Impact of Expectation on Food Waste

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Abstract. This research believes culture plays a minimum role in contributing to it as we have observed similar behavior across countries. Multiple pieces of research showed that educational campaigns hardly reduce food waste. This paper aims to study individual behavior and expectations as determinants of food waste. The research question is what are the factors that lead to food waste? We designed questionnaires and distributed them to restaurant customers in both China and the United States in the form of QR codes. Then we collected a total of 152 responses and conducted an analysis on R studio. We found that the greater the difference between one's expected spending and actual spending, the more percentage of food one will likely waste. Such a pattern is also true for expected consumption and actual consumption. This result is interpreted through the lens of satisficing theory developed by Herbert Simon and anchoring by Tversky and Kahneman. We applied satisficing theory in the food industry to analyze food waste. This extends the application of the theory and provides an alternative way to interpret food waste. It shows that food waste is the result of consumers' rational utility-maximizing behavior. Additionally, the research also shows that people tend to spend more than they would have expected during a dining experience. Our research has confirmed conclusions from previous studies on consumers' awareness of consumption amount and external impacts on their behavior. More importantly, we connect those impacts with food waste percentage and obtain a model that has predictive power on food waste percentage.

Keywords: Food waste · Satisficing · Anchoring · Consumer behavior · Expectation

1 Introduction

A new report, *The Business Case for Reducing Food Loss and Waste: Restaurants*, reveals there is a compelling business case for restaurants to reduce food waste [14]. For every $1 restaurants invested in programs to reduce kitchen food waste, on average, they saved $7 in operating costs. The report includes an evaluation of financial cost and benefit data for 114 restaurants across 12 countries, revealing that nearly every site realized a positive return on its investment to reduce food waste. Globally, one-third of all food produced is never eaten, which has tremendous economic, social and environmental consequences.

A summary report released by the Food and Agriculture Organization of the United Nations [4] in 2013 has presented the economic and ecological consequences of food

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wastage. The report defines food waste as food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiry date or left to spoil, and food wastage refers to any food lost by deterioration or waste. Thus, the term "wastage" encompasses both food loss and food waste. Food wastage incurs an economic loss of about 750 billion dollars annually, and about 28% of the world's agricultural area was used to produce wasted food. The ecological footprint was equally severe if not worse. Food wastage's carbon footprint is about 3.3 billion tons of CO_2 released into the atmosphere. More importantly, only a low percentage of wasted food is composted, while the rest causes even more pollution as the byproducts of landfills. Similarly, in 2011, approximately 1/3 of the produced food was wasted globally.

While research has identified where food waste occurs, many of them focus on the supply side and attribute food waste to influences from cultural, psychological, and social factors. However, we believe that using behavioral economics and some social theories, we are able to arrive at a conclusion that specifically delineates consumer's behavior and shed light on the causes of food waste that are more applicable and universal.

2 Contribution

Our research identified that consumers' actual behavior in terms of their spending and consumption when they dine out always differs from their expectation before the order. They always spend more than they expect, and they order more than what they eat. The differences between expectation and actual behavior causes food waste to occur. The larger the difference, the more food waste is generated. Our paper interprets this using the satisficing theory. Consumers do not always have complete information on their utility in eating and the appropriate corresponding quantity to order. They have insufficient information about the food served – its portion and its quality. The costly process of searching for the right dishes and quantity that maximizes their utility, which is minimizing spending and maximizing utility in eating, prompts them to order safely more than what they can eat to guarantee their utility in eating, which leads to food waste. Our research extends the application of the satisficing theory into the food industry, and provides a new perspective in stating that food waste is the rational utility-maximizing decision made by the consumers given their limited information. Moreover, we also adopt the anchoring theory in explaining food waste. We believe that the physical and mental state of the consumer are crucial aspects contributing to food waste; when one is hungry, the size she orders differs from her usual appetite in common knowledge. The anchoring theory offers an explanation of such behavior by emphasizing the distinction of one's state in two different times. Besides, we confirmed its implication in consumer's behavior when ordering food and showed its impact on food waste. Lastly, our research also approves other previous research on consumer's awareness of consumption quantity and their misconception, and we draw connections between the results from previous research and food waste, revealing the significance of these factors.

3 Literature Review

This research paper studies the process and rationale of consumer ordering decisions. Many researches have focused on the source of food waste from suppliers' side. A case study of food waste in island-based hotels in Malaysia used backward induction of sustainable food waste management method to deduce the drivers FW generations. However, the drivers identified were largely concerned with the management of the hotel and external factors and not consumer behaviors [8].

A lot of research provides solutions to Food Waste. Filimonau studied that the determinants of consumer engagement in restaurant food waste mitigation includes high levels of public environmental knowledge and environmental concerns [3]. It also revealed the policy and management opportunities related to the determinants. Kallbekken and Sælen used a different-in-different model to prove that reducing plate size and providing social cues could alleviate food waste significantly by 20% with no change in guest satisfaction [7]. Both measures reduced food waste in hotel restaurants by around 20%, and the private costs of the restaurant also decreased, making it a win-win solution to food waste. Wansink and Ittersum also supported that food waste could be induced by consumption norms highly correlated with plate size [17]. Reducing plate size can reduce food intake and waste – a win-win solution. Dinnerware serves a visual anchor of an appropriate fill-level. Experiments conducted in this research showed people consume and waste significantly more if served with larger plates. Education campaigns regarding food waste serve no use in reducing how much people waste. Wansink also categorized environmental factors that increase food intake and consumption volume, which included atmospherics, structure and perceived variety, the size of packages and portions, and so on [16]. These environmental factors inhibit consumption monitoring and alter consumption norms. Wansink suggested direct future research towards the psychological mechanisms behind consumption.

