, the size and composition of a household are connected to other factors which may play a more important role in household FW, such as food skills (higher for older households), food safety concerns (higher for households with children), planning and convenience orientation (younger or single households plan less and are more convenience-oriented than other households) (Aschemann-Witzel et al., 2015). Socio-demographic factors therefore should not be over-estimated, and psychosocial processes may be more relevant to explain household FW. Among the psychological processes, Egolf et al. (2018) show that food disgust sensitivity increases the frequency of throwing out food. In addition to the different types of variables mentioned above, the marketing strategies of retailers also can have an influence. For example, Aschemann-Witzel et al. (2017) investigate whether the purchase of products on promotion which are close to the expiry date increases a household's food waste. They show that price-focused consumers throw away these products less than other consumers do.

A range of contributions have specifically investigated the reasons that households waste food. Several of these studies have focused on determinants from the Theory of Planned Behaviour[2] (Stancu et al., 2016; Visschers et al., 2016). While these determinants are useful, they do not take into account barriers such as routines (Evans, 2011), lack of knowledge or skills related to food storage, handling or cooking, or the image of a good food provider (Porpino et al., 2015; Visschers et al., 2016).

[2] Theory of Planned Behaviour states that intentions preceding a given behaviour result from a cognitive process in which beliefs indirectly influence behavioural intention and behaviour (Ajzen, 1991). Attitude toward behaviour, subjective norms and perceived behavioural control directly determine behavioural intention and indirectly determine behaviour.

In their theoretical paper, Block et al. (2016) list the major sources of food loss across what they call "the squander sequence", and propose a focus from consumer acquisition to disposition. The authors list several well-established psychological/perception biases that can lead consumers to waste food, and mention the waste-generating potential of routines linked with rituals and traditions. However, they do not mention the existence or the positive role of waste-prevention routines. Past research has established that planning routines (making shopping lists, planning meals in advance, checking stocks before shopping) allow FW to be reduced (Quested et al.,2013; Stancu et al.,2016; Romani et al. 2018). The adoption of such routines may be motivated by concerns about the consequences of FW on the environment (unsustainability), and/or by specific personal goals such as reducing household's expenses or managing time and space efficiently.

To conclude, the literature review on the determinants of household FW supports the necessity of reversing the question from "How are we wasting food?" to "How are we avoiding wasting food?". It also calls for a better understanding of the complex chain of determinants of *avoiding* FW. This leads to the need to define consumer CFW and to study its dimensions, antecedents, and impact on waste-prevention routines. Such work has not yet been done. In the following sections, this article provides a definition and measurement of CFW and an integrative model to predict waste-prevention and waste-related routines.

2.2. From environmental concern to concern for food waste

As discussed in the introduction, the question of FW is closely linked to sustainability through the environmental costs of food production and waste management, food security, ethical questions, economic losses, etc. The wastage of all types of resources is one of the numerous aspects taken into account in various scales measuring environmental concern (e.g., Roozen and de Pelsmacker, 2000) and, more specifically, "the amount of food that is wasted" also appears in a measure of concern for sustainability (Grunert et al., 2014). In the same vein, Gilli et al. (2018) and Romani et al. (2018) incorporate the fact of being bothered by wasting unconsumed food in their studies of intrinsic motivations toward waste prevention and recycling. However, as previously mentioned, the specificities of food consumption and - consequently - of FW (Cecere et al., 2014), require a specific definition and measure of concern for FW.

The three dimensions of attitude (affective, cognitive, behavioural) emerging from the research on environmental concern (Fransson and Gärling, 1999) are relevant for CFW. CFW is thus defined as attaching importance to FW, being aware of its consequences (cognitive dimension), being emotionally affected by the experience of FW or the general issue of FW (affective dimension) and having the general intention to limit one's FW (behavioural dimension). CFW reflects the extent to which consumers are worried about FW.

Furthermore, the three levels evoked by Schultz (2001) and Hansla et al. (2008) in their works on environmental concern (oneself, others, biosphere) are relevant for CFW. Hence CFW will be studied taking into account these different levels.

2.3. The latest step of a wider research project

As indicated in Table 1, the study presented in this article is part of wider research work encompassing two quantitative and two qualitative studies which we describe hereafter. In this subsection, we briefly describe the first three studies that allowed the preparation of this fourth study (called hereafter "Study 4"). Study 4 will be presented starting in Section 2.4.

TABLE 1
Sequence of studies

<table>
<tr><td></td><td>Study 1</td><td>Study 2</td><td>Study 3</td><td>Study 4</td></tr>
<tr><td>Source</td><td colspan="2">Authors (2013)</td><td>Authors (2015) (communication)</td><td>Present article</td></tr>
<tr><td>Purpose</td><td colspan="2">Explore FW concern</td><td>Build CFW scale</td><td>Explanatory model</td></tr>
<tr><td>Method</td><td>Qualitative study (interviews)</td><td>Qualitative study on French web</td><td>Quantitative study</td><td>Quantitative study</td></tr>
<tr><td>Participants and procedure</td><td>20 semi-structured interviews
Thematic analysis</td><td>252 comments of 588 publications on FW
Thematic analysis</td><td>300 respondents /224 valid responses
Internet questionnaire</td><td>1500 respondents /1018 valid responses
Internet questionnaire</td></tr>
<tr><td rowspan="3">Results</td><td colspan="2">Perceived consequences of FW</td><td rowspan="3">Reliable and valid CFW scale</td><td rowspan="3">Structural equation model of antecedents and consequences of CFW</td></tr>
<tr><td>Different dimensions of CFW: personal, interpersonal, global</td><td>Antecedents of CFW: Food education, concern for purchasing power</td></tr>
<tr><td colspan="2">List of 41 items
for the CFW scale</td></tr>
</table>

Study 1 (Authors, 2013) relies on 20 semi-structured interviews with French consumers which started with a focus on their negative experiences associated with wasting. Thematic analysis (vertical and horizontal analysis) of the verbatim highlights five types of FW consequences - environmental, ethical, psycho-affective, financial and social - perceived by consumers. The analysis also leads one to distinguish different levels/dimensions, from personal/interpersonal to global concern.

