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Modelling Functional Food Choice and Health Care Impacts: A Literature Review

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The global market for functional foods is estimated to be worth about US$33 billion (Hilliam, 2000). Given the information asymmetry inherent in functional foods, labelling information plays a key role in allowing consumers to make informed choices. Understanding consumer choices with respect to functional foods is an important new area of research. Several potential consumer choice models are available to assess consumer choices for functional food. This paper provides an overview of key consumer research questions, and a review of several different models, including the Stated Preference Choice Model with Discrete Choice Analysis, Dependent Preference Model, and modified Protection Motivation Theory.

Keywords: information asymmetry, stated preference models, protection motivation, functional food

JEL Classification: Q13, I1, D12, D82

Introduction

When Canadian consumers are asked, "have you ever heard about functional foods?" we can expect a range of responses from puzzlement, to vague familiarity, to knowledgeable interest. While relatively few consumers are likely to have a clear idea about the term 'functional foods', a substantial number of them have probably consumed functional foods at some point in the recent past, whether knowingly or not. Functional foods have become recognized as a separate food category only in recent years in Canada and the United States, while they have been popular in Europe and Japan since the 1990s. The central characteristic of functional foods is the pro-active 'health benefits' that the food imparts; placing the food category between normal food and medicine. The American Dietetic Association (Bloch and Thomson, 1995) points out that accumulating scientific evidence supports the role of functional foods in the prevention and treatment of at least four kinds of leading diseases: cancer, diabetes, cardiovascular disease, and hypertension. Given the broad range of functional food attributes, there is no simple, commonly accepted and exclusive definition for the term 'functional food'. Different countries use different definitions in their regulatory systems. Different researchers appear to have a variety of understandings of the concept, but they all recognize 'health benefits' as the main contribution of functional foods. From the consumer's point of view, the health benefits of functional foods affect consumption decisions: an individual consumer might over consume unhealthy foods or under consume healthy foods.

This paper addresses the question of which analytical methods could be used to model functional food choice among consumers given information asymmetry regarding the (presence or efficacy of the) functional attribute. The literature reviewed in this paper should provide a useful basis on which future researchers in this area of study can build. For individual consumer choice, the classical consumer theory of utility maximizing might be the most useful framework; we also need to consider the effects of information asymmetry and uncertainty, labelling information, and the effects of consumption decisions of perceived health outcomes.

What causes consumers to under-consume healthy food or over-consume unhealthy food? Consumers face two types of uncertainty: uncertainty about the health attributes of a specific food (does this food contain elevated levels of conjugated linoleic acid (CLA)?), and uncertainty over future health outcomes (will consumption of foods high in CLA improve my long-term health, and to what extent?). Information asymmetry therefore underlies consumers' decision regarding the consumption of functional foods. Labelling can play an important role in informing consumers: if the label is credible, and if consumers know how to use the information on the label. Given the importance of labelling and information asymmetry to understanding the consumer decision-making process for functional foods, this paper discuss examples of how these issues have been explored in the literature.

The paper focuses on three modified choice methods that represent very different ways of modelling consumer preferences for functional food: the Stated Preference Choice Model with Discrete Choice Analysis, Dependent Preference Model, and modified Protection Motivation Theory. For each method, the paper provides the underlying reasons why this method might be useful to model functional food, presents the theoretical framework underlying each approach, and discusses the advantages and limitations of the method.

The paper is organised as follows: section 2 discusses some key characteristics of the emerging functional food sector and discusses the information asymmetry problem facing consumers. Section 3 provides a detailed discussion of three alternative consumer choice models. The final section presents conclusions and suggestions for future research directions.

Functional Food and Information Asymmetry

What are functional foods? The central idea is that they are foods with health benefits. There are a number of definitions; for example, Poulsen (1999) defines functional food as:

"A product which has been modified or enriched with naturally occurring substances with a specific physiological preventative and/or health-boosting effect. The product must also be part of the normal daily consumption of food/fluids." (p.1).

Poulsen (1999) also categorizes four 'enrichment' methods by which functional foods can be produced: upgrading, by adding more of a substance that the food already contains; substitution, by replacing a substance with a similar but healthier component; enrichment, by adding an ingredient not normally found in the food product; and elimination, by removal of an unhealthy ingredient from a food. Health Canada (1999) defines functional foods as a food product that is consumed as part of a usual diet, and has demonstrated physiological benefits and/or reduces the risk of a chronic disease beyond a basic nutritional function. Functional food includes both traditional food products and food innovations derived through conventional breeding methods or through genetic engineering.

Functional food is still a 'new' word for many Canadians, although there are increasingly a wide range of functional food products available in Canada, such as probiotic yogurts, omega-3 milk and eggs, vitamin E and C enhanced soft drinks, and health breakfast cereals, etc. Von Alvensleben (2001) provides a useful schematic representation of the relative position of functional food.

Figure 1: Conceptual market positioning of functional foods
Source: von Alvensleben, 2001

Estimates of the size of the global market for functional foods vary, depending on the source of the information and on the definitions of a functional food. For example, Hilliam (2000) estimated the global market of functional food to be at least US$33 billion. The European market of functional food is dominated by digestive health products, with dairy products originally being the key sales category at US$1.35 billion in 1999 (Hilliam, 2000). Some observers have noted a 30-50% price premium in high volume functional food segments, such as functional dairy products in Europe, while raising questions about the sustainability of those premia in the long-run without proven efficacy and credible health claims (Menrad, 2003).

Little detailed data exists on the Canadian market for functional food: the sector is relatively young, and Canadian regulations do not permit health claims for functional foods[1]. Nevertheless, the German market can illustrate the type of innovations that have occurred in the functional food sector. It has been estimated that 305 products were launched in the functional food sector in Germany between 1999 and 2000, with soft drinks, confectionary, dairy and bakery representing the three largest categories of functional food innovation during that period (see Figure 2).

