AN ECONOMIC ANALYSIS OF OFFSETTING BEHAVIOUR IN HEALTH IMPROVEMENTS: AN APPLICATION TO FUNCTIONAL DAIRY PRODUCTS

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ABSTRACT

AN ECONOMIC ANALYSIS OF OFFSETTING BEHAVIOUR IN HEALTH IMPROVEMENTS: AN APPLICATION TO FUNCTIONAL DAIRY PRODUCTS

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This thesis reports the results of a study investigating the impact of functional food consumption on broader dietary choices. A theoretical framework of individual response to regulatory protection is adapted to investigate potential offsetting behaviour in the context of averting behaviours undertaken to improve health and/or reduce the risk of illness such as functional food consumption. Data was collected through two online surveys using a representative consumer panel in Guelph, Ontario, Canada. Estimation of probit models for two types of offsetting behaviour namely increased overall consumption of a functional food carrier and reduced propensity to make health dietary choices suggest that the addition of a functional ingredient to a food may lead to increased overall consumption of that food; however the probability of that occurrence is low. Empirical results do not support that consumption of a functional food reduces the propensity to make healthy dietary choices.

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Chapter 1

Introduction

1.1 BACKGROUND

Chronic diseases are the major cause of death and disability globally (World Health Organization 2005). In 2005, over 89 percent of Canadian deaths were attributed to non-communicable diseases such as cardiovascular disease, cancer, chronic respiratory disease, diabetes and musculoskeletal disease (Public Health Agency of Canada 2006) where cancer, heart disease, stroke and chronic respiratory diseases were the top four causes of death that year (Statistics Canada 2009c). In Ontario, the top four causes of death in 2003 were heart disease, cancers, stroke and pulmonary respiratory disease (Ontario Ministry of Health and Long-Term Care 2007). The number of deaths attributed to chronic disease in Canada, diabetes in particular, is expected to rise over the ten year period from 2005 to 2014 (World Health Organization 2005).

As a result of being a major cause of death and disability, chronic diseases place a large economic burden on Canada's healthcare system and economy. According to the World Health Organization (2005), Canada stands to lose up to $9 billion in national income from premature deaths due to heart disease, stroke and diabetes over the ten year period from 2005 to 2014. In Ontario, chronic diseases are estimated to account for 55 percent of direct and indirect health care costs, which includes lost productivity from disability and premature death (Ontario Ministry of Health and Long-Term Care 2007)

In economic theory, social costs arising from the actions of other consumers (i.e. negative externalities), such as direct and indirect healthcare costs arising from chronic diseases, provide rationale for government intervention in the market via policies, regulations, initiatives and programs. In Canada, federal, provincial and territorial governments have developed and funded a number of programs and initiatives targeting chronic disease in general (Integrated Strategy on Healthy Living and Chronic Disease, Manitoba Chronic Disease Prevention Initiative) as well as specific chronic diseases such as cancers (Canadian Strategy for Cancer Control, Canadian Breast Cancer Initiative), heart disease (Canadian Heart Healthy Strategy, Ontario Heart Health Program), stroke (Ontario Stroke Strategy), diabetes (Canadian Diabetes Strategy, Aboriginal Diabetes Initiative, Ontario Diabetes Strategy) and respiratory disease (National Health Lung Network).

Alongside public strategies, initiatives and programs developed to reduce chronic disease in Canada, functional foods have emerged as a private sector solution to address chronic diseases and potentially to reduce the associated direct and indirect healthcare costs. Functional foods have also emerged and gained acceptance due to an increasing belief in the link between diet and health based on evidence that a healthy diet can contribute to reduced risk of chronic diseases (Cash et al 2006; Agriculture and Agri-Food Canada 2009). Although there is no generally accepted definition of a functional food, the present study follows Health Canada's (1998) definition:

> A functional food is similar in appearance to, or may be, a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional requirements (p. 3)