There are various theories that model the wasting process. Benjamin Hennchen applied practice theory to issues of food waste. His research shifted the analytical focus from individual behaviors to social practices by discussing the meaningfulness and materiality of knowledge [5]. Cruwys illustrated social modeling of eating by demonstrating the tendency to adapt one's food consumption to that of one's companions independently of internal cues such as hunger or satiety [2].

Herbet Simon proposed to use a definition of rational choices that are more similar to the actual decision-making process [11]. The assumption of the economic man is broken because customers neither have complete information about their preferences nor a strong computational ability to calculate utility. There is no room for unanticipated consequences or certain pay-offs. Simon's theory is particularly applicable to the issue of food waste. Researchers have taken this theory and applied it to multiple sectors and industries. Trenton G. Smith attempted to answer how people choose their food using the satisficing theory when they face a tradeoff between tastes and health [13]. However, instead of focusing too much on the theoretic problem of choosing within the satisficing framework, he introduced the effects of evolution and culture to shed light on how people choose. He weakened the equivalence between individual choices and individual welfare. Bruce E. Kaufman demonstrated how firms, the supply side, react according to satisficing theory in his paper [9]. The model showed that a firm maximizes their profit to a sufficient degree that maintains the survival of the management, but not beyond, in exchange for other higher order needs under the framework of traditional utility maximizing theory. Mauro Papi developed a price competition model with the satisficing consumers [10]. Firms endogenously influence the consumers aspiration price via marketing.

However, these papers do not specifically focus on the demand side nor shed light on the issues of food waste. The partial goal of this paper is to analyze the issues of food waste through interpreting consumers' satisficing behaviors and prove that wasting food is the result of consumers maximizing their utility with limited information and uncertainty in payoffs.

Daniel Kahneman and Richard H. Thaler have offered an alternative approach to explain and predict individual behaviors other than utility maximization [6]. They pointed out that people do not always know what they want, and their preferences and choices about future utility are greatly impacted by their current states, misguiding their expectation on future experienced utility. In other words, when people are aroused by emotions, it's hard to accurately predict their utility under a cool state in the future, creating systemic errors. Additionally, they also called attention to the phenomenon of peak/end rule, which violates the assumption of temporal monotonicity. The peak/end rule indicates that retrospective experiences are impacted by the most extreme moments; the remembered utility can be improved if a mildly painful end is introduced to individuals. In 1974, Tversky and Kahneman suggested that the expected utility estimated initial values are biased, and different starting points yield to different estimation [15].

Brian Wansink and Jeffery Sobal in 2016 revealed that consumers are only aware of a fraction of the food decisions made [18]. The research also highlighted that consumers do not stop eating when it is full but keep consuming depending on how much is served. Moreover, average participants in the research consumed 31% when exaggerated environment cues were present. However, only 2% of the participants were aware of their more-than-usual consumption. Despite that individuals may intentionally calculate how much has been consumed, the cues and rules of thumbs often yield inaccurate estimation, and how much is eating occurs at a low level of consciousness. Consumer's awareness of their consumption behavior was, therefore, not obvious and oftentimes even misleading and susceptible to external influence. The report showed the visceral factors will temporarily elevate craving for a desired item; food cues specifically will increase the desire to eat regardless of one's hunger level. Furthermore, supported by Brian Wanisnk and Jeffery Sobal, consumers often rely on external cues to decide how much to eat and when to stop. These results have challenged the conventional wisdom that individuals are rational and will maximize their utility under a budget limit. We also found a cue-theory of consumption. The research indicates that cues raise the marginal utility of consumption and are an important determinant of habit-forming behaviors. The conclusion is also supported by the Becker and Murphy Model, which indicates that past consumption is complementary with future consumption [1].

4 Research Question

Our research attempts to test whether consumers' expectation before order differs from their actual behavior in terms of both spending and consumption and whether the difference, if there are, has increasing impacts on food waste.

5 Data and Results

Our empirical work relates several factors during dining to food waste outcomes. In this section, we will describe the data utilized in the analysis.

A. Methodology

A challenge to study food waste related to behavioral decision-making is the difficulty to collect data measuring and modeling customer's behaviors since they enter restaurants. The explanatory factors behind their decisions are hard to predict and identify. This paper estimates some variables that yield statistical value to our hypothesis.

Data used in this paper were collected through surveys in the form of questionnaires. We distributed the questionnaires via Google forms in New York City and Tengxun Wenjuanxing in several cities located in different provinces in China from October 2021 to January 2022. Participants who filled out the questionnaire come from Metropolitan cities like Beijing, Shanghai, and New York City, new first-tier cities like Zhengzhou, Wuhan, and third-tier cities like Zhenjiang, Pingdingshan, and so on.