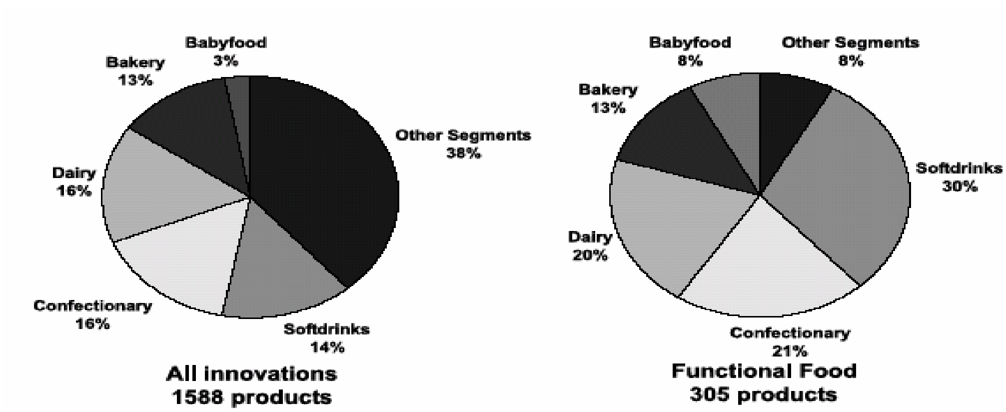

Figure 2: Innovations in the food and drinks market in Germany of 1999-2000
Source: Anonymous, 2001

The soft drink segment includes non-alcoholic beverages with vitamins or other enhanced ingredients; in the confectionery segments, innovations included chewing gum for dental hygiene, while omega-3 milk was an important functional food innovation in the dairy product sector; functional bakery products included breakfast cereals with cholesterol-lowering ingredients. Notice that the other product segments contributed to only 16% of new functional products compared with 41% of products innovations in the total food and drinks market (Menrad, 2003). This suggests that functional foods are a relatively concentrated food category. A multitude of new product innovations occurs constantly in the food and drinks sector, such that any snapshot in time is just that: a glimpse of the state of play at any given moment. Nevertheless, the German case discussed above provides an interesting insight into the extent of functional food innovations in a specific market.

[1] In 2003, new regulations were introduced in Canada allowing health claims for Natural Health Products (herbal remedies, homeopathic medicines, vitamins, minerals, traditional medicines, probiotics, amino acids and essential fatty acids), but not for functional foods.

The market for functional foods is characterized by information asymmetry for consumers with respect to the presence, level and efficacy of the functional attributes. This point has been recognised in the literature: Menrad et al (2000) argue that information and communication activities are needed to deal with the problem that consumers have limited information and knowledge about the health effect of some functional ingredients; Malla et al (2005) discussed labelling as a solution to information asymmetry regarding health attributes in food products.

Food quality and labelling issues have been of interest to food and agricultural economists for some time. Hooker and Caswell (1996) explain that quality refers to many attributes of food products, including animal welfare, origin, production process, control of food safety, nutritional attributes, appearance and taste. In general, goods are categorized has having search, experience and credence quality attributes (Nelson, 1970, & Darby and Karni, 1973). The quality of a search attribute is determined before purchase (e.g. the appearance of the food); an experience attribute is one whose quality is determined after purchase (e.g. taste); while the quality of credence good cannot be determined either before or after purchase (e.g. nutritional component of the food). The more recent market implications of this insight are provided by Caswell and Modjuzska (1996). Functional foods are usually considered to be foods with credence attributes, since (in the absence of labelling) the functional properties cannot be inferred by the consumer before or even after purchase.

In many cases, information about food quality can be considered non-rival and non-excludable; substitutes (for the information) do not exist and if made available to one consumer, the information is usually available to all others. In this respect, quality information could be viewed as a public good. Henson and Traill (1993) suggest that as a public good, information about food safety is undersupplied in the market, while Antle (1999) argued that information could be treated as a club good which is non-rival but excludable as long as the information is restricted to a certain group of people.

Akerlof's (1970) well-known paper on the market for lemons underpins most subsequent work on information asymmetry as a cause of market failure. Briefly, he argued that good quality products could be eventually driven out of the market by poor quality products because of information asymmetry between buyers and sellers. Sellers have more knowledge about product quality; if the quality cannot be credibly signalled, goods of both qualities will sell at the same price. The absence of a price premium for higher quality results in only low quality products being offered for sale.

Two information problems are apparent in the functional foods market. One is whether the functional component is present, such as the presence of elevated levels of omega-3 fatty acids. Of course, this is related to different quality levels of functional foods: higher quality (functional foods) and lower quality (no specific health benefit: 'normal' foods). The other information problem is whether the functional health claim is credible, which depends on whether consumers believe that consumption of functional foods will lead to specific health outcomes.

If consumers cannot identify functional foods, they will not be willing to pay a higher price for foods with those qualities, and the economic incentive to produce functional food is not present. Eventually there would be no functional food in the market. Clearly, producers of functional food have a strong incentive to label their products. Labelling can be viewed as a means of providing information for consumers to make choices, and there is a lot debate about the merits of different labelling policies. Unfettered, unregulated labelling can lead to misleading health claims, confusion and distrust among consumers, while the absence of labelling information or very restrictive, limited labelling information does little to alleviate the uncertainty and information asymmetry facing consumers. The two types of information asymmetry problem in the functional foods market are related to the credibility of labelling.

Food labelling is generally classed as mandatory or voluntary labelling. Mandatory labelling requires that products with certain kinds of ingredients be labelled clearly (CFIA 2001); for example, food containing allergens in Canada, or food containing genetically modified (GM) ingredients in the European Union. Mandatory labelling is usually imposed where it is perceived that the private market would fail to provide sufficient information to consumers. Voluntary labelling allows firms the choice of labelling as an attribute, but if the products are labelled, the information must be true and credible (Caswell 2000); this approach is used for voluntary labelling of GM-free foods in Canada and the US. For functional foods with a 'health benefit' attribute, voluntary labelling is appropriate as firms have an incentive to label the presence of a positive attribute, albeit labelling claims may be regulated to ensure credibility and prevent misleading health claims.