The empirical literature on consumer acceptance of functional foods is becoming well-established both within Canada (see for example West and Larue 2005; Cranfield et al 2007; Peng et al 2006; Labreque et al 2006; Henson et al 2008; West et al 2002; Malla et al 2007; Herath et al 2008; Hailu et al 2009) and internationally (see for example Verbeke 2006; Verbeke 2005; Cox and Bastiaans 2007; Cox et al 2008; Luckhow and Delahunty 2004; Urala and Lahteenmaki 2003; Cox et al 2004; Bech-Larsen et al 2001; Sorenson and Bogue 2005; Van Kleef et al 2005). However, the literature has focused primarily on what influences acceptance of functional foods and, although knowing what influences acceptance is important to industry and government, there is a gap in the literature with respect to how consumption of a functional food affects broader dietary choices. Research in this area is important, particularly if consumption of a functional food reduces the propensity to make healthy dietary choices which could potentially offset the benefits of consuming the functional food in the first place; the consumer may be worse off following consumption of a functional food than before. Research on how functional food consumption affects broader dietary choices may also be important for government, Health Canada specifically, in assessing health claims proposed by new functional foods.

The question of whether consumption of a functional food reduces the propensity to make healthy dietary choices can be explored using the offsetting behaviour hypothesis (Peltzman 1975) which argues that individuals may offset the benefits of increased health or safety protection by taking more risks and/or fewer precautions. The offsetting behaviour hypothesis has been applied primarily to traffic accidents (Crandall and Graham 1984; Peterson et al 1995; Poitras and Sutter 2002; Yun 2002), workplace accidents (Viscusi 1979) and consumer product accidents (Viscusi 1984; Viscusi and Cavallo 1994; Peltzman 1987) following mandatory safety regulations. Although consumption of a functional food is voluntary, unlike prior scenarios investigated using the hypothesis, the concept of offsetting behaviour could apply in the present context if consumption of a functional food leads to an increased propensity to take dietary risks and/or a decreased propensity to make healthy dietary choices.

There are two forms of offsetting behaviour that could occur following consumption of a functional food. The first form of offsetting behaviour would occur if, following adoption of a functional food, an individual's propensity to make broader healthy dietary choices was reduced. An example of this first form would be decreased fruit and vegetable consumption and/or increased "junk" food consumption following consumption of a functional food. The second form of offsetting behaviour that could occur following consumption of a functional food is if using an 'unhealthy' carrier for a functional food encouraged excess consumption of that 'unhealthy' food. In the Canadian market, functional foods such as probiotic/prebiotic frozen yogurt, omega-3 enriched cookies and high-protein chocolate bars are available for purchase and consumption. The addition of functional ingredients to unhealthy foods may create a 'health halo' effect where individuals may consume larger amounts of these products under the false impression that they are healthy (Chandon and Wansink 2007). Previous studies in the marketing literature have found that individuals consume more of unhealthy products when they are marketed as healthy (see for example Wansink and Chandon 2006; Chandon and Wansink 2007; Provencher et al 2009), which is an example of offsetting behaviour.

As the offsetting behaviour hypothesis has been applied primarily to mandatory safety regulation (see for example Crandall and Graham 1984; Peterson et al 1995; Poitras and Sutter 2002; Yun 2002), the present study is one of the first to apply the concept to voluntary health improvements (Dickie and Gerking 1997; Kahn 1999; Mancino and Kuchler 2009) and the first to apply the concept to functional food consumption. The present study aims to fill gaps in both the functional food and offsetting behaviour literature by investigating how consumption of a functional food affects broader dietary choices.

1.2 ECONOMIC PROBLEM

Costs associated with chronic disease in Canada are non-trivial and are borne by consumers, taxpayers and the economy in general. Although functional foods have emerged as a private solution to potentially reduce the risk of chronic diseases, improve health and reduce healthcare costs, the potential benefits and cost savings of functional food consumption may be offset if consumption reduces the propensity to make other healthy dietary choices. Previous studies in the functional food literature have focused on what influences acceptance but have not addressed how consumption influences broader dietary choices. The present study addresses this knowledge gap by investigating, theoretically and empirically, how functional food consumption, or more broadly undertaking a dietary averting behaviour, affects broader dietary choices.