We circulated questionnaires through printed QR codes and online links. Participants were asked to reflect upon their dining out experience immediately after a meal. The questionnaire includes 26 questions in total, taking the form of self-reporting. Survey questions are listed in the appendix. Participants were asked to report specifics on their spending habits, the factors they depend on when ordering and eating, and background information like, education background, and age. All of the data, beside dummy variables, are winsorized.

B. Definition of variables

EF: Variable EF represents the expected food consumption measured in percentage of the meal subject based on to fill out the questionnaire. This variable reflects how much the participants believe should have been consumed to just reach the state that yields the most satisfaction for them.

When asking this question, the participant reflected on how much has been consumed and his/her subject feeling of being full or not.

FWPbyconcept:

$$FWPbyconcept = 100\% - EF$$

This is our unique definition of food waste. It includes not only the reported food waste in percentage but also the participants' overconsumption, "excessive" to being full. This concept will be illustrated more comprehensively in later paragraphs.

FWP: The amount of food left on the table in percentage of the whole meal.

ES: Expected spending is denoted as ES in regression. It represents how much the participant expected to spend before ordering in the restaurant. We believe that the value of this variable for each individual is largely contingent on this particular subject's income and their expectation on the restaurant they went to, which potentially include the restaurant's average price, whether they like the restaurant, and so on.

AS: Subject's actual spending as indicated on the check is denoted as AS.

DiffASES:

$$DiffASES = AS - ES$$

Variable DiffASES represents the difference between participants' actual spending on the meal and actual spending after the meal. DiffASES is converted and calculated in unit US dollars.

AF: Variable AF represents the actual food consumption measured in percentage of the meal subject based on to fill out the questionnaire.

DiffAFEF:

$$DiffAFEF = AF - EF$$

Variable DiffAFEF represents the difference between participants' actual consumption and expected consumption. DiffAFEF is measured in unit percentage.

CogError:

$$CogError = 100\% - AF - FWP$$

Since both AF and FWP are measured in percentage, intuitively, the summation of AF and FWP should equal 100%. However, we believe that individuals may not adopt a mathematical approach to calculate or estimate how much has been consumed and wasted but rather a "gut" feeling. The difference between 100% and the summation of AF and FWP signifies participants' awareness of their food consumption estimation. A difference occurs due to lack of awareness, which can be found supported by [18].

BudgetN: The amount of budget is denoted as BudgetN in regressions. Different from expected spending, budget is a spending constraint on spending. The features of the restaurant have little influence on budget.

RAP: Restaurant Average Price is denoted as RAP in regressions. For restaurants in New York, average prices were collected from Yelp and Google, and Dazhongdianping for China.

FP: Food portion is a dummy variable denoted as FP. If the subject takes the food portion into consideration when they decide how many dishes to order, this variable returns 1, otherwise 0.

HungryBefore: Hungry is a dummy variable that signals whether the participant is hungry before coming to the restaurant. If they are hungry, this variable returns 1, otherwise 0.

FirstT: FirstT is a dummy variable. If this customer's questionnaire is based on their experience of eating at a new restaurant that they have never been to, this variable returns 1, otherwise 0. We believe that going to a new restaurant affects customer's expectations.

Price: Price is a dummy variable denoted as FP. If the subject takes the price of the food into consideration when ordering, this variable returns 1, otherwise 0.

YUA: YUA is a dummy variable. If the subject considers their usual appetite (how much food they normally consume) when ordering, this variable returns 1, otherwise 0.

College: C is a dummy variable that returns 1 if the highest education of the subject is college, otherwise 0.

Grad: Grad is a dummy variable that returns 1 if the highest education of the subject is Graduate school, otherwise 0.

MSL: MSL is an ordinal variable that takes the value of 1, 2, and 3. If the customer thinks they consumed more than their normal diet, this variable returns 3; less, 2; same 1.

Delicious: Delicious is a dummy variable that returns 1 if the customer thinks the food is delicious, 0 otherwise.

FullAfter: Variable Full represents the participants' assessment on their level of consumption. The participants would indicate full if he/she ate enough or more than enough. This is a dummy variable. If they indicate full, this variable returns 1, otherwise 0.

Diet: Diet is a dummy variable that returns 1 if the participant is on a diet, 0 otherwise.

Fleft: Diet is a dummy variable that returns 1 if there is food left on the table, 0 otherwise.

C. Determinants of Spending Habits

Model 1:

$$ES \sim BudgetN + RAP + HungryBefore + FP + FirstT$$

We believe that, after picking a restaurant, the customer forms an "expected spending (ES)" before ordering. We regress model 1. As Table 1 indicates, "expected spending" is positively related to the participant's budget (BudgetN) and the restaurant's average price (RAP). Particularly, if the participant is hungry before coming to the restaurant, expected spending will rise by approximately \$5, as we predicted that feeling hungry encourages customers to order more. If the participant takes the "food portion" into consideration while ordering, their expected spending will approximately rise by \$5. Customers have multiple channels to learn about food portions. They may directly ask the waiter about the food portion or observe other people's order. The positive effect of food portion (FP) on expected spending (ES) indicates that customers, on average, consider the food portion they perceive in the restaurant as small. They feel the need to order more to satisfy their appetite. If a customer is hungry and takes the food portion (FP) into consideration, their expected spending approximately rises by \$7. These two variables reinforced each other's effect. Whether it is the first time the participant frequents the restaurant is served as a control variable because prior experience with the restaurant can serve as an anchor for the customers' expected spending this time. Customers react differently when they try a new restaurant.