Study 2 (Authors, 2016) consists in analyzing 252 comments out of a pool of 3,127 comments of web users in reaction to publications (press articles, forum topics, etc.) related to FW. Thematic analysis again reveals the various consequences of FW perceived by consumers and expressions of concern about FW. The results confirm that for Internet users, waste refers to environmental concerns and moral conscience, supporting the work of Graham-Rowe et al. (2014). Users' comments refer to two antecedents of their concern for FW: education about

food received from parents and concern for purchasing power (financial concerns), as already highlighted by Quested et al. (2013).

The two thematic analyses of Studies 1 and 2 led to a list of items, used in Study 3, to build a reliable measure of CFW. An online survey was sent to a panel of 300 respondents that contained 19 items (7-point Likert scale) and asked for the gender, age and socio-professional category of the respondent. A quota method based on national population statistics (on age, gender and socio-professional category) ensured diversity of these criteria. After excluding incomplete or 'automatic' answers, 224 answers were retained. In terms of gender, 47% of the respondents were men, and of age, 30% were between 20 and 34 years, 36% between 35 and 49, and 27% between 50 and 64.

Exploratory factor analysis reveals a structure of concern with two factors accounting for 73% of the total variance, relying on a selection of eight items. Given the items associated with each factor, the interpretation of their theoretical meaning is clear. The first factor refers directly to concern for FW at an individual level, while the second one refers to concern oriented to a "global" level (Table 2).

TABLE 2: Structure of CFW after exploratory factor analysis

Dimensions of CFW	**Items**
Individual concern for food waste	I would feel ashamed if someone saw me getting rid of edible food
	I am really affected when I see someone throwing away edible food
	Managing food properly in order to waste as little food as possible is a real concern for me
	Around me, throwing away food is frowned upon
	Throwing away food poses an ethical problem to me as regards those who are starving
Global concern for food waste	Food waste poses problems for waste management in cities
	Today, food waste is a significant issue in France
	Food waste has really harmful consequences for the planet

Confirmatory factor analysis conducted in Study 4 confirms this structure. The loadings and other relevant indicators for the measuring scale of CFW are given in Appendix B, along with the other measures.

Having described the first three preparatory studies, we shall now present Study 4, which is the focus of this paper.

2.4 Research hypotheses and model

We model two kinds of behaviour. First, we formulate hypotheses to explain the frequency of a direct 'wasting behaviour', namely throwing away leftovers after a meal. Second, we present six waste-prevention routines to be used as dependent variables (hypotheses indexed 'a' to 'f'): Making written shopping lists before shopping (a), Planning meals in advance (b), Keeping

fridge in order, which means storing products in different areas according to their categories (c), Storing leftovers in closed boxes (d), Consuming in priority products that are close to their expiry date (e), and Checking stocks before shopping (f). As mentioned in the literature review, past research has established the waste-prevention impact of these six routines (Hoj, 2011; Quested et al., 2013; Stancu et al., 2016; Romani et al., 2018) and supports the choice of these routines for our study.

While previous literature has demonstrated that FW is the result of different actions linked to the purchase, storage, preparation and consumption of food, little attention has been paid to potential antecedents of these actions. Nonetheless, existing studies have mentioned three variables which this research shall analyze: (1) concern for purchasing power, (2) food education, and (3) food involvement. Food involvement is defined here as the importance people give to food in their everyday lives and in the definition (and the expression) of their person, the interest they have in it, and the pleasure they derive from it. This concept is similar to the definition of involvement given by Laurent and Kapferer (1986), namely "an unobservable state of motivation, excitement or interest [that is] created by a specific object or situation..." Nevertheless, it departs from this definition in that it does not concern a product or a category of products, but food, which encompasses not only a multitude of product categories but also a multitude of behaviours. Preparatory qualitative studies (Authors, 2013, 2016) also support the choice of these antecedents and are presented in Section 3.1.

Concern for purchasing power

Although concern for purchasing power has received little attention, past studies on consumer FW behaviour show that consumers focus on economic and financial concerns (Lyndhurst, 2009). Consumer concern for purchasing power – defined as the level of importance attached by a consumer to preserving his/her capacity to purchase (Bertrandias and Lapeyre, 2009) - might then have an effect on CFW. Moreover, some routines that decrease waste at the household level might result from financial motivations. Furthermore, some studies have found that consumers who waste less food are those who are more price-conscious (Williams et al., 2012). Conversely, consumers who are less price-conscious are the ones who report the highest levels of FW (Mallison et al., 2016).

H1: Concern for purchasing power has a positive relationship with Concern for food waste

H2: Concern for purchasing power has a negative relationship with the frequency of throwing away leftovers after a meal

H3(a) to (f): Concern for purchasing power has a positive relationship with the adoption of waste-prevention routines (a) to (f).