1.3 ECONOMIC RESEARCH PROBLEM

Understanding how consumption of a functional food affects broader dietary choices may aid researchers and policymakers in valuing potential health benefits and cost savings from functional food consumption. Also, empirical results suggesting that addition of a functional ingredient to an unhealthy food could lead to over-consumption or that consuming a functional food reduces the propensity to make healthy dietary choices may aid government, Health Canada specifically, in assessing proposed health claims for new functional food. The propensity to take increased dietary risks following consumption of a functional food has not been investigated, representing a significant gap in the functional food literature. The present study fills the literature gap by investigating the probability of two forms of increased dietary risk following consumption of a functional food.

As the two possible forms of increased dietary risks investigated are examples of offsetting behaviour, conceptual frameworks of offsetting behaviour (Peltzman 1975; Hause 2006; Viscusi 1984) can be used to investigate the impact of functional food consumption on broader dietary behaviour. Previous conceptual models of offsetting behaviour, however, have investigated response to regulatory and safety regulation and only with respect to one behaviour or an aggregate of all averting behaviours. Recognizing the need for a conceptual framework, the present study builds on previous conceptual models to develop one that is applicable to the context of offsetting behaviour in health improvements, including functional food consumption.

Research specific to how consumption of a functional food affects broader dietary choice is important, however, a greater understanding of how undertaking health improvements may impact broader dietary and lifestyle choices may have a wider application. The conceptual framework developed in this study could be applied to potential offsetting behaviour in health improvements such as food choice, exercise, prescription medications and contraception. This is particularly important for government in assessing the costs and benefits of proposed policies as not taking into account potential offsetting behaviour could lead to overstating the benefits.

1.4 PURPOSE AND OBJECTIVES

The purpose of this study is to determine how consumption of a functional food affects broader dietary choices. Specific objectives are:

1. To develop a conceptual framework to investigate offsetting behaviour in voluntary health improvements based on previous theoretical frameworks developed to investigate individual response to regulatory and safety protection;
2. To develop an experimental design within which offsetting behaviour in voluntary health improvements can be explored;
3. To investigate whether addition of a functional ingredient to a food leads to increased overall consumption of that food;
4. To investigate whether consumption of a functional food reduces the propensity to make other healthy dietary choices;
5. To make recommendations for future research on offsetting behaviour and on how consumption of a functional food affects broader dietary choices as well as to discuss policy implications of the present study.

In the following chapter, a conceptual framework to investigate offsetting behaviour in health improvements will be developed based on three previous conceptual models of offsetting behaviour (Peltzman 1975; Viscusi 1984; Hause 2006). Empirically testable hypotheses will be derived in the conceptual framework. To test the hypotheses, an experimental design will be developed which will guide data collection and the empirical analysis including investigation of whether the addition of a functional ingredient to an unhealthy food leads to increased consumption of that food and whether consumption of a functional food reduces the propensity to make broader healthy dietary choices. Upon completion of the empirical analysis, policy implications of the present study will be discussed and recommendations will be developed for future research on offsetting behaviour and functional food consumption.

1.5 SUMMARY

The present study represents a significant contribution to the literature on offsetting behaviour and functional food acceptance by investigating how consumption of a functional food affects broader dietary choices. Previous studies investigating functional food acceptance have investigated what influences acceptance but not how functional food consumption affects broader dietary choices. The conceptual framework developed in the following chapter will allow for the derivation of a general set of comparative static results not previously seen in the offsetting behaviour literature.

A conceptual framework to investigate offsetting behaviour in health improvements will be developed in the following chapter, building on previous research, in particular conceptual models of individual response to regulatory and safety protection. Past research on offsetting behaviour has focused primarily on response to mandatory regulations; however, in the present study the potential offsetting effect is not the result of a regulation, but rather undertaking a voluntary health improvement and the ensuing dietary choices. The fact that the present study is one of the first to investigate offsetting behaviour in health improvements (Dickie and Gerking 1997; Kahn 1999; Mancino and Kuchler 2009) provides motivation to expand previous analytical frameworks developed to investigate offsetting behaviour to the present context of offsetting behaviour in health improvements.