Compared to the labelling of functional food, the labelling of GM foods has been studied much more widely. The GM food labelling literature provides some useful insights for potential research directions with respect to functional foods. Hu et al (2005) suggest that there are two research areas in terms of the impact of (GM) labelling. One area is to study existing (GM) food labelling and how this labelling affects consumer behaviour; the other area is related to the labelling context and how different types of labelling information affect consumers' choices. A considerable literature exists on the effect of food labelling information on consumer choices; researchers have used stated choice methods (e.g. Blend and Ravenswaay 1999), contingent valuation (e.g. Roosen et al 2003), and experimental auctions (e.g. Rousu et al 2004). Since functional food is a relatively new food category in Canada, and the regulatory environment for functional food labelling claims remains opaque, the second area of the labelling context may be an appropriate focus for future work, particularly with respect to health claim attributes and understanding how consumers make choices in an uncertain information environment.

Definitions of functional food vary, as do estimates of the size of the market for functional foods. Nevertheless, the inherent information asymmetry given the credence nature of functional food is hard to dispute. It is also hard to escape the conclusion that labelling (in whatever form) is a central means of providing consumers with information about functional food. The interesting research questions lie in understanding the labelling context: how do consumers make decisions in environments of uncertainty; which sources of information are credible; how do different information environments affect willingness to pay; how do different perceived health risks affect consumer behaviour with respect to functional foods. The next section discusses a number of different consumer choice models and their potential application to modelling consumer behaviour with respect to functional foods.

Modelling Consumer Choice of Functional Food

The last section explained how information plays a key role when consumers make food choices. In this section we take a closer look at the consumer choice process and how consumer decisions can be modelled.

The basic economic framework of individual preferences is the standard microeconomic consumer theory of maximizing utility. An individual consumer chooses a consumption bundle faced with his budget restriction. It is assumed that the consumer will exhibit rational behaviour: choosing the bundle which is at least as good as any other among all the bundles. Manski's (1977) random utility approach is more consistent with consumer theory. The individual consumer is always assumed to select the alternative with the maximum utility. However, the analyst does not know the utilities with certainty, and must take the utilities as the random variables, known as random utility. Usually the random utility can be separated into deterministic (observed) and random (unobserved) components for the utility function.

Three different consumer choice models are examined in this section: the Stated Preference Model with Discrete Choice Analysis, Dependent Preference Model, and modified Protection Motivation Theory.

Stated Preference Model with Discrete Choice Analysis

The Stated Preference Method is a useful empirical research technique to understand and predict the decision makers' choice behavior among discrete products. This method focuses on assessing consumer responses to potential product characteristics (Quagrainie et al 1998). The respondents make their choices in a series of hypothetical choice sets. In each scenario of the stated choice experiment, the choice alternatives are described by different levels of the attributes, and the descriptions of the alternatives vary between scenarios. Then the effect of the attributes of the product on preferences can be derived by observing the changes in stated choices due to the variation in the alternatives description.

The Stated Preference Method derives its behaviour originally from random utility theory. Many previous studies have applied random utility models with standard discrete choice methods. Discrete choice analysis is a useful research method that could empirically test theoretical hypotheses about choice behavior, such as the effect of some product attributes. The Stated Preference Choice Model with the Discrete Choice Analysis method can be estimated by a number of different of consumer choice estimation techniques, such as Multinominal Logit, Nested Logit, Mixed Logit, and Ordered Probit, etc.

There are two kinds of choice data: Stated Preference (SP) and Revealed Preference (RP). The SP data are generated from the decision experiment (survey), while the RP data are from consumers' actual observed choice decisions. There are some major advantages of a stated preference method compared with revealed preference studies: for example, the SP method allows researchers to estimate and predict the demand for new products with new attributes; in the marketplace, the explanatory variables have little variability and they are usually highly collinear, which makes it difficult to obtain significant estimation results, usually, SP data is less costly to collect and less time consuming than gathering RP data.

Clearly, a challenge of stated preference surveys is their hypothetical nature; consumers may provide unrealistic answers if there is no cost to overstating their willingness to pay. Also, if consumers are unfamiliar with the product (which could be the case for a new functional food attribute) their stated willingness to pay may be inaccurate, because the SP method asks respondents to state their preference values, but does not record an actual choice action as is the case with revealed preference studies. The fact that the SP method is based on what people say rather than what people do is the source of its greatest strengths and its greatest weaknesses. In empirical studies, researchers often use "cheap talk" to partially overcome the overstatement limitations. The "cheap talk" technique means that before the respondents complete the questionnaires, there are several statements to describe the product in detail by its attributes and encourage the respondents to imagine that they are in real consumption environments. When completing the survey questionnaires, some respondents may be inclined to provide responses that reflect broader notions of public welfare, rather than responding in a way that truly reflects their personal preferences, which might lead to biased responses. To some degree, using the "cheap talk" method encourages the respondents to assume that they are in real shopping environments, and to provide responses that reflect their own behavioural choices.

The stated preference method with discrete choice analysis is becoming increasingly popular among researchers. Larue et al (2004) used a stated preference method to analyze consumers' response to different kinds of functional foods, produced by conventional, organic, and GM technology. A representative sample of 1,008 Canadian household food shoppers responded to the stated preference experiment administered through a telephone survey. Each choice set in the questionnaire asked consumers to choose between the same foods produced by three different food production processes. As this was a phone survey, the number of other characteristics describing the foods had to be quite small, and the three alternatives differed only in terms of price and the presence or absence of a functional health property, so it is almost a "pure" functional health and price attributes trade-off survey. A Mixed Logit model was used to analyse the responses. Results indicated that many Canadian consumers will avoid GM foods regardless of the presence of functional health properties, and they are accepting of conventional and organic functional foods if the prices are reasonable.