Food education

Previous studies on predictors of FW did not focus specifically on food education but included it in personal norms, which are determinants of self-reported FW in households (Visschers et al., 2016). Some studies reveal that a link may exist. A study of US consumers reveals that

consumers with ancestral affiliation with Asia report more FW guilt than other consumers. The authors explain this difference with the hypothesis of a stronger education about FW in these countries (Qi and Roe, 2016). A study conducted in a restaurant context identified food culture and education as being related to attitudes and behaviours toward FW (Sirieix et al., 2017). This leads to the following hypotheses:

H4: Food education has a positive relationship with Concern for food waste

H5: Food education has a negative relationship with the frequency of throwing away leftovers after a meal

H6(a) to (f): Food education has a positive relationship with the adoption of waste-prevention routines (a) to (f)

Food involvement

In the same vein, food involvement does not appear in the body of predictors in previous studies related to household FW. However, Parizeau et al. consider in their study the variable of food awareness, measured with items related to special diets, food gardens, and reading nutrition labels (Parizeau et al., 2015). They demonstrate that Canadian consumers with high food awareness feel more confident that they could reduce FW in their homes. Likewise, Mallison et al. show that UK consumers who appreciate food-related activities (cooking and eating) are those who generate the least waste (Mallison et al., 2016). In a restaurant context, food involvement also has been identified as being related to attitudes and behaviours toward FW (Sirieix et al., 2017). Food involvement is included in the model as follows:

H7: Food involvement has a positive relationship with Concern for food waste

H8: Food involvement has a negative relationship with the frequency of throwing away leftovers after a meal (H6a)

H9(a) to (f): Food involvement has a positive relationship with the adoption of waste-prevention routines (a) to (f)

Concern for food waste

Finally, in the same way that environmental concern leads to green purchase behaviour (e.g., Kim and Choi, 2005) and environmentally-friendly behaviour (Kilbourne and Pickett, 2008; Haws et al., 2014), CFW is expected to influence various behaviours and routines which have been shown to have an effect on FW. These include shopping and planning routines (Mallison et al., 2016; Stancu et al., 2016), domestic routines such as keeping the fridge in order, consuming leftovers as soon as possible, giving priority to products that are close to their expiry date, and checking supplies before shopping (Hoj, 2011, Quested et al., 2013).

A discrepancy may seem to exist between a conscious concept such as concern and routine behaviours which occur without deliberation (Verplanken, 2006). Indeed, routines are characterized by lack of awareness, difficulty to control and mental efficiency (Verplanken, 2006). However, the lack of awareness is related to the routine behaviour itself, and not to the reason why the behaviours have been adopted. The automaticity of the routine does not mean

that individuals are not aware of the problem that led them to adopt more sustainable behaviours. Indeed, Stancu et al. (2016) have shown that awareness of the consequences of FW is associated with food-related routines. However, they did not include awareness of food waste consequences in their model and did not study CFW.

In line with the literature on the Environmentally Concerned Consumer and his/her ecological behaviour, we thus propose the following hypotheses:

H10: Concern for food waste has a negative relationship with the frequency of throwing away leftovers after a meal

H11(a) to (f): Concern for food waste has a positive relationship with the adoption of waste-prevention routines (a) to (f)

Mediations

Kim and Choi (2005) remind us that attitudinal constructs such as environmental concern play a mediating role between individual values and behaviour. In the same vein – and according to the former hypotheses - behavioural influence of concern for purchase power, food education, and food involvement may be mediated by CFW. The following mediation hypotheses will thus be tested:H12: Concern for food waste mediates the relationship between concern for purchasing power and the frequency of throwing away leftovers after a meal

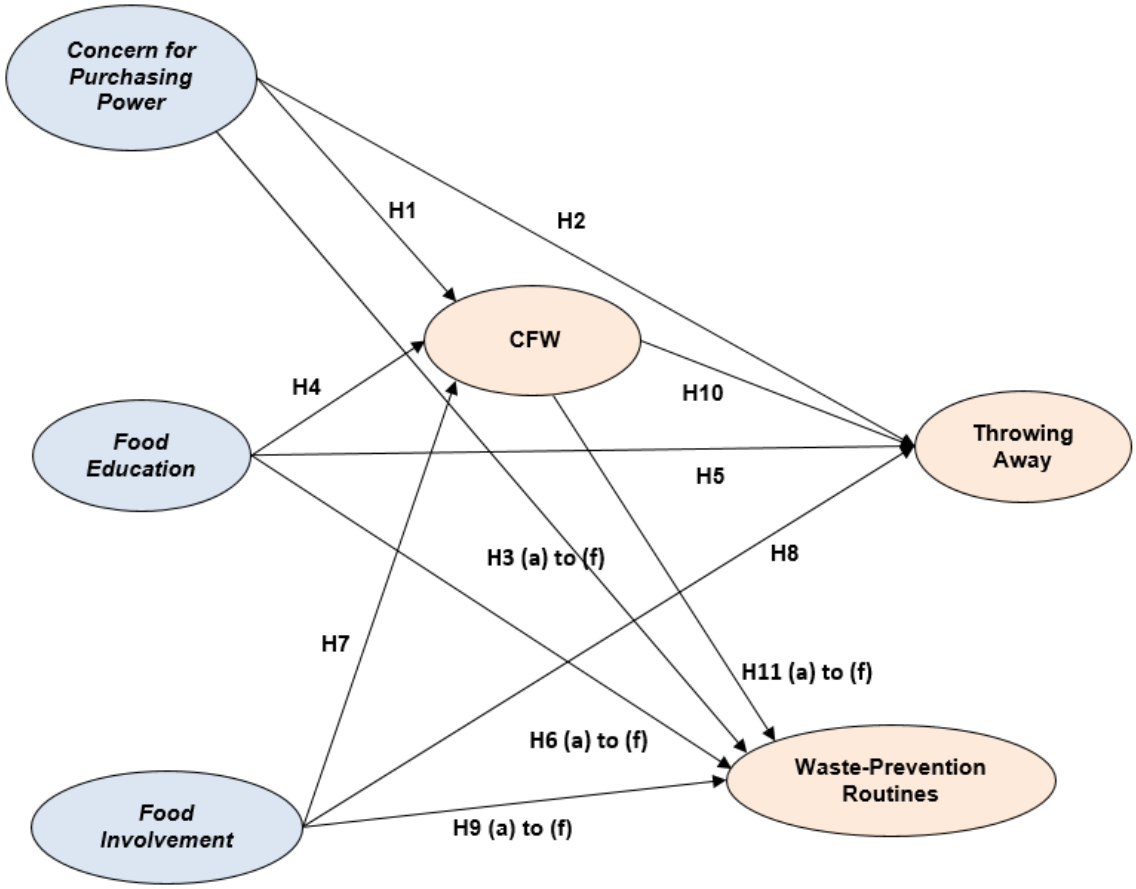
H13: Concern for food waste mediates the relationship between food education and the frequency of throwing away leftovers after a meal