Model 2:

$$(1) \quad AS \sim RAP + ES + Price + YUA + College + Grad + Gender + Age$$

We regress according to model 3. According to column 1 in Table 2, as we predicted, an increase in either restaurant average price or expected spending is positively associated with an increase in actual spending. If the customer took the price of the meal and their usual appetite into consideration, their actual spending would decrease. The price serves

Table 1. Determinants of Customers' Expected Spending

	(1)	(2)
Intercept	−4.36443	−0.7401
	(3.1104)	(2.1471)
BudgetN	0.0646**	0.0682**
	(0.0284)	(0.0278)
RAP	0.9437***	0.9279***
	(0.1173)	(0.1162)
HungryBefore:FP		7.6833***
		(2.8137)
HungryBefore	5.0359*	
	(2.8982)	
FP	5.0784*	
	(2.6002)	
FirstT	2.5619	2.2570
	(2.8100)	(2.7668)
Adjusted R^2	**0.5341**	0.5395
F-statistics	**35.39**	44.94
DF	**145**	146

This table shows the factors influencing customers' expected spending when dining out and their correlation with expected spending. Specifically, column 1 shows the coefficient of the multivariate OLS regression of each variable. Column 2 shows the multivariate regression that includes interaction terms between *HungryBefore* and *Food Portion*. Adjusted R^2, F-statistics, and sample size are shown at the bottom. Standard error of each variable is shown within the parenthesis. ***means p-value < 0.01; **means p-value < 0.05; *means p-value < 0.1

as a constraining force when customers order their meal. This also shows that the actual ordering is not always strictly catering to the appetite of the customer. Considering how much the customers themselves can consume in one meal can reduce the food they order. An increase in education background is also associated with a decrease in actual spending. We presume that people with higher education may pay more attention to food waste and its consequences. Adjusted R-squared is 0.9084, showing that these factors capture the determinants of actual spending.

Model 2 with interaction terms:

(2) $AS \sim RAP + ES + YUA + Price : YUA + C + Grad + Gender + Age$
(3) $AS \sim RAP + ES + YUA + ES : Price + YUA + C + Grad + Gender + Age$
(4) $AS \sim RAP + ES + ES : YUA + Price + C + Grad + Gender + Age$

Table 2. Determinants of Actual Spending

	(1)	(2)	(3)	(4)	(5)
Intercept	7.4883**	6.7770**	6.8499**	4.8253	5.6205*
	(3.2946)	(3.3041)	(3.0784)	(3.0831)	(3.1826)
RAP	0.3769***	0.3804***	0.3427***	0.3774***	0.3361***
	(0.0681)	(0.0686)	(0.0646)	(0.0688)	(0.0642)
ES	0.7803***	0.7782***	0.8658***	0.8756***	0.8997***
	(0.0639)	(0.0644)	(0.0632)	(0.0780)	(0.0661)
Price	−2.4954**			−2.5996**	12.9000**
	(1.0044)			(1.0156)	(6.3394)
YUA	−3.3163 **	−2.7581**	−3.7855**		−3.3912**
	(1.3301)	(1.3733)	(1.2527)		(1.4236)
ES:YUA				−0.1061*	
				(0.0545)	
ES:Price			−0.2422***		−0.7077***
			(0.0524)		(0.2415)
YUA:Price		−2.2717**			−11.4833*
		(1.0950)			(6.4242)
ES:Price:YUA					0.4004
					(0.2484)
College	−4.0713*	−4.0612*	−3.9531*	−4.0012*	−3.8331*
	(2.2732)	(2.2925)	(2.1358)	(2.3038)	(2.119)
Grad	−5.9829**	−6.0166**	−6.8062***	−5.8848**	−7.1375***
	(2.4944)	(2.5183)	(2.3536)	(2.5216)	(2.3464)
Gender	−1.9637**	−1.9494**	−2.0749**	−1.9983**	−2.1820**
	(0.9497)	(0.9577)	(0.8926)	(0.9598)	(0.8865)
Age	0.0344	0.0366	0.0479	0.0212	0.0547
	(0.0565)	(0.0569)	(0.0531)	(0.0566)	(0.053)
Adjusted R^2	**0.9084**	**0.9069**	**0.9191**	**0.9064**	**0.9206**
F-statistics	**144.8**	**142.2**	**165.8**	**141.4**	**123.2**

(*continued*)

Table 2. (*continued*)

	(1)	(2)	(3)	(4)	(5)
DF	**108**	**108**	**108**	**108**	**105**

This table shows the factors influencing customers' actual spending in a restaurant and their correlation with expected spending. Specifically, column 1 shows the coefficient of the multivariate OLS regression of each variable. Columns 2, 3, and 4 display the multivariate regression that include interaction terms between expected spending, price, and usual appetite in different combinations. Column 5 included all the interaction terms in one OLS multivariate regression. The results are still significant. Adjusted R^2, F-statistics, and sample size are shown at the bottom. Standard error of each variable is shown within the parenthesis. ***means p-value < 0.01; **means p-value < 0.05; *means p-value < 0.1