Chapter 2

Conceptual Framework

2.1 INTRODUCTION

The purpose of this chapter is to develop a theoretical framework that will enable investigation of the impact of consumption of a functional food on broader dietary choices. In alignment with previous theoretical models, consumption of a functional food and broader dietary choices will be referred to as averting behaviours in the present conceptual framework (Peltzman 1975; Viscusi 1984; Hause 2006). The theoretical model developed in this study enables investigation of the decision to undertake an averting behaviour, the impact of changes in exogenous variables on the optimal level undertaken of an averting behaviour and the impact of the adoption of a new or second averting behaviour (e.g. consumption of a functional food) on the optimal level undertaken of the original averting behaviour (e.g. broader dietary choices). In developing the theoretical model, empirically testable hypotheses and theoretical results are derived for subsequent empirical analysis. The present chapter will first provide a discussion of previous studies that have investigated possible offsetting behaviour by individuals. It will then adapt a model of individual response to regulation to the context of individual behaviour following voluntary health improvements. This chapter will conclude with a discussion of the impact of the adoption of a second averting behaviour on the optimal level undertaken of the original averting behaviour.

2.2 OFFSETTING BEHAVIOUR HYPOTHESIS – INDIVIDUAL RESPONSE TO REGULATORY PROTECTION

The concept of market failures in microeconomic theory provides a rationale for government intervention in the market via policies and regulations which are enacted to reduce social costs associated with externalities resulting from accidents, illness and other harmful events. Although policies and regulations are enacted to reduce harm, they may not always have their full intended effect due to offsetting behaviour. The offsetting behaviour hypothesis predicts that individuals respond to safety regulation by engaging in riskier behaviour and/or by reducing their level of precautionary effort or averting behaviour (see for example Peltzman 1975; Hause 2006; Crandall and Graham 1984; Peterson et al 1995; Chirinko and Harper 1993; Evans and Graham 1991; Sen 2001). Economists now recognize that the benefits of policies and regulations may be reduced and possibly reversed because of offsetting behaviour undertaken by potential victims as they either reduce averting behaviour or increase risky behaviour in response to policies and regulations (Hause 2006).

The first study to highlight the possibility of offsetting behaviour in response to safety regulation was Peltzman's (1975) study of American automobile safety regulation. Prior to Peltzman's article, studies investigating the impact of the use of various safety devices in automobiles in the United States predicted that there would be a reduction in the highway death rate following the installation and mandatory usage of safety devices than what would have otherwise occurred (see for example Joksch and Wuerdeman 1972; U.S. National Highway Traffic Safety Administration 1968; Lave and Weber 1970). Peltzman (1975), however, hypothesized and found that individuals responded to the mandatory installation of safety devices in automobiles by engaging in riskier behaviour or by undertaking more of what he called "driving intensity", which partially offsets the beneficial effects of the government regulation through more pedestrian deaths and non-fatal accidents.

Following Peltzman (1975), a number of studies have applied the offsetting behaviour hypothesis primarily to traffic accidents (Crandall and Graham 1984; Peterson et al 1995; Poitras and Sutter 2002; Yun 2002), workplace accidents (Viscusi 1979) and consumer product accidents (Viscusi 1984; Viscusi and Cavallo 1994; Peltzman 1987). There have been relatively few published studies that deal with offsetting behaviour in the context of voluntary health improvements. In the economic literature, Dickie and Gerking (1997) found that individuals partially offset genetic skin cancer protection when choosing precautionary efforts to avoid sun exposure and ultimately skin cancer, Mancino and Kuchler (2009) found that the use cholesterol-lowering drugs is correlated with increased fat intake, while Kahn (1999) found little evidence that medicated diabetics have worse health habits than non-medicated diabetics. In the marketing literature, studies have found that individuals are likely to consume more of an "unhealthy" food when it is perceived or marketed as "healthy" (see for example Wansink and Chandon 2006; Chandon and Wansink 2007; Provencher et al 2009).