H14: Concern for food waste mediates the relationship between food involvement and the frequency of throwing away leftovers after a meal

Based on these hypotheses, Figure 1 presents the model that is tested in Section 3.

FIGURE 1

Consumer Concern for Food Waste (CFW) - Model



Legend:

- Circles in light blue correspond to independent variables
- Circles in light pink correspond to dependent variables

3. Materials and methods

The objective of this study was to examine the links between CFW, its antecedents, and various food-related behaviours. Specifically, hypotheses H1 to H11 were tested.

An online questionnaire containing the CFW items and the items intended to measure relevant constructs and reported behaviours was sent to a sample of French respondents. One thousand five hundred questionnaires were sent to potential respondents via a market studies firm that selects respondents from a nationwide panel of households. After the elimination of incomplete or blatantly insincere responses, 1,018 satisfactory responses remained.

Thirty-six percent of the respondents were men, which is close to the share of households in France where a man is the 'main person responsible for food purchases'. In terms of age, 22.5% of the respondents were between 20 and 34 years, 31.2% between 35 and 49, 28.8% between

50 and 64, and 20.4% were 65 or older. Forty-seven percent of respondents had completed high school or held an undergraduate or higher degree.

In what follows, we present the scale measures of Food involvement, Food education, Concern for purchasing power and CFW. We then present the food-related and waste-prevention-related routines selected for this study.

As mentioned before, we adapted the measure of food involvement from the involvement scale of Laurent and Kapferer (1986). The scale measures the first three facets of involvement (Importance, Sign value, Pleasure value) along a 6-item 7-point (do not agree at all /… / totally agree) Likert scale (α=.84). Food education was assessed with an ad hoc 3-item 7-point Likert scale (α=.81). The three items were adapted from statements collected in Studies 1 and 2. The concern for purchasing power scale used in this study was adopted from Bertrandias and Lapeyre (2009), again with a 3-item 7-point Likert scale design (α=.82). We assess CFW with the 8-item scale developed by Authors (2015) and presented in Section 3.1. Appendix B presents these scales and lists their items, along with the relevant corresponding indicators.

Food-related and waste-prevention-related routines were selected based on their proven impact on FW avoidance (Evans, 2011; Quested et al., 2013; Stancu et al., 2016; Romani et al., 2018), with the support of qualitative Studies 1 and 2. The recourse to these routines was assessed through their reported frequencies. Respondent were asked at which frequency they "make shopping lists" / "put leftovers in closed boxes" / etc. Frequencies were simultaneously proposed in a subjective (adverbs) and objective (ratios) way ("Never or almost never (less than 1 out of 5) / From time to time (approx. 1 out of 3) / Most of the time (approx. 2 out of 3) / Systematically") to both limit subjectivity bias and cognitive effort. Table 3 lists these routines.

TABLE 3
Six waste-prevention-related routines and a direct wasting behaviour

Type of behaviour or routine	**Behaviour or routine**
One type of direct wasting behaviour	Throwing away leftovers after a meal
Planning routines	Making written shopping lists before shopping
	Planning meals in advance
Management of stocks and leftovers	Keeping fridge in order (storing products in different areas according to their categories)
	Storing leftovers in closed boxes
	Consuming in priority products that are close to their expiry date
	Checking stocks before shopping

Because of the negative connotation of the word "waste", the study aims to attenuate social desirability bias as much as possible by including a measure (7-point Likert scale) of social desirability and including it as a control variable in the model. The measuring scale was adapted from Paulhus' Balanced Inventory of Desirable Responding (BIDR) (Paulhus, 1988) (see Appendix A).

4. Analysis and results

Data from this and the following surveys were analyzed using XLSTAT 2018 software.

4.1. Reliability, convergent validity and discriminant validity of constructs

Reliability of the scales was assessed for each construct with Cronbach's alpha coefficient, composite reliability, and average variance extracted (AVE) (Fornell and Larcker 1981; Gerbing and Anderson, 1988). Appendix B reports these results. Scales showed good internal consistency (α>.8) and good levels of reliability (composite reliability >.8).

In particular, empirical data and confirmatory factor analysis revealed a two-dimensional structure of CFW: a 'personal/interpersonal' dimension and a 'global' dimension. Given the meaning of the items and the signification of the two main factors, it seemed theoretically necessary to split CFW into two distinct variables in order to study the roles of these two dimensions separately. These consist of 1) a second-order latent variable, 'individual CFW', based on two first-order latent variables corresponding to the two sub-factors forming individual CFW: 'affect' and 'norms', and 2) a 'global CFW' latent variable measured by the items linked to the 'global' factor (see Appendix B). As in Study 2, high levels of individual CFW (m=5.9, s.d.=1.0) and global CFW (m=5.9, s.d.=1.0) were found in this sample.

Confirmatory factor analysis established reliability, convergent validity and, discriminant validity for the variables considered in the model (with the split of CFW into 'individual CFW' and 'global CFW') using the HTMT method (Henseler et al., 2015) (see Appendix C). The HTMT scores were all below the 0.85 threshold commonly retained for discriminant validity (Henseler et al., 2015). In particular, discriminant validity between individual and global CFW was established, supporting the theoretical choice described above.