Table 2 also contains models with interaction terms. Actual spending is directly determined by how much customers order. When ordering food, customers are influenced by the price of the meal and their usual appetite in daily life to determine how much to order. Since the customer already picked the restaurant after considering the restaurant's price and tastes before walking into the restaurant, customers' estimation of their usual appetite plays a main role when they decide how much to eat. However, the individual price of each dish may still potentially influence decision making. We estimate that these two factors will reinforce each other. According to column 2 in Table 2, the effect of restricting food ordered to usual appetite instead of ordering excessively is reinforced by the effect of considering price. Two factors both have restraining effects on actual spending. However, according to column 3 and column 4 in Table 2, Price and YUA diminish the effect of expected spending on actual spending. This potentially indicates that if the customer takes their usual appetite and price of the dish into consideration, the expected spending formed initially will have less effects on their actual spending.

Model 3:

(1) $DiffASESabs \sim EF + FirstT + FullAfter + Delicious + Age + C + Grad$

Model 4 with interaction terms:

(2) $DiffASESabs \sim EF + EF : FirstT + Full + Delicious + Age + C + Grad$
(3) $DiffASESabs \sim EF + EF : Delicious + FirstT + Full + Age + C + Grad$
(4) $DiffASESabs \sim EF + EF : FirstT + EF : Delicious + Full + Age + C + Grad$

The difference between expected and actual spending often signals customers' uncertain estimation of how much they can eat and how much to order. According to Table 5, the larger the difference between expected and actual spending is, the larger quantity of food wastes will be generated. Table 3 tries to find the explanatory variables for the deviation between expected spending and actual spending. One of the factors is Expected Food. Expected food consumption is what people think they should consume to gain the maximized satisfaction from the meal. People feeling too full after a meal may fill in a smaller percentage in the questionnaire, and vice versa, as proven by Table 4. Therefore, how much, in retrospect, people think they should eat in percentage of the meal is negatively related to the magnitude of the deviation. A large expected food percentage signals that the customer has an accurate estimation on how much to order to get full, diminishing the difference between expected and actual spending. The data shows that one percent increase in expected food consumption is associated with a $6.19 decrease in the difference between expected and actual spending. According to the table, if it is the first time the subject has been to the restaurant, their actual spending would also deviate from expected spending more. If customers think the food is delicious, they may order more and then deviate from the expected spending. According to the interaction terms, the effect of expected food percentage is weakened by whether the food is delicious and whether it is the first time the subject has been to the restaurant.

Whether the participants get full as a dummy variable is served as control because only after people get full can they accurately tell how much to consume is the ideal amount to eat. People usually only, especially when it comes to delicious food, notice they are too full after they feel slightly uncomfortable for eating too much, not before. Secondly, we establish "full" as a control variable because we assume that getting full is one of the priorities of any dining experiences; we assume that if individuals do not get full, there must have been other exogenous factors such as the flavor of food is not desirable, diet, etc. More importantly, if individuals fail to get full, it complicates the model by introducing more variables that are not focused in this study.

D. Expected Food Consumption

Model 4: $EF \sim AF + MSL + Delicious + Hungry + Full + Diet$

We define expected food consumption as the ideal amount the customers think they should consume after they finished their meal. MSL represents more, same or less. Customers self-report their current meal consumption compared to their regular diet. As we predicted, variable MSL in Table 4 indicates that if the subject consumed more than their regular diet, they will put a value smaller than 1 as their expected consumption—they think they should consume less to gain the most satisfaction. The rest of the variables in the model serve as control variables.

E. Determinants of Food Waste

In this paper, we adopt two definitions of food waste. The first one is defined by $FWPbyconcept = 100\% - EF$. By this definition, food waste comprises both tangible unconsumed food and overconsumption. We believe that an average adult has a comfortable consumption range determined by various factors. The range should remain relatively constant. We want to extend such belief so that any amount of food consumed that surpasses the range is food waste. Overconsumption does not contribute to an individual's utility maximization if not worsen it because as the individual has already achieved their utility maximization point, any extra food consumed does not further increase utility but decrease it by incurring the feeling of eating too much. Though the impact on individuals is so trifling that one may ignore, the over-consumed portion can

Table 3. Determinants of the Difference between Actual Spending and Expected Spending

	(1)	(2)	(3)	(4)
Intercept	20.9799***	21.5175***	21.3420***	21.8948***
	(3.3288)	(3.3476)	(3.3150)	(3.3331)
EF	−6.1946**	−6.8299**	−6.6780**	−7.3210***
	(2.5853)	(2.6558)	(2.6003)	(2.6690)
FirstT	2.4877***		2.4858***	
	(0.7495)		(0.7464)	
Delicious	1.4635*	1.5289*		
	(0.8340)	(0.8373)		
EF:FirstT		2.6779***		2.6721***
		(0.8661)		(0.8633)
EF:Delicious			1.8833*	1.9438**
			(0.9730)	(0.9777)
Full	−10.3991***	−10.4122***	−10.4247***	−10.4352***
	(2.3375)	(2.3543)	(2.3297)	(2.3471)
Age	−0.0877*	−0.0885*	−0.0879**	−0.0889**
	(0.0445)	(0.0447)	(0.0443)	(0.0445)
College	−0.9243	−0.8522	−0.8749	−0.8050
	(1.8278)	(1.8376)	(1.8234)	(1.8336)
Grad	−1.9274	−1.9152	−2.0183	−2.0032
	(2.0758)	(2.0887)	(2.0729)	(2.0861)
Adjusted R^2	**0.2686**	**0.2599**	**0.2728**	**0.2638**
F-statistics	**7.295**	**7.02**	**7.43**	**7.143**
DF	**113**	**113**	**113**	**113**