Although there are three primary conceptual models of offsetting behaviour, Peltzman (1975), Viscusi (1984) and Hause (2006), the model developed in the present study is largely based on Viscusi's (1984) "lulling effect" model which suggests that individuals may use safer products less carefully to the point that they may end up with a greater risk of illness or accident. Viscusi (1984) argued that safety regulations, such as child-proof bottle caps, lull individuals into believing that they are safer or more protected which results in individuals using products less carefully, that is, exerting less precautionary effort to avoid illness or accident.

The conceptual models of Peltzman (1975) and Hause (2006) investigated whether a regulation induces an individual to engage in riskier behaviour, while Viscusi (1984) investigated whether a regulation lulls an individual into undertaking less precautionary effort. More simply, Peltzman (1975) and Hause (2006) looked at whether regulation encourages "bad" behaviour while Viscusi (1984) looked at whether regulation discourages "good" behaviour. Although the present study differs from both Peltzman (1975) and Viscusi (1984) in that it investigates the response to a voluntary health improvement, it looks at whether the adoption of a second averting behaviour, such as a functional food, reduces the level undertaken of the original behaviour such as reducing the propensity to make healthy dietary choices. As the present study looks at whether undertaking the second averting behaviour discourages "good behaviour", Viscusi's (1984) lulling effect is the more appropriate model.

The model developed in the present conceptual framework differs from Viscusi (1984) in that it investigates the adoption of a new averting behaviour or voluntary health improvement on the optimal level of the original averting behaviour rather than the impact of a new regulation on total averting behaviour undertaken. In terms of the analysis, this difference means that neither the original nor the second averting behaviour is mandatory (unlike a regulation) and so the individual must make a decision to consume an averting behaviour or both averting behaviours based on some rule. Additionally, the optimal level of the averting behaviour undertaken will be influenced, not by the level of stringency of a regulation, but by other exogenous factors such as prices or effectiveness.

The conceptual framework developed in the present study will first investigate how an individual selects the optimal level of an averting behaviour, followed by an analysis of the impact of the adoption of a second averting behaviour on the optimal level undertaken of the original averting behaviour.

2.3 ONE-BEHAVIOUR ANALYTICAL FRAMEWORK

Following Viscusi (1984), the analytical framework for individual response to the adoption of a new averting behaviour will first be developed to investigate the decision to undertake an averting behaviour[1]. This is done to identify how an individual selects the optimal level of an averting behaviour and adjusts the optimal level undertaken following an exogenous shock[2]. The process by which an individual chooses and adjusts the optimal level of an averting behaviour will help to provide a basis to investigate the impact of the adoption of a second averting behaviour.

2.3.1 Selection of the Optimal Level of an Averting Behaviour

It is assumed initially that one averting behaviour, a_1, is available to reduce the probability of acquiring illness k and thus the expected loss resulting from that illness, EL_i^k, where $i = 1$ is the number of averting behaviours available. Additionally, it is assumed that averting behaviour a_1 only works to reduce the probability of illness k and has no impact on the probability of acquiring any illness other than k. Following Peltzman (1975), Viscusi (1984), and Hause (2006), the expected loss from illness, can be represented as:

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[1] The term "averting behaviour" is analogous to what Viscusi (1984) called "precautionary effort".
[2] Assume initially that there is only one averting behaviour available prior to the new averting behaviour. In reality, it is a set of averting behaviours. This can be relaxed by generalizing from an individual averting behaviour to a set of averting behaviours.

$$EL_1^k(a_1, e_1) = \pi_1^k(a_1, e_1) \cdot L \qquad (2.1)$$

Where $EL_1^k(a_1, e_1)$ is the value of an individual's expected loss from illness k, $\pi_1^k(a_1, e_1)$ is the probability of acquiring illness k, a_1 is the level of averting behaviour, e_1 is the effectiveness per unit of a_1 and L is the size of the loss associated with illness k. Although Peltzman (1975) and Hause (2006) both assumed that both the probability of illness and the size of the loss vary with averting behaviour, the present analytical framework follows Viscusi (1984) in assuming that the size of the loss is constant and is a positive value. Hause (2006) demonstrated that, in the context of his model, varying the size of the loss (Peltzman 1975) and keeping the size of the loss constant (Viscusi 1984) produce essentially the same result, however, the two different specifications are not necessarily appropriate for all applications.