The data were then fit to a structural equation model. Structural equation modelling was run with the PLSPM (Partial Least Square Path Modelling) method. Significance of path coefficients led us to accept or reject the corresponding hypotheses. The results which follow are those for the model with "frequency of throwing away leftovers after a meal" as the explained behaviour. Table 4 then sums up the results for the other models (one model for each explained behaviour). Given the split of CFW into individual CFW and global CFW, corresponding hypotheses were duplicated (e.g., H1 becomes $H1_{indiv}$ and $H1_{glob}$).

4.2. Fit and hypothesis testing - Main model

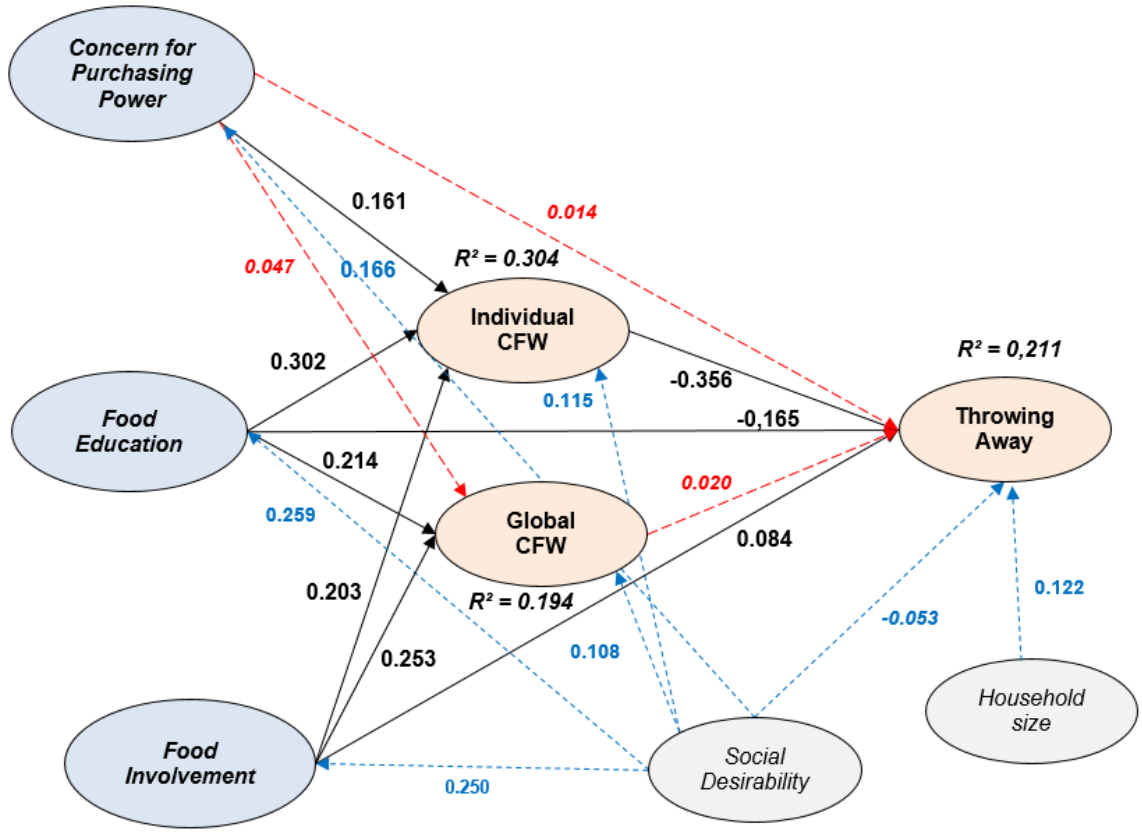
The fit indexes showed that the model has a satisfactory fit with the data. The absolute Goodness of Fit (GoF) was 0.53, far above the 0.36 threshold for excellent fit suggested by Wetzels, Odekerken-Schroder & Van Oppen (2009). Overall, the model accounted for 21% of the variance of the "throwing away leftovers after a meal" variable (named "throwing away" hereafter).

Path coefficients were given after 5000 bootstrap replications, and most of them were significant (12 out of 16). Path coefficients and significance levels are presented in Figure 2.

The paths from food involvement, food education, and concern for purchasing power to Individual CFW and to Global CFW were all significant and positive (H4 and H7 were validated), except the path from concern for purchasing power to global concern ($H1_{indiv}$ was validated, $H1_{glob}$ was not validated). The path from Individual CFW to "throwing away" was significantly negative (-.356, p<.01), whereas the path from Global CFW to "throwing away" was not significant ($H10_{indiv}$ validated, $H10_{glob}$ not validated). Finally, among the antecedents of CFW, only food education had a significant (negative) path to the waste behaviour after meals (H5 validated, H2 and H8 not validated). The three antecedents had indirect relationships with throwing away leftovers after meals, via CFW. Mediation effects were tested with successive Sobel tests on 5000-replication bootstrapped data, as recommended by Zhao, Lynch and Chen (2011), for the relationships of antecedents of CFW with "throwing away" behaviour. Individual CFW was a partial mediator for the Education→"Throwing away" relationship (39% of total effect), and a rival mediator for the Involvement→"Throwing away" relationship (positive direct effect, and negative indirect effect). Thus, $H13_{indiv}$ and $H14_{indiv}$ were validated, while $H12_{indiv}$, $H12_{glob}$, $H13_{glob}$, and $H14_{glob}$ were not validated.