Another example of the application of the SP method is the paper written by Quagrainie et al (1998). A stated preference experiment was administered in major cities in western Canada in 1996 via a mail survey; there were 530 respondents. The research question dealt with how product origin, packaging, and selected demographics affect consumers' choice of red meats. Several attributes were selected for each several different fresh meat products, including price, product origin and the packaging characteristic. A multi-nominal nested logit model was used to analyse the SP data. The estimation results indicated that the consumers generally preferred Alberta fresh beef rather than a more general Canadian origin, but the consumers were indifferent for fresh pork from Canada. Consumers' age, household income and family size were found to have an effect on meat choice.

SP method can be applied not only to market goods, such as functional food, but also to non-market goods, such as information. However, very few surveys have been done to examine stated preference for additional information. Latvala and Kola (2000), attempted to find out whether consumers are willing to pay for additional information about beef quality and safety, how much and what kind of information was needed, and who the consumers believe could offer reliable information. To measure the economic benefits for this kind of non-market good, Contingent Valuation Method is the most widely applied method, in which the consumers are asked their WTP for obtaining some benefits in simulated scenarios related to the investigated good.

Survey data allows researchers to investigate demand for specific product attributes, for products that are not widely available on the market (and therefore for which market data is not yet available), and allows researchers to link consumers' stated preferences to socio-economic, demographic and psychological factors. Discrete choice analyses are often used as the econometric estimation method to analyze the data. When designing a stated preference questionnaire for functional food, a number of aspects should be considered. The objective of the survey could be to ascertain consumer preferences for specific functional food attributes and determine the extent to which consumers would trade-off among attributes, e.g. perhaps less convenience for a healthier food product. Also, there are some other aspects that might be useful for the researcher to think about before designing the survey. First, the acceptance of a specific functional ingredient: consumers maybe more likely to accept a familiar ingredient which has been available to them for a longer period of time than a relatively new ingredient, particularly if the consumers already have some knowledge of the health effects of specific ingredients. For example, Menrad (2003) pointed out that consumers exhibit rather higher rates of acceptance for the long-established functional ingredients, (e.g. vitamins, fibre, minerals, calcium, and iron) than the newer ones (e.g. flavonoid, carotinoids, Omega-3 fatty acids).

Having obtained SP data, a number of estimation methods are available. The following section discusses Mixed Logit and Ordered Probit as examples of discrete choice analytical methods, primarily because they are more widely used and with relatively fewer limitations.

Mixed Logit Model with heterogeneity of consumer preferences

McFadden and Train (2000) argue that a mixed logit (ML) model can approximate any random utility model. A flexible ML model could be used to explain consumers' choice behaviour toward functional food. Jain et al (1994) developed a ML model that described consumers' choices with unobserved heterogeneity of preferences. According to that paper, the general random utility framework can be written as in formula (1). U_{ij} is the consumer i's utility of product j. The variables (var1…varv) are the attributes of the product under study, with β's as parameters to be estimated and e_{ij} as an unknown error term.

$$U_{ij} = ß_1*var1 + ß_2*var2 +...+ß_v*varv + e_{ij} \quad (1)$$

With some basic assumptions, the probability of the consumer i choosing different products j can be expressed in a familiar conditional logit form. However, unlike the traditional conditional logit models, which ignore these variations around the coefficients, the central idea of the mixed logit model is that consumers' choices are assumed to be heterogeneous through the specification distribution of the coefficients, which captures the consumer's heterogeneity preference (Hu et al, 2005).

Applying this approach to the case of functional food, the crucial part is to specify the determinant variables (different attributes related to functional food) in the utility function by which consumers make their consumption decisions. Potential variables include: (1) some health related variables, such as certain functions that consumers expect to get by choosing functional food; (2) some psychology variables, such as motivation and perception; (3) some demographic variables, and; (4) other factors, such as taste, convenience and variety. For example, the indirect utility of consumer i choosing functional food alternative j could be written in a random utility framework as:

$$U_{ij} = ß_1*var(health) + ß_2*var(psychology) + ß_3*var(demographic)+... \\ +ß_v*var(general\ factors) + e_{ij} \quad (2)$$

Hu et al (2005) used a Stated Preference Choice approach, estimated by the ML model to analyze the impacts of GM food labelling in Canada.

Ordered Probit Model

Given the major limitation of the Multinomial logit model, the well-known IIA property[2], researchers have turned to Ordered Probit models as an alternative. Train (2003) pointed out that Probit models can deal with the limitations of the Logit model, for example, they can handle random taste variation; they allow any pattern of substitution due to the IIA property; and they are applicable to panel data with correlated errors which means the unobserved factors are correlated over time for each decision maker. If these correlated errors occur, the estimation result will be biased and inconsistent under a Logit model. The key assumption of the Probit model is the jointly normal distribution of unobserved utility components. Generally speaking, the Probit model is suitable to model any choice behaviour (Hausman and Wise, 1978). Probit models are generally estimated by Maximum Likelihood Estimation.

Similarly to the ML model, the application of a Probit model to functional food choice could also take the variable 'whether a consumer chooses functional food' as the dependent variable, and the typical attributes as the independent variables, such as health-related information, psychology variables, and demographic variables as mentioned with the mixed logit models. In fact, probit and logit models are similar, and the distribution of the unobserved error term determines which model should be used; if the error term is assumed to be normally distributed, the probit model is used, and if the logistic distribution is assumed, the logit model should be adopted.

The main limitation of Probit models is the requirement of normal distributions for all unobserved components of utility. In most situations, normal distributions provide an adequate representation of the random components. However, in some situations, normal distributions are inappropriate and can lead to incorrect forecasts. Other than this restriction, the Probit model is quite generally adopted (Train, 2003).

While the Stated Preference Choice methods with discrete choice analysis have long been popular among economists, there is increasing interest in understanding the influence of a consumer's psychology on the decision-making process. The Reference

[2] The Independence of Irrelevant Alternatives (IIA) property of Multinomial logit model: the relative odds of alternative i over j depends only on the relative attractiveness of i and j, and is completely unaffected by the attractiveness of any third alternative k. (See Ben-Akiva and Lerman, 1985, pp108-111, who discuss violations of the IIA property by the so-called Red Bus and Blue Bus paradox.)