Following Viscusi (1984), the current model assumes that the acquisition of illness k is a discrete event and that an individual can undertake averting behaviour to reduce the probability of acquiring or developing illness k. However, if the individual does become ill, the size of the loss does not depend on the level of averting behaviour undertaken prior to developing illness k. Additionally following Viscusi (1984), the parametric structure of the probability of illness, $\pi_1^k(a_1, e_1)$ and thus the expected loss from illness $EL_1^k(a_1, e_1)$ is kept general. It is not known, a priori, what parametric structure the probability of illness function takes nor the relationship between the level of a_1 and its effectiveness e_1 within that parametric structure. It is also assumed that there are no misperceptions about the effectiveness of the averting behaviour[3].

It is assumed that the probability of developing illness k, π_1^k is convex[4] and both the level of averting behaviour, a_1, and its effectiveness, e_1 reduce the probability of illness at a diminishing rate (Viscusi 1984), that is $\frac{\partial \pi_1^k(a_1,e_1)}{\partial a_1} < 0$, $\frac{\partial \pi_1^k(a_1,e_1)}{\partial e_1} < 0$ and $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1^2} > 0$, $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial e_1^2} > 0$. Additionally, it is assumed that $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1 \partial e_1} < 0$; the reduction in the probability of illness from increased averting behaviour is larger following an increase in effectiveness than before the increase in effectiveness. The negative cross-partial implies that there is an interrelationship between the level of averting behaviour and its effectiveness within the probability of illness function. However, for the probability function to be convex, $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1^2} \cdot \frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial e_1^2} > \left[\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1 \partial e_1}\right]^2$ must be true. The curvature assumptions of the probability function can be extended to the expected loss function, which is the probability function multiplied by the size of the loss, which is a scalar. This is because the probability function is convex and multiplying a convex function by a scalar produces a convex function (Chiang 1984). Thus, both the averting behaviour a_1 and its effectiveness e_1 reduce the expected loss at a

[3] This assumption could be relaxed. Viscusi (1984) incorporated misperceptions into his model by stating that if an individual does not properly perceive the probability of an accident, he or she may over-estimate the safety associated with the new product. That is, the expected loss curve is perceived to be lower than it actually is. Vicusi (1984) argued that misperceptions could cause safety precautions to decline, perhaps to the extent that overall safety is reduced.

[4] The assumption that the probability function is convex implies that it has a positive definite Hessian matrix. This implies that all principal minors are greater than zero. The probability function has a 2 by 2 matrix and thus 2 principal minors. The first principal minor is $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1^2}$, which is assumed to be greater than zero. The second principal minor is $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1^2} \cdot \frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial e_1^2} - \left[\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1 \partial e_1}\right]^2$. By assumption, both components of the second principal minor are positive, however, to ensure that the probability function is indeed convex, $\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1^2} \cdot \frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial e_1^2} > \left[\frac{\partial^2 \pi_1^k(a_1,e_1)}{\partial a_1 \partial e_1}\right]^2$ must also be true.

diminishing rate, $\frac{\partial EL_1^k(a_1,e_1)}{\partial a_1} < 0$, $\frac{\partial EL_1^k(a_1,e_1)}{\partial e_1} < 0$, $\frac{\partial^2 EL_1^k(a_1,e_1)}{\partial a_1^2} > 0$, $\frac{\partial^2 EL_1^k(a_1,e_1)}{\partial e_1^2} > 0$,

$\frac{\partial^2 EL_1^k(a_1,e_1)}{\partial a_1 \partial e_1} < 0$ and $\frac{\partial^2 EL_1^k(a_1,e_1)}{\partial a_1^2} \cdot \frac{\partial^2 EL_1^k(a_1,e_1)}{\partial e_1^2} > \left[\frac{\partial^2 EL_1^k(a_1,e_1)}{\partial a_1 \partial e_1}\right]^2$.