FIGURE 2

The Consumer Concern for Food Waste (CFW) Model: Structural Equations Model Results for Throwing Away Behaviour



Legend:

- Circles in light blue correspond to independent variables
- Circles in light grey correspond to control variables
- Circles in light pink correspond to dependent variables
- Numbers in *red* or ***blue*** & ***italics*** correspond to non-significant path coefficients

- Red dotted arrows correspond to non-significant path coefficients
- Blue dotted arrows correspond to control variables

4.3. Models for waste-prevention-related routines

In addition, six similar models were fitted to data, with one model for each explained routine. This means that "throwing away" was successively replaced by each of the six food-related routines in the main model as the explained variable. In contrast with "throwing away", these routine behaviours are waste-prevention routines, be they performed for this purpose or not. Individual concern had a positive and significant direct influence on the frequency of each of the six routines, while global concern had no significant path on any of them. Regarding CFW's antecedents, those having significant direct influence on routines differed from one routine to the other. Whereas planning routines (planning meals in advance, making shopping lists) were mainly explained by concern for purchasing power and individual CFW, the management of stocks and leftovers (checking stocks before shopping, eating in priority products that are approaching their "use by" date, storing leftovers in closed boxes) was explained by food education and individual CFW. Food involvement influenced directly and positively "keeping fridge in order" and "planning meals in advance" routines.

Table 4 summarizes the significance and sign of the paths heading from each construct to each routine. Hypotheses that were validated appear in the table under the corresponding path coefficient.

TABLE 4
Paths from each construct to each behaviour or routine

Behaviour / **Variable**	**Throwing away leftovers**	**Making shopping lists**	**Planning meals in advance**	**Keeping fridge in order**	**Storing leftovers in closed boxes**	**Priority to near expiry date**	**Checking stocks before shopping**
Concern for Purch. Power	n.s.	.090* H3a	.066* H3b	n.s.	n.s.	n.s.	n.s.
Food Involvement	.084*	n.s.	.100* H9b	**.147** H9c**	n.s.	n.s.	n.s.
Food education	**-.165** H5**	n.s.	n.s.	.072* H6c	.102* H6d	.107* H6e	.084* H6f
Individual Concern	**-.356** H10$_{indiv}$**	.115* H11a$_{indiv}$	.081* H11b$_{indiv}$	**.121** H11c$_{indiv}$**	**.166** H11d$_{indiv}$**	**.188** H11e$_{indiv}$**	**.239** H11f$_{indiv}$**
Global Concern	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

** **bold print**: Positive *(.147**)* or Negative *(-.356**)* relationship, significant at the 1% threshold

: Positive (.090) relationship, significant at the 5% threshold

Absolute GoFs (for the six models) range from .52 to .53.

5. Discussion and implications

5.1. Discussion and implications for theory

Study 4 confirms that CFW has two dimensions: individual concern and global concern. Although they are rather highly correlated (Pearson's correlation coefficient = .58), these two dimensions do not have the same behavioural implications. More precisely, when considering the two influences simultaneously through the PLSPM approach, individual concern has a significant relationship (with the expected signs) with all of the tested behaviours and routines, whereas global concern has no significant relationship with any of them. With regard to research on sustainability-related concern(s), this result allows a finer understanding than that achieved in studies which only consider a single dimension (Kilbourne and Pickett, 2008; Grunert et al., 2014). Unlike other concerns related to environmental and ethical dimensions of sustainability, the consequences of FW are immediately visible at the household level, making the distinction between individual and overall levels of concern more relevant.

This study highlights three antecedents of CFW: food education, concern for purchasing power, and food involvement. Among the three antecedents, food education has the strongest positive influence on individual concern for FW. It also has a strong negative influence on the frequency of throwing away leftovers after a meal, and a strong positive influence on the waste-prevention routines, with the exception of planning routines. This supports the idea that when behavioural habits – which may or may not be linked to principles – are learned early in life, this probably has a greater impact on future concern and behaviour than simply learning principles alone (McGregor, 2009). Consequently, this also calls for education policies emphasizing tips on how to manage food, cook, avoid wasting, re-using, etc., to shape the habits of future adults. Concern for purchasing power has a positive relationship with two routines related to purchasing (making shopping lists) and planning (planning meals in advance) and on Individual CFW. Conversely, it has no significant influence on Global CFW. Again, these results legitimize the choice made in this study to distinguish between the two levels of concern. They also help to understand why the results on the relationship between purchasing power concern and waste-related routines are divergent in the existing literature.

Food involvement has a positive impact on CFW, having a negative indirect relationship (mediation by CFW) with throwing away. However, it has a positive direct relationship with the frequency of throwing away leftovers after a meal. This might come from a possible contradiction between two goals: on the one hand, not wasting food, on the other, enjoying food consumption. This second goal sometimes leads to cook more than necessary and/or to prefer eating dishes that have just been cooked rather than leftovers. Food involvement thus appears to have two potentially opposite influences on this specific FW behaviour.

The other main research goal was to highlight relevant antecedents of six waste-prevention routines and a waste behaviour. Study 4 confirms most of the relationships hypothesized, and reveals that waste-prevention routines have different antecedents according to their type.

Planning routines are mainly explained by concern for purchasing power, while routines of leftovers (and stock) management are explained by food education and CFW. That makes sense, since shopping lists and meals lists are both part of purchase planning, which is one of the main ways to try to limit and/or rationalize expenses. Food education's influence on the management of leftovers also is logical, such routines being acquired during childhood through involvement in their performance and education on values with regard to respecting food. In the same vein, results show that food involvement positively influences meal planning and fridge organization management. Again, these results have strong implications, discussed in Section 5.2.

Finally, this study also reveals an age effect, already found in other studies (Quested et al., 2013), namely older people generally declare wasting less than the average (and usually do waste less). This may be due to the household's characteristics mentioned previously, but also to a "generation" cause, since people that are 60-and-above may have experienced penury during and after the Second World War, or felt the effects of this penury through their parents' discourses and actions. However, a potential social desirability bias cannot be excluded.