This table shows the factors influencing the difference between customers' actual spending in a restaurant and their expected spending, and their correlation with the independent variable *DiffASES*. Specifically, column 1 shows the coefficient of the multivariate OLS regression of each variable. Columns 2, 3, and 4 display the multivariate regression that include interaction terms between expected food consumption, whether it is a first visit to the restaurant, and whether the food is delicious in different combinations. Adjusted R^2, F-statistics, and sample size are shown at the bottom. Standard error of each variable is shown within the parenthesis. ***means p-value < 0.01; **means p-value < 0.05; *means p-value < 0.1

yield much higher utility per portion if offered to another individual. Both the food consumed after the customers reach their maximum utility and the food left unconsumed in the plate lose the function of being allocated to others who are in exigencies of the food for subsistence. In this regard, in situations where individuals finish his/her portion of food presented on the table or not do not signify food waste. The amount where his/her

Table 4. Determinants of Expected Food Consumption

	(1)
intercept	0.3835***
	(0.0837)
AF	0.5660***
	(0.0715)
MSL	−0.0264**
	(0.0120)
Delicious	−0.0049
	(0.0248)
College	0.0413
	(0.0527)
Grad	0.0632
	(0.0597)
Age	−0.0002
	(0.0011)
Adjusted R^2	**0.3622**
F-statistics	**12.36**
DF	**114**

This table shows the factors influencing customers' expected food consumption in a restaurant, and their correlation with the independent variable ES. Specifically, column 1 shows the coefficient of the multivariate OLS regression of each variable. Adjusted R^2, F-statistics, and sample size are shown at the bottom. Standard error of each variable is shown within the parenthesis. *** means p-value < 0.01; **means p-value < 0.05; *means p-value < 0.1

utility is maximized is the threshold. Since the ideal amount people reported is the variable expected food consumption, it is the amount the customers think they can gain most satisfaction (utility). We use $1 - EF = FWPbyconcept$ to derive the food waste percentage under this definition. Since $FWPbyconcept = 100\% - EF$ is a percentage of the meal each individual customer's order as a whole, we weighted *FWPbyconcept* by $FWPbyconcept \times Actual\ Spending \div Restaurant\ Average\ Price$. We assumed that each restaurants' average price per person can purchase one portion of food for one individual at that particular restaurant. The food amount purchased is the normal amount of food an adult can consume at that restaurant. This weighting formula is to calculate how many portions this subject has wasted. $Actual\ Spending \div Restaurant\ Average\ Price$ calculates how many portion this subject bought, and *FWPbyconcept* is the food wasted in percentage of these portions in total. This weighting formula eliminates the difference between each different restaurant and only measures the normal amount of food an adult can consume. Since *FWPbyconcept* is a percentage, we use $FWPbyconcept \times 100$ to make the coefficients compatible.

Table 5. Determinant of Food Waste

	(1)	(2)	(3)
Intercept	0.2282*	0.1767	0.1131
	(0.1214)	(0.1160)	(0.1115)
DiffASES	0.0091***	0.0124***	0.0175***
	(0.0030)	(0.0033)	(0.0037***)
CogErrorWgt	0.9287***	0.9463***	1.051***
	(0.1022)	(0.1000)	(0.1006)
DiffAFEFWgt	0.8116***	0.8406***	0.8496***
	(0.1226)	(0.1213)	(0.1151)
YUA	−0.1165**	−0.0984**	−1.012**
	(0.0489)	(0.0473)	(0.0445)
Fleft	−0.0734*	−0.0744**	−6.69*
	(0.0387)	(0.0370)	(0.0342)
MSL	0.0384**	0.0393**	0.0388**
	(0.0162)	(0.0160)	(0.0153)
Gender	−0.0610**	−0.0557*	−0.0535*
	(0.0289)	(0.0288)	(0.0271)
DiffASES:Delicious		−0.0100*	
		(0.0052)	
CogErrorWgt:Delicious			−0.5076**
			0.2115
			(0.2115)
DiffASES:FirstT			−0.0179***
			(0.0055)
FirstT	−0.0469	−0.0456	
	(0.0304)	(0.0301)	
RAP	0.0008	0.0012	0.0015
	(0.0016)	(0.0016)	(0.0016)
BudgetN	−0.0002	−0.0003	−0.0001
	(0.0003)	(0.0003)	(0.0003)
Delicious	−0.0398		
	(0.0354)		
Price	0.0355	0.0318	0.0236

(*continued*)

Table 5. (*continued*)

	(1)	(2)	(3)
	(0.0307)	(0.0304)	(0.0286)
College	−0.0557	−0.0325	0.0379
	(0.0705)	(0.0700)	(0.0699)
Grad	−0.0544	−0.0493	−0.0162
	(0.0803)	(0.0791)	(0.0754)
Age	0.0006	0.0005	−0.0004
	(0.0019)	(0.0019)	(0.0018)
Adjusted R^2	**0.598**	**0.6072**	**0.6508**
F-statistics	**12.31**	**12.75**	**15.1600**
DF	**99**	**99**	**99.0000**