It is assumed that undertaking averting behaviour, a_1, may generate disutility or utility for an individual, $V(a_1)$, where $\frac{\partial V(a_1)}{\partial a_1} > 0$ when undertaking averting behaviour generates disutility and $\frac{\partial V(a_1)}{\partial a_1} < 0$ when undertaking averting behaviour generates utility. Regardless of whether undertaking averting behaviour generates utility or disutility, the disutility function $V(a_1)$ (following Viscusi (1984)) is convex in averting behaviour, $\frac{\partial^2 V(a_1)}{\partial a_1^2} > 0$. The current model builds on Viscusi (1984) by accounting for the possibility that an averting behaviour may generate utility rather disutility because an individual may enjoy undertaking averting behaviour and is better off or, in the context of Viscusi's (1984) model, less worse off by undertaking a higher level of averting behaviour. For instance, for some individuals exercising regularly generates disutility while other individuals enjoy exercising and are happier (better off) by undertaking more of it[5].

In the present study, as an averting behaviour represents a functional food or another behaviour (i.e. broader dietary choices) that an individual can undertake to reduce the risk of developing a specific illness, it has a direct monetary cost. Although the direct

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5 Two clarifications on the disutility function are important. First, it is assumed that the disutility of averting behaviour reflects an underlying quasi-linear utility function, $u(x, a_1) = x + V(a_1)$, where x reflects the utility of all other goods, ceteris paribus. Second, the decision to undertake an averting behaviour may be governed by a weak inequality constraint which says that disutility of undertaking an averting behaviour, $V(a_1)$, must equal or be less than a reference level of disutility. In this case, the expected utility maximization problem is a constrained problem, where disutility is constrained to be less than or equal to the reference level of disutility. This assumption is similar to the participation constraint in the principal-agent problem. This assumption that disutility must be less than or equal to a reference level has not been included in the present model, however incorporating a reference level of utility is a possible extension.

monetary cost of averting behaviour did not appear in Viscusi's (1984) model, Peltzman (1975) and Hause (2006) both included the amount spent on avoidance behaviours as a choice variable in their models. Specifying a unit of averting behaviour as the amount spent on the behaviour is one method of incorporating the direct cost of undertaking averting behaviour into the present analytical framework. This method, however, does not allow for the investigation of the impact of a change in price of averting behaviour on the optimal level undertaken. In addition, Peltzman (1975) and Hause (2006) group all expenditures on accident avoidance behaviour together, rather than looking at different behaviours individually. A cost function is therefore included to account for the direct monetary cost of undertaking an averting behaviour (Deaton and Muellbauer 1980). This will allow for a comparative static exercise to investigate the impact of a price change on the optimal level of averting behaviour. Therefore, let $C(a_1, p_1) = p_1 \cdot a_1$ represent the linear cost function where p_1 represents the price of the averting behaviour a_1 and $\frac{\partial C(a_1,p_1)}{\partial a_1}, \frac{\partial C(a_1,p_1)}{\partial p_1} > 0, \frac{\partial^2 C(a_1,p_1)}{\partial a_1^2} = \frac{\partial^2 C(a_1,p_1)}{\partial p_1^2} = 0$. The cost of undertaking averting behaviour a_1 is increasing in the price and the level of averting behaviour at a constant rate. Additionally, $\frac{\partial^2 C(a_1,p_1)}{\partial a_1 \partial p_1} = \frac{\partial^2 C(a_1,p_1)}{\partial p_1 \partial a_1} = 1$.

The choice variable, a unit of averting behaviour or precautionary effort, has been defined differently in previous studies. Hause (2006) defined a unit of averting behaviour as the monetary equivalent of victim avoidance behaviour. Peltzman (1975) had two different units of averting behaviour: the time devoted to driving a given speed limit and the driver's expenditures on reduction of accident losses. Unlike Hause (2006) and Peltzman (1975),Viscusi (1984) did not define a unit of precautionary effort. The present model will follow Peltzman (1975) and define a unit of averting behaviour as the time devoted to undertaking the behaviour. This recognizes that different types of averting behaviour have different time requirements. The effectiveness variable then relates how much time an individual needs to devote to undertaking the behaviour. The price variable reflects the direct cost of the averting behaviour, however, as a_1 reflects time devoted to averting behaviour, there is also a time cost, w, the wage rate or opportunity cost of time associated with its usage.