Dependent Model, discussed in the next section, is useful in this regard.

A Reference Dependent Model

In traditional consumer theory, human rationality is one of the fundamental assumptions: we assume that a consumer's rational choice should be consistent and coherent. Tversky and Kahneman (1981) described decision problems that violate the requirement of consistency and coherence, and they "trace these violations to the psychological principles that govern the perception of decision problems and the evaluation of options." (p.453) Their model, called Prospect Theory, modifies expected utility theory under uncertainty to accommodate some incompatible observations to humans' rational assumptions. In Prospect Theory, the reference point effect measures the value of changes involving a gain or a loss compared with a reference point; and the changes of the reference point often lead to reversals of preference. Later in 1991, Tversky and Kahneman formally introduced the Reference Dependent theory of loss aversion in riskless choice based on Prospect Theory. "The central assumption of the theory is that losses and disadvantages have greater impact on preferences than gains and advantages. Implications of loss aversion for economic behaviour are considered."(Tversky and Kahneman, 1991, p.1039)

To intuitively help to understand the basic idea behind the Reference Dependent Model, we use Tversky and Kahneman's (1981) experiment as an example. This example presents an illustration of preference reversals through two problem sets, with data collected from about 150 respondents (denoted by N) in each problem set.

"Problem 1 (N=152) let the respondents imagine that there will be the outbreak of a serious disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimate results of the programs as follows, which of the two programs would you favour:

If program A is adopted, 200 people will be saved. [72% choosing option A]

If program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved. [28% choosing option B]

A separate group of respondents was given the same kind of story as problem 1 except with a different formulation of the alternative programs, as follows:

Problem 2 (N=155):

If program C is adopted, 400 people will die. [22% choosing option C]

If program D is adopted, there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die. [78% choosing option D]" (Tversky and Kahneman 1981, p453,)

The formulation of problem 1 involved gains (saving 200 people), and the majority choice in this problem is risk averse, which means the option of certainly saving 200 lives is more attractive than the risky option of equal expected value. In contrast, problem 2 involved losses (400 people will die), and the majority choice is risk taking: the 2/3 probability 600 will die is more acceptable than the certain death of 400 people. However, it is obvious that the two problems are effectively identical, and the only difference is that the outcomes are described in problem 1 by the number of lives saved and in problem 2 by the number of lives lost. But the inconsistent responses to problem 1 and 2 arise, which illustrates the evidence that people have contradictory attitudes towards risks involving gains and losses. This example represents a common pattern of preference: "choices involving gains are often risk averse and choices involving losses are often risk taking." (Tversky and Kahneman, 1981, p.453)

In Prospect Theory, outcomes are expressed as gains or losses from a neutral reference outcome. As illustrated in figure 3, the value function is commonly asymmetrically S-shaped, concave above the reference point and convex below it. There are three essential properties of the value function in figure 3 mentioned in the Reference Dependent Model by Tversky Kahneman, 1991 (p.1039): first, "Reference dependence: the carriers of value are gains and losses defined relative to a reference point." Individuals' preferences depend on a reference point, and the changes of reference point often lead to reversals of preference; second, "Loss aversion: the function is steeper in the negative than in the positive domain; losses loom larger than corresponding gains." Since losses dominate, people will work harder to avoid losses than to obtain gains; third, "Diminishing sensitivity: the marginal value of both gains and losses decreases with their size". For example, the difference of value between gains of $1 and $10 is greater than the difference between gains of $101 and $110.

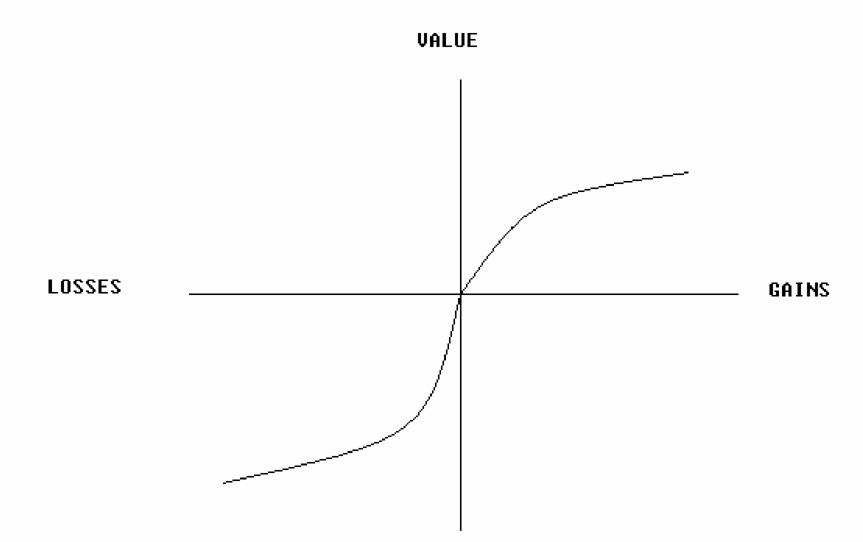

Figure 3: An Illustration of A Value Function
Source: Tversky and Kahneman, QJE, 1991

Much of the literature on modelling heterogeneous consumer choices has focused on taste heterogeneity. By estimating taste heterogeneity through the random coefficients of a mixed logit model, researchers make the behavioural assumption that all differences in consumers' choices are reflected in their taste variations. This is likely to be an over statement (Hu et al, 2006). At least, there might be some reference point effects in Prospect Theory that could be used to explain part of the heterogeneous choices. Reference point effects reflect the fact that individuals with different reference points could make heterogeneous choice decisions. The key point is how to construct the utility function that depends on the reference condition. One form widely used is to make dummy variables that reflect "gains" and "losses" from the reference point, and interact with the interested attribute. For example, Hu et al (2006) apply the reference point effects in models of food attribute demand. They measure the price and some other attribute reference point effects by the introduction of dummy variables and the corresponding attributes. For the price reference point effect, they ask the respondents questions and take the reference price (Pr) as the reference point, and compare with the actual price (Pa) they would like to pay: if Pa < Pr, gain = 1, otherwise 0; if Pa > Pr, loss = 1, otherwise 0; Gain and Loss are interacted with price. Then they use a ML Model to estimate the random utility function, and get a significant coefficient for the price loss, which verifies an asymmetric price reference point effect.