5.2. Implications for practice

Stöckli et al. (2018) point out that although informational interventions on FW are popular among practitioners, evidence of their effectiveness is lacking. The results of this study – in particular the poor impact of global concern – confirm that informational interventions alone may be ineffective in changing consumer behaviour. Chandon and Wansink (2011) suggest the use of small-step approaches, "[nudging] consumers into making slightly better but repeated food choices without thinking about it". Modifying the environment, or encouraging and allowing small changes in food habits, are steps that do not depend on resources which are limited, such as consumers' self-control or attention. In their meta-analysis of the implementation of nudges targeting eating behaviours, Cadario and Chandon (2020) show that nudges that directly target a behaviour are more effective than those that target the cognitive or emotional determinants of the behaviour, a result that can be explained by the importance of habits within eating behaviours. However, nudges may have a limited effect (in extent and in time), as highlighted by Hummel and Maedche (2019). The effect of nudges may be small, especially in the face of variables such as promotional offers or the promotion of abundance. Smith and Toprakkiran (2019) thus emphasize that nudges can only have a limited effect because they act only on the immediate environment (the architecture of choice) but do not alter the social, economic and political structure in any way. In doing so, they remind us that the environment of consumption, which determines consumption choices, is not limited to the immediate environment. Study 4 illustrates this with the ambivalent influence of food involvement (which has a pleasure dimension) on "throwing away" behaviour. For consumers paying great attention to food pleasure, initiatives suggesting delicious recipes that can be made with leftovers would be relevant. More generally, the environment of consumption could be improved in a broader way (increasing fresh food accessibility by supporting small retailers in neighbourhoods, giving free storage boxes to promote efficient storage of leftovers, etc.) to help gradually change – or to switch - routines in the long run.

Personal motivations also can help consumers adopt some behaviours. FW has the "advantage" in that it involves concrete concerns affecting individuals rather than more abstract global environmental concerns, and these can be used in communications. Given the poor impact on

routines of global CFW, and the high impact on routines of individual/interpersonal concern and the antecedents of concern such as concern for purchasing power, messaging that is closer to the concerns of individuals is necessary. Approaches that use these levers by linking FW and purchasing power, which already have been implemented in various projects, might be more effective than "why you should" campaigns which emphasize abstract knowledge of global consequences. This approach would seek to have an impact on food-waste-related routines through individual/interpersonal CFW and its antecedents. Moreover, increasing food involvement, teaching how to cook and how to care about food, could help more specifically young individuals, since older consumers generally declare wasting less and do waste less than the average. For individuals who are involved in food and more precisely in the pleasure dimension of food, initiatives aiming at providing tips and recipes in order to prepare enjoyable dishes are relevant (e.g., on the BBC Good Food website[3]).

Moreover, campaigns aiming to limit FW should be designed in coherence with other campaigns, such as food safety or nutritional campaigns (Dyen et al., 2018). For instance, in France, the "5-to-10-fruits-or-vegetables-in-a-day" may lead consumers to buy more than they are "able" (or accustomed) to eat, and to waste fruits and vegetables. While this recommendation is justified on nutritional grounds, it should be supported with tips on how to properly store fresh products, with classes at school to learn how to prepare/consume fruits and vegetables, so that individuals can learn and implement the complex chain of practices related to the consumption of fruits and vegetables.

Birau and Faure (2018) highlight the backfiring effects of messages that blame consumers for waste, confirming the findings of Evans (2011) about FW. They also claim that manipulating the perceived difficulty of a task through messages such as "it is really not that difficult to reduce paper waste" helps increase the effectiveness of anti-waste campaigns. We do not think that these results are applicable to FW, as avoiding FW generally involves not only intention but also a complex set of behaviours (including routines) and trade-offs. As confirmed by this work, many consumers end up wasting food despite their high concern and their intention - and sincere efforts – to avoid waste. It is, for instance, too late to avoid waste when a perished food product is discovered in the fridge. Avoiding FW requires *inter alia* prophylaxis along with the performance of a large set of food-related routines (including those we have studied here). An institutional statement like "it is not so hard not to waste food" (be it true or not) might lead the consumers who "try but don't manage to avoid waste" to feel guilty. Such advertising might hence be ignored, denied (to avoid cognitive dissonance) or generate a severe reaction by consumers, like other messages directly blaming consumers (Authors, 2016).

5.3. Limitations and further research

The empirical results reported herein should be considered in the light of some methodological limitations. First, the sensitive nature of the topic suggests the possibility that respondents might minimize their reporting of waste. Even if this study considers the social desirability bias and tries to dampen it, future research should monitor actual waste behaviours to acquire the most accurate indication of real FW, and not just self-reported behaviour. Second, the sample is not strictly representative of the French population since it stems from a consumer panel of

[3] www.bbcgoodfood.com/recipes/collection/leftovers-recipes

respondents, with a probable selection bias due to the fact of willingly belonging to such a panel.

Theoretical limitations should also be mentioned. We focused here on concern for FW, setting aside other psychological and behavioural determinants of FW at home. In the same vein, we focused on a restrained number of antecedents of CFW. Finally, the Throwing Away variable refers to just one of many routes for wasting food.

The theoretical limitations of this study indicate that further research attempts might enrich the conceptual model, explain some unexpected relationships between variables, and study actual and not just self-reported behaviour.

First, future research can enrich the conceptual model presented in Study 4. A broader conceptual model should be tested, including additional antecedents of concern for FW and other personal variables such as perceived consumer effectiveness, self-efficacy, locus of control and perceived responsibility. Further studies should also consider values and beliefs as antecedents of concern for FW, in particular materialistic values as Kilbourne and Pickett (2008) did for environmental concern.