This table shows the factors influencing customers' quantity of food waste, and their correlation with the independent variable FWPbyconcept. The variables initially denominated as percentage of a meal are weighted as regressed as the percentage of the portion size according to different individual restaurants. Specifically, column 1 shows the coefficient of the multivariate OLS regression of each variable. Columns 2 and 3 display the multivariate regression that include interaction terms. Adjusted R^2, F-statistics, and sample size are shown at the bottom. Standard error of each variable is shown within the parenthesis. *** means p-value < 0.01; **means p-value < 0.05; *means p-value < 0.1

Model 5:

$$\begin{aligned} FWPbyconceptWgt \sim\ & DiffASES + CogErrorWgt + DiffAFEFWgt \\ & + YUA + Fleft + MSL + Gender + FirstT + RAP \\ & + BudgetN + Delicious + Price + C + Grad + Age \end{aligned} \tag{1}$$

Model 6 with interaction terms:

$$\begin{aligned} FWPbyconceptWgt \sim\ & DiffASES + DiffASES : Delicious + CogErrorWgt \\ & + DiffAFEFWgt + FirstT + YUA + Fleft + MSL \\ & + Gender + RAP + BudgetN + Price + C + Grad + Age \end{aligned} \tag{2}$$

$$\begin{aligned} FWPbyconceptWgt \sim\ & DiffASES + CogErrorWgt : Delicious \\ & + DiffASES : FirstT + CogErrorWgt \\ & + DiffAFEFWgt + YUA + Fleft + MSL \\ & + Gender + RAP + BudgetN + Price + C \\ & + Grad + Age \end{aligned} \tag{3}$$

In Table 5, we examined the influence of various variables on food waste. We found out that the difference between actual spending and expected spending have an increasing effect on food waste. The more customers' actual spending deviates from expected spending, the more they waste food. We also found that there is often a cognitive error happening when the customers report their consumption. Their reported actual food consumption and food left on the table does not always add up to one—-sometimes larger than and sometimes smaller than 1. We discovered that the larger the cognitive error, the more people waste food. The positive effects also extend to the difference between actual food consumption and expected food consumption. The more these two variables deviate from each other, the more likely the customer wastes food. If customers take their usual amount of consumption into consideration when ordering food, it is associated that they would waste less food.

Robust Test

Model 6: t.CogError

$$H_{null} : Actual\ Spending = Expected\ Spending$$

$$H_a : Actual\ Spending > Expected\ Spending$$

We predicted that *actual spending* would deviate from expected spending by a positive margin potentially due to customers' wish to maximize their utility from eating. If the customer wants to increase the diversity of dishes on the table, and the price of the meal is below their highest willingness to pay, they would order more than they can eat to satisfy their desire for diversity. More food can better guarantee the maximization of utility. According to the one-tail t.test we performed, actual spending is always larger than expected spending by an average of \$2.17.

6 Conclusion

6.1 Satisficing Theory

Economics, which has traditionally been concerned with what decisions are made rather than how they are made, has more and more reason to interest itself in the procedural aspects of decision.

Herbert A. Simon [12]

The process of ordering in a restaurant is a process of seeking the right combination of dishes that can maximize utility. Assuming that there is a perfect quantity of food that gives consumers the highest utility possible from one meal if they finish all of it. In that way, the consumer has the exact food quantity and combination to satisfy their desires, and they fully utilize every penny they spend on the meal. Due to the differentiation of restaurants, portion size and tastes of the dish are uncertain. It is costly, "formidable" in Simon's words, in terms of energy and time to search for the perfect food quantity. It may take the form of asking the waiter for more information on the dish, or observing other people's order. Or they may choose to order very little each time and order multiple times. These choices are all costly. The consumers face a trade-off between money and food. The consumers can choose to search for the perfect quantity of food at the expense of spending more time and energy, or they can purchase more than what they perceive as the perfect quantity to ensure their appetite is satisfied if the price is lower than their willingness to pay for the perfect food. The extra money they spend is to relieve them of the burden of searching for perfection. Consumers use prior knowledge of their eating habits and experiences of dining out to derive an ordering quantity that specifies the conditions under which search will be terminated. Instead of performing a sequential search for the utility maximizing quantity, which is the variable expected food percentage in our paper, the consumers are willing to pay a higher price for the meal and purchase more food to ensure their satisfaction. Consumers are often indifferent between these two options.

This is further complicated by the fact that consumers do not have an accurate estimation of their utility-maximizing food quantity when they are postulating how much to order. They have biased perceptions on how much food their money can buy, how much food they can consume, and the actual portion size of the food. And according to the data collected, people often order more than their perfect quantity, represented by expected food percentage. They overestimate their ideal quantity. It is worth noting that this is irrelevant with how much consumers actually eat and the utility coming out of it after dinner – this is only about expectation.