The other technique to measure the reference point effect is to use the "distance" from the reference point as a measure. For example, Koszegi and Rabin (2005) modelled reference dependent preferences by separating utility into intrinsic and transactive components, and the transactive component of utility was measured by using the "distance" from the reference point of utility.

The Reference Dependent Model could be applied to functional foods demand analysis because modelling the choice of functional food products satisfies all three essential properties of the model: reference dependence, loss aversion, and diminishing sensitivity. For example, to measure the "health benefits" attribute of a functional food, an individual consumer needs a reference point to value whether there is a gain or loss from consuming the functional food products. We assume that people take their current health situation as the reference points, and compare with the prospective health situation after taking the products. Assume the health situation could be categorized into 5 categories: very healthy, healthy, not sure, unhealthy, and very unhealthy. The individuals taking different health situations as the reference points will have different attitudes toward the value of a "health benefits" attribute: individuals who are currently unhealthy are more likely to believe that it is a gain of his total utility to consuming functional food, because the health benefits attribute could improve their health situation; while, the individuals who are currently very healthy are more likely to believe it is a loss to his total utility, because it is not necessary to improve their health situation but they have to pay a cost for the products. So consumers with different health reference points could make different consumption choices.

For the diminishing sensitivity characteristic of functional food choice, the marginal value of "gain" for the individuals who are currently unhealthy, not sure or healthy, is more likely to be greater than the individuals who are currently very healthy or very unhealthy. The health benefits characteristic of functional food may only work well for chronic diseases, but has no obvious effect on very unhealthy or very healthy situations.

The loss aversion property of the reference dependent model opens another door to study the functional foods market. According to the psychological principle of loss aversion, the key characteristic of functional foods should emphasize “diseases treatment and prevention”, rather than “health benefits”, since losses dominate and people will work harder to avoid losses than to obtain gains. For example, this suggests that people will be more likely to accept and choose Omega-3 eggs if they believe that this kind of functional food could treat and prevent heart diseases, rather than just promoting a healthy heart function, because perceived losses and disadvantages of disease have a greater impact on preferences than gains and advantages of health promotion. Therefore, the regulatory environment governing allowable health claims for functional foods is critical on two levels. First, influencing the extent to which consumers are expected to adopt functional foods in response to health claims, and second, in terms of the incentives firms have for mis-stating health claims to imply a disease prevention function.

Now we need think about how to construct a utility function that depends on the reference condition. Following the general cases, dummy variables could be used to reflect “gains” and “losses” from the reference point, and then interact with the interested attributes. If the researchers are interested in the reference point effects of price and the “health benefits” attribute of Omega-3 eggs, four dummy variables could be used to capture those effects. For the price variable, the researchers could ask the respondents questions on how much they normally pay for regular consumed eggs, and take those perceived prices as the reference point prices (Pr), and compare with the prices (Pa) of omega-3 eggs they would like to pay: if $Pa < Pr$, gain = 1, otherwise 0; if $Pa > Pr$, loss = 1, otherwise 0; Gain and Loss dummies are interacted with the price variable. The specification of the reference point for the “health benefits” attribute could modify the method used by Hu et al (2006). If the “Health Benefits” (HB) attribute is normally perceived in the regular consumed egg product, HBr = 1, otherwise HBr = 0. Use HBa =1 to represent that the respondent believes the omega-3 eggs have the “health benefits” attribute, otherwise HBa = 0. The “health benefits” gain =1 if HBa – HBr = 1, otherwise 0; and the “health benefits” loss =1 if HBr –HBa = 1, otherwise 0. A Mixed Logit Model could then be used to estimate the random utility function to see whether the coefficients of the “gain” or “loss” variables are significant and check whether the reference point effects of price and “health benefits” attribute are verified.

Sometimes it is difficult to find the appropriate reference points for some attributes of the products. For example, for the functional foods products with potential health benefits dealing with memory loss, the reference points for different individuals are difficult to define, because everyone has different levels of memory loss. Also, the consumers' preferences and reference point effects of some health benefits attributes could change over time after the consumers gain experience with these attributes. Those are the major limitations of Reference Dependent model and there is a need for further research to overcome these limitations.

Protection Motivation Theory (PMT)

Originally from the psychology literature, Rogers (1983) modified PMT and introduced it to the economics literature. In fact, PMT has also been developed from Prospect Theory, just as was the case for the Reference Dependent Model (RDM) discussed above. However, RDM focuses on how to construct the random utility model that depends on the reference condition, while PMT uses two cognitive processes that subsume four psychology variables (the severity, vulnerability, self-efficacy, and response efficacy) to explain an individual's decision making process when one encounters a health threat. Generally speaking, PMT is a more complicated model than RDM in terms of the psychology perception.

Rogers (1983) modified Protection Motivation Theory to address the research question: what kind of cognitive processes arouse people's intention to change their attitude. The basic idea is that people's protection motivation[3] comes from the cognitive appraisal of a noxious event which is likely to occur; furthermore they believe that a recommended coping response can effectively prevent the occurrence of the event. Applied to the question of functional food consumption decisions, the protection motivation arises from the severity and vulnerability of a disease that is likely to occur, and with a belief that a recommended coping response (consuming functional foods) can effectively prevent or treat the diseases and enhance health benefits.

[3] Protection Motivation: "an intervening variable that has the typical characteristics of a motive: it arouses, sustains, and directs activity".(see Rogers 1983, p.158)

A schema depicting the key elements of Protection Motivation Theory is shown in figure 4. PMT are built on two cognitive processes: threat appraisal and coping appraisal process. The threat appraisal process includes the variables that create the danger, and the coping appraisal process includes the variables to cope with and eliminate the danger.