Second, in addition to analyzing the influence of CFW on food wastage, further research could look at the combined influence of CFW with other psychological determinants of FW, such as sensitivity to disgust (Egolf et al., 2018). More broadly, it would be interesting to study its impact on all food-related behaviours and routines as previous research has highlighted the link between FW and other food-related behaviours, for instance, the effect of concerns about food wastage on mothers' reoffering of vegetables to children (Holley et al., 2018).

Verplanken and Wood explain that changing people's beliefs and intentions is not sufficient to change habits. More precisely, downstream interventions such as providing information or changing beliefs are effective when the behaviour to be changed is not or is rarely habitual. In contrast, when the behaviour is strongly habitual, these interventions must be associated with context-changes related to the physical environment or the social environment (Verplanken and Wood, 2006). Studies which adopt a theory of practice approach discuss how daily food practices are organised and how the routines that develop can be changed. Dyen et al. (2018) show that practices are systematized to different degrees and are related to time, commitment, social relations and material context. This makes everyday routines very stable. Hence, in order to change them, one must understand their dynamics. More precisely, Devaney and Davies (2017) show that materiality, social context, social relations and micropolitics of practices have to be taken into account in order to change them. They propose to implement in-home experiments for more sustainable eating, or Home-Labs.

Further research thus should take into account the elements constituting the practices. An experimental study with households could consist of comparing the evolution in behaviour of two subsamples. For the first subsample, the focus could be on the provision of information to increase food waste concern, while for the second, the focus could be on the implementation of new practices thanks to a context-change.

In the present context of the Covid-19 crisis and lockdown, it also would be relevant to study the influence of this context-change both on CFW and on food habits.

In conclusion, the current study contributes to a better understanding of FW avoidance. Our results reveal four antecedents of efficient waste-prevention routines: food education, food involvement, concern for purchasing power, and CFW. The conceptualization and measure of CFW proposed in this study, completed by a model showing its mediating role, provide a basis for future research to improve understanding of food-related behaviours associated - or not - with less FW.

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Appendix A: Measure of social desirability

Adapted from Paulhus (1988), 7-point Likert scale.

Dichotomous scoring (only extremely high answers – six or seven – count for one point) is used, following Paulhus.

Category	Items	Mean dichotomous score
Self-Deceptive Enhancement (SDE)	My first impressions of people usually turn out to be right	.42
	I never take things that don't belong to me	.69
	I don't care to know what other people really think of me	.39
	I never regret my decisions	.14
Impression Management (IM)	I have said something bad about a friend behind his or her back (*Reverse-scored item*)	.20
	I don't gossip about other people's business	.54

Mean dichotomous score: 2.38. Standard deviation: 1.54.

Appendix B: Reliability and validity

Construct / Items		Loadings	J's rho*	AVE
Individual Concern for food waste *The first factor accounts for 57% of the variance. Second factor: 15%. Cronbach Alpha: 0.81*				
Affect	I would feel ashamed if someone saw me getting rid of edible food	.794	0.87	0.58
	I am really affected when I see someone throwing edible food away	.810		
	Managing food properly in order to waste as little food as possible is a real concern for me	.774		
Norms	Around me, throwing food away is frowned upon	.684		
	Throwing food away poses an ethical problem to me as regards my relatives	.749		
Global Concern for food waste *The first factor accounts for 69% of the variance. Cronbach Alpha: 0.78*				
Food waste poses problems for waste management in cities		.824	0.87	0.69
Today, food waste is a significant issue in France		.830		
Food waste has really harmful consequences for the planet		.834		
Food involvement (adapted from Laurent and Kapferer (1985)) *The first factor accounts for 55.5% of the variance. Second factor: 16.7% Cronbach Alpha: 0.83*				
Importance - Pleasure	I like to talk about what I've eaten or what I'm going to eat	.688	0.88	0.55
	Food is very important to me	.778		
	Eating is a pleasure for me	.727		
	When I buy food, I try to indulge myself	.748		
Sign	The food I buy somewhat tells who I am	.714		
	What I eat reflects part of the kind of person I am	.782		
Concern for Purchasing power (Bertrandias and Lapeyre, 2009) *The first factor accounts for 74% of the variance. Cronbach Alpha:0.82*				
Even if it requires a lot of energy, I try to maintain my purchasing power		.870	0.89	0.73
When I shop, I'm concerned about maintaining my purchasing power		.861		
I hate the idea of losing purchasing power		.844		
Food education *The first factor accounts for 73 % of the variance. Cronbach's alpha: 0.81*				
When I was young, my parents always asked me to eat all the food on my plate		.840	0.89	0.74
When I lived with my parents, we used to keep and consume all the leftovers		.871		
When I was a child, playing with food was not allowed at home		.850		

*Joreskog's rho

Appendix C: Squared correlations, AVE and, HTMT scores

Squared correlations and AVE:

	Individual CFW	Global CFW	Involvement	Education	CPP	AVE
Individual CFW	**1**	.337	.124	.216	.162	.584
Global CFW	.337	**1**	.116	.118	.070	.688
Involvement	.124	.116	**1**	.069	.118	.547
Education	.216	.118	.069	**1**	.239	.729
Concern for Purchasing Power	.162	.070	.118	.239	**1**	.739
Average Variance Extracted (AVE)	.584	.688	.547	.729	.739	**0**

HTMT scores:

HTMT	Individual CFW	Global CFW	Involvement	Education	Concern for Purchasing Power (CPP)
Individual CFW					
Global CFW	.735				
Involvement	.407	.416			
Education	.574	.438	.294		
CPP	.487	.334	.380	.659	

Scores are all below the common .8 threshold (Henseler et al., 2015)