As the data indicates, the more uncertainty there exists for the consumer, the more food waste they generate. When there are a lot of discrepancies between actual consumption and expected, or actual spending and expected spending, it indicates the existence of enormous uncertainty. The consumers have an estimation of their spending that deviates a lot from their actual spending when they check out. When expected food consumption deviates from actual food consumption, it shows erroneous estimation on how much they can eat when ordering. These phenomenon are represented by two variables – *DiffASES* and *DiffAFEF*. Uncertainty arises when it is the first time the consumer has frequented the restaurant. It may not be fully eliminated even if the consumer has frequented the restaurant many times. The uncertainty makes the searching process particularly costly to consumers, so that they are willing to order more to avoid the process. Therefore, the more uncertainty there is, the more consumers will order. While how much they can consume stays constant, more food ordered will result in more food waste. On the other hand, if the consumers are very familiar with the restaurant, the cost of search is 0. They know exactly how much to order, so they tend to waste less.

Significance: this part of our paper shows that the more uncertainty there is regarding the information on food quality, portion size, and personal assessment, the more food waste there likely is. There are policy implications. If the restaurant can give ample information to the consumers concerning food, the consumers can make better choices that reduce food waste. However, restaurants often are less incentivized to inform the customer if they face a downward trend of food order because of it. Government intervention of forcing restaurants to reduce portion size would also be one way to restrain the food quantity consumers order each time, giving consumers room to adjust for the unanticipated payoffs. They can add additional dishes if they require more after finishing the first order. However, this may also generate push backs from restaurants.

6.2 Anchoring Theory

We believe that the result can be best explained by Kahneman's anchoring effect. The theory states that individuals often do not know what they will want in the future t_1 when they position at t_0. Essentially, "forecasts of future hedonic and emotional states are anchored in the current emotional and motivational state" [6]. A customer faces decisions of what to order and how much to order at an initial value that is different from the future one; she must order a certain quantity of food that will be consumed on a continuous timeline with a changing feeling of fullness and a limited capacity to eat. If we assume a diminishing return to each bite, a customer's marginal utility constantly decreases at each stage. Not only does each bite yield strictly less utility than the previous one, a customer also approaches the maximum eating capacity. From the result we can see that the actual spending is always greater than expected spending. To fully understand the phenomenon, we need to combine this with the theory that claims one's desire, including appetite, is susceptible to exogenous cues. For example, the smell and image of food will temporarily exaggerate the customer's desire for food, prompting her to believe that she wants more food than usual. We can also assume that while a customer is making decisions on ordering, her exposure to the restaurant's information increases along with the time she spends in there; she acquires more information about the food and its smell. Therefore, a customer is exposed to more external cues by the restaurant's environment when she makes the order than the moment she takes her first step into the restaurant. Her appetite will be exaggerated accordingly with the increasing exposure to external cues. Using the anchoring effects, we can identify that a customer is positioned at two different states when she makes an approximation of how much to spend versus when she makes the actual order. More importantly, her later states crave more food than the former, leading to an elevated demand for food and expected utility. Therefore, we see a greater value in actually spending than expected spending across customers in this set of data.

In this paper, we illustrated how consumer's utility maximizing behavior induces food waste. Our main findings are that consumers demonstrate the satisficing behaviors when ordering food. They lack sufficient computational power and a complete understanding of their utility to make the perfect combination of dishes to order. Rather than going through the costly search process for the combination, they are willing to spend more money and try to order more dishes than the perfect amount to ensure their utility in eating. Food waste occurs in this process. We apply the satisficing and search theory in the food industry. Policy makers can intervene to increase the transparency of the menu, giving consumers more information on dishes, or impose a portion maximum limit to reduce food waste.

Furthermore, our paper also supports the conclusion from previous research paper that consumers are not aware of how much they have consumed and how much is left. This is shown through the consistent cognitive error that we identified when two indicators of consumed quantity fail to equal each other. More importantly, this paper takes a further step and suggests that such cognitive errors not only exist but also have a negative impact on food waste. Moreover, we also confirmed that, in addition to that individuals consume more, these consumptions do have financial impact. The miscalculation and overestimation of their future consumption directly inflict an economic cost that could have been avoided. Lastly, this paper serves to uncover the relationship between food waste amount and individual consumption behavior while advocating future studies on strategies that can eliminate anchoring effects to enable individuals to make more accurate approximations about their prospect utility. With the identified factors, policy makers and restaurant owners are more informed about consumer's behavior and how to implement policies that can best engineer and influence them to achieve a socially optimal result.

Appendix

Questionnaire Content:

1. Your Approximate Monthly Spending ($)
2. Is this the first time you have been to that restaurant?
3. Do you have a per person budget estimation for the meal? ($)
4. How much did you expect to spend to get full when you order (average per person)? ($)
5. How much did you actually spend on this meal (per person)? ($)
6. Did you get full?
7. How much food do you think should be consumed to get full? In percentage of a whole meal.
8. How much did you actually consume (in percentage of a whole meal)?
9. What did you rely on when determining how much (quantity) to order?
10. What did you rely on when determining how much (quantity) to order? Usual Appetite
11. What did you rely on when determining when to stop eating?
12. Did you consume More or Less than your regular diet?
13. Were you hungry before coming to the restaurant?
14. Have you frequented that restaurant before?
15. What did you think of that meal?
16. Was there any food left on your plate?
17. If yes, how much in percentage of a whole meal?
18. Highest Education
19. Self-Identified Gender
20. Age

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