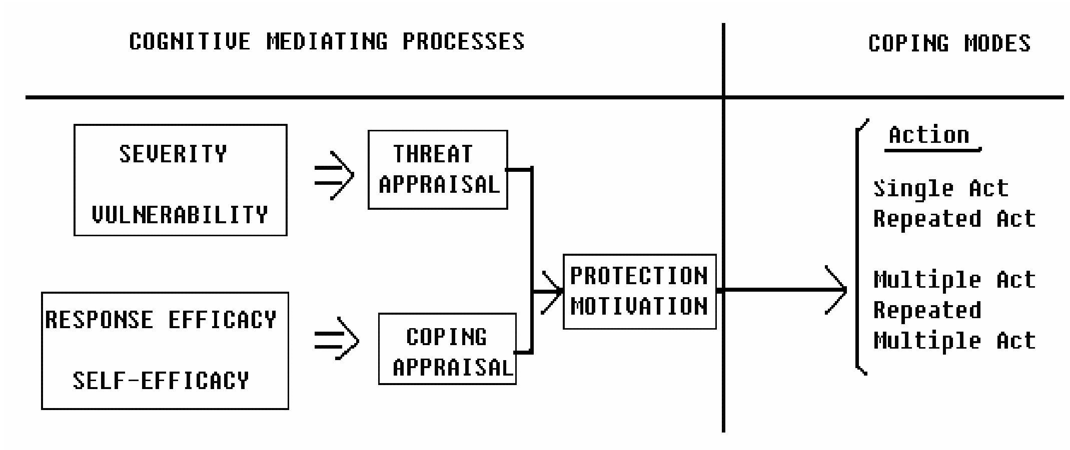

Figure 4: A Modified Schema of Protection Motivation Theory
Source: Adapted from Rogers (1983)

Severity and vulnerability are the elementary variables that form the threat appraisal process, while response efficacy and self-efficacy are the two major psychology variables included in the coping appraisal process. These two appraisal processes lead to an individual's intention of protection motivation to prevent the noxious event from occurring. The coping modes are the real actions aroused by the protection motivation, which could be a single act or repeated acts. Rogers (1983) indicated that the major assumption of PMT is that the motivation to protect oneself from danger is a positive linear function of four beliefs: (1) the threat is severe, (2) one is personally vulnerable to the threat, (3) one has the ability to perform the coping response, and (4) the coping response is effective in averting the threat.

A few studies have applied the PMT model to eating behaviours. One example is Cox et al (2004) who used PMT to predict intentions to consume functional foods and supplements to offset memory loss. Four products were examined: Bitter-FF (naturally bitter functional foods); Sweetened-FF (artificially sweetened to offset bitterness); GM-FF (genetically modified to enhance the function); Supplement (convenient non-food products with the same functional benefits). Their major research question focused on how consumers would react to different described products in terms of their taste, technological modification of bitterness, function and convenience analysed by the PMT method.

Cox et al. (2004) used a mailing survey to collect stated preference data. Their participants, aged 40-60 years, were asked for self-reported perceived memory loss, and had been separated into two groups: the perceived high vulnerability group and the perceived low vulnerability group. The questionnaire describes the purpose of the study, which was to assess attitudes towards functional foods and supplements, provides an introduction of what functional foods are, and an explanation that the foods described did not yet exist.

To provide a better illustration of the PMT questionnaire for functional foods, Table 1 from Cox et al (2004) is partially reproduced as table 1 here. From this table, we can see that Cox et al have translated PMT variables into corresponding survey questions. To quantify those psychology variables, each variable was measured with anchored seven-point scales. Then using regression analysis, they took the "intention to consume" variables as the dependent variables and the independent variables were the variables in PMT: severity, vulnerability, product-efficacy and self-efficacy. The regression results illustrated that PM predictors of intention to consume functional food and supplements explained 59-63% of the R^2 variance. Overall, the response efficacy and the self efficacy were the most important predictors of intention to consume. The respondents preferred natural functional food and supplements more than artificial sweetness functional food, and they disliked GM functional food.

Table 1: Components of PMT model and respective questions

The dependent variable: the primary intentions were measured with two items	
For me, protecting my memory through choosing from functional food range (Naturally bitter/GM/Sweetened/supplement) is	Extremely unimportant/extremely important
If it were available in the supermarkets at a reasonable cost, what is your intention to consume functional food range (Naturally bitter/GM/Sweetened/supplement)	Extremely unlikely/extremely likely
Independent variable 1: the severity of the health threat	
Having memory loss would significantly alter my lifestyle	Completely disagree/completely agree
Memory loss is a severe condition	
Independent variable 2: vulnerability to the threat of memory loss	
People in my age group are vulnerable to memory loss	Completely disagree/completely agree
Compared to the average person in my age group, my risk of developing memory loss is	Extremely low/extremely high
I believe that my chances of getting, or already having, some form of memory loss is	
Being vulnerable to memory loss is	Extremely unimportant/extremely important
Someone important to me has developed memory loss	Yes/no/don't know
My family has a history of memory loss	
Independent variable 3: efficacy of proposed protective behaviour (consumption of functional foods/supplement) at averting the threat	
In my opinion, memory loss is inevitable as one gets older and there is little one can do about it	Completely disagree/completely agree
In my opinion, a diet that includes functional food range (Naturally bitter/GM/Sweetened/supplement) could counteract memory loss	
Consumption from functional food range (Naturally bitter/GM/Sweetened/supplement) may be an effective measure to prevent memory loss, for me	
Please indicate how confident you would be in consuming the necessary amount of active ingredients from these foods (supplements)	Extremely unconfident/extremely confident
Independent variable 4: self-efficacy at carrying out the advocated protective behaviour (consumption of functional foods/supplements)	
In your opinion, how confident are you that you could consume from functional food range (Naturally bitter/GM/Sweetened /supplement) at the recommended frequency	Extremely unconfident/extremely confident

Source: Adapted from Cox et al (2004), p.58

Applying PMT to the issue of consumers' functional food choices, the study needs to focus on the health benefits of prevention and treatment of diseases. The adaptive response is to believe the health benefits functions. Factors that increase peoples' confidences are the self-efficacy and response efficacy that they believe the product is effective to prevent diseases and the belief that one can obtain health benefits after consuming functional food. A person's suspicion of the 'health benefits' functions which might lead to a refusal to consume functional food is the maladaptive response. The factors increasing the likelihood of the suspicion are intrinsic rewards, e.g. the confidence in one's own health status, and extrinsic rewards, e.g. there is no perceived health improvement after consuming functional foods. Factors decreasing the probability of the suspicion are beliefs in the severity of the diseases and in one's vulnerability to these diseases. The coping modes are the real consumption actions for functional food after the protection motivation has been realized by consumers.

One can choose a single act (e.g. trying the functional food a single time), repeated acts (e.g. continuous consumption), multiple acts (e.g. consuming the functional food and the normal food at the same time). Furthermore, the acts can involve either direct action or the inhibition of action which means avoiding the unhealthy food. Using regression analysis, 'intention to consume functional food' can be defined as the dependent variable, with the independent variables represented by the main variables in the PMT model: severity, vulnerability, product-efficacy and self-efficacy.

One of the major advantages of the PMT model is that the researcher can explain the psychological decision-making variables behind consumers' choices. Because the PMT model originally comes from the psychology literature, the biggest disadvantage of the model for an economist is the challenge in quantifying the choices, since the dependent variable (intention to choose functional food) and independent variables (response efficacy, self efficacy, severity, and vulnerability, etc.) are psychological variables which are difficult to measure. Stated Preference techniques can be used to explain these variables (i.e. maybe these methods are complementary, not alternatives). Another disadvantage of the model is that the threat appraisal is the soul of the model, but often for functional food, the major function is health benefits, not disease threats, so consumers' severity and vulnerability of the diseases from not consuming functional food are not as strong, which reduces the importance of the threat appraisal process.

Conclusion and Future Research

Consumer interest in the link between diet and health creates a potential source of demand for functional food products with positive health attributes. Burgeoning health care costs and a growth in diet-related diseases have made health a key policy issue, with important questions over the role of public versus private R&D in novel functional foods. The global market for functional foods is estimated to be worth about US$33 billion (Hilliam, 2000). This large growing market will expand rapidly both domestically and internationally. Canadian companies are emerging as a leading world supplier in these functional foods markets, such as probiotics, fish oil, beta glucan, and flax bioactive products, etc. Surprisingly little socio-economic research has examined the functional food sector in Canada. Through a review of the literature, this paper has examined several methods that could be used to model functional food choice among consumers facing information asymmetry. Since information asymmetry could cause consumers to under-consume healthy food or over-consume unhealthy food, labelling could be one efficient and practical way to solve this problem. The interesting research questions relate to understanding the labelling context: how do consumers make decisions in environments of uncertainty; which sources of information are credible. In this paper, we modified some existing consumer choice models and suggest how they could be applied to functional foods. Clearly there are a great variety of potential methodologies, however, we focus on three consumer choice models: the Stated Preference Choice Model with Discrete Choice Analysis, Dependent Preference Model and modified Protection Motivation Theory.

Each method has its own advantages and limitations in modelling functional foods. The Stated Preference Method is used to assess consumer responses to potential product characteristics, especially to estimate and predict the demand for new products with new attributes. The challenge of the method is its hypothetical nature, which means that consumers may provide unrealistic answers if there is no cost to overstating their willingness to pay. The fact that the SP method is based on what people say, rather than what people do, is the source of its greatest strengths and its greatest weaknesses. Discrete Choice Analyses, such as the Mixed Logit and Ordered Probit models, are often used as the econometric estimation methods to analyze the stated preference survey data. In fact, Probit and Logit models are similar, and the distribution of the unobserved error term determines which model should be used. When modelling heterogeneous consumer choices, many papers focus on taste heterogeneity, and some researchers make the behavioural assumption that all differences in consumers' choices were reflected in their taste variations. However, there might be some reference point effects in the Reference Dependent Model that could explain part of the heterogeneous choices. The major limitations of the Reference Dependent model are that sometimes it is difficult to find appropriate reference points to some product attributes, also consumers' preferences and reference point effects with respect to product attributes could change after the consumers gain experience with these attributes. Modified Protection Motivation Theory has been developed from Prospect Theory, as with the Reference Dependent Model, but it is a more complicated model than RDM in terms of the psychology perception variables. The central assumption of Prospect Theory is that losses and disadvantages have a greater impact on preferences than gains and advantages. One of the major advantages of the PMT model is that the researcher can explain the psychological decision-making variables of consumers' choices. However, the biggest disadvantage of this model is the challenge in quantifying the choices, since both the dependent variable and independent variables are psychological variables which are difficult to measure.

Ultimately, which method is more suitable depends on the specific research questions and the available data. If the researchers are more concerned about quantifying the strength of preferences, or the demand for product attributes, it may be better to choose the Stated Preference Method with Discrete Choice Analysis; if the consumers' psychological decision-making processes are the major research objectives, the Reference Dependent Model and modified Protection Motivation Theory may be more appropriate. Finally, it may be that these methods can be complementary in a comprehensive analysis of consumer preferences, rather than simply viewed as alternatives.

Functional food is a relative new food category positioned between medicine and conventional foods. This food sector has increasingly attracted the attention of consumers, market researchers, public health policy makers, and the food industry. In Europe and Japan, functional foods already have had a relatively mature market. While products are now on the market, this sector has been somewhat slower to develop in Canada. Future research focusing on specific functional foods (e.g. probiotic yogurt, or Omega-3 milk, etc) has the potential to be very beneficial to the Canadian agri-food industry in terms of improving the industry's understanding of the market for value-added functional foods products and identifying appropriate strategies for R&D and value-added product development. The methodologies outlined in this paper can enable researchers to provide insights into how consumers make choices, what motivates these choices, and how consumers trade-off product attributes (e.g. price, origin, health, taste, etc) when making decisions.

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