In addition to the costs of undertaking an averting behaviour, the income of an individual also has an impact on the undertaken level. Viscusi (1984) defined income as an exogenous variable, while Peltzman (1975) defined income as dependent on the level of avoidance behaviour undertaken by an individual. Following Viscusi (1984) and Peltzman (1975), as well as the neoclassical model of labour supply (Deaton and Muellbauer 1980), it is assumed that any time devoted to undertaking averting behaviour reduces the time that an individual has available for hourly work. Therefore, let M represent total income, let T represent the number of hours available to the individual for work and averting behaviour, w represent the wage rate of the individual which may be interpreted as the opportunity cost of time and I represents a non-labour or salaried income which is not influenced by the level of averting behaviour. The total income of the individual can be represented by the linear function $M = I + w(T - a_1)$. Note that $-w \cdot a_1$ could also be included in the cost of undertaking averting behaviour as it reflects the time cost

Incorporating all of the previous elements, the payoff to an individual in the case of illness k is $I + w(T - a_1) - V(a_1) - C(a_1, p_1) - L$ and the payoff to an individual if they do not acquire illness k is $I + w(T - a_1) - V(a_1) - C(a_1, p_1)$. Assuming risk neutrality, the individual's expected utility is:

$$EU = I + w(T - a_1) - V(a_1) - C(a_1, p_1) - \pi_1^k(a_1, e_1) \cdot L^6 \quad (2.2)$$

The individual will select a non-negative optimal level of averting behaviour, a_1^* to maximize expected utility. The expected utility maximization problem can be expressed as:

$$\underset{a_1 \geq 0}{Max}\, EU = I + w(T - a_1) - V(a_1) - C(a_1, p_1) - \pi_1^k(a_1, e_1) \cdot L \quad (2.3)$$

To account for the potential corner solution (i.e. $a_1 = 0$), the expected utility maximization problem is set up as a constrained maximization problem:

$$\underset{a_1, \lambda}{Max}\, \mathcal{L} = I + w(T - a_1) - V(a_1) - C(a_1, p_1) - \pi_1^k(a_1, e_1) \cdot L - \lambda \cdot a_1 \quad (2.4)$$

Where λ is the Lagrange multiplier or shadow value associated with the non-negativity constraint. Maximizing equation (2.4) with respect to λ and a_1 results in the following first-order (Kuhn-Tucker) conditions:

$$\frac{\partial \mathcal{L}}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1)}{\partial a_1} - \frac{\partial \pi_1^k(a_1, e_1)}{\partial a_1} \cdot L - \lambda = 0 \quad (2.5)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = a_1 \geq 0, \lambda \geq 0, \lambda \cdot a_1 = 0 \quad (2.6)$$

There are two possible solutions to the constrained maximization problem. The first possible solution is an interior solution where the individual undertakes a positive level of the averting behaviour, $a_1^* > 0$. In this solution scenario, the shadow value must equal zero for $\lambda \cdot a_1^* = 0$ to be true. Equation (2.5) then implies that in choosing the

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[6] Note that equation (2.2) could be written as $EU = I + w \cdot T - V(a_1) - (p_1 + w) \cdot a_1 - \pi_1^k(a_1, e_1) \cdot L$ where $(p_1 + w) \cdot a_1$ represents the time cost associated with undertaking a_1.

optimal level of averting behaviour, $a_1^* > 0$, the individual equates the marginal benefit of undertaking averting behaviour to the marginal cost of undertaking the averting behaviour.

The values of the marginal benefit and the marginal cost of undertaking a_1 depend on whether undertaking averting behaviour generates utility ($\frac{\partial V(a_1)}{\partial a_1} < 0$) or disutility ($\frac{\partial V(a_1)}{\partial a_1} > 0$). In both cases, the marginal direct cost of averting behaviour, p_1, and the marginal time cost in terms of foregone wages, w , are components of the marginal cost and the marginal reduction in expected loss, $-\frac{\partial \pi_1^k(a_1,e_1)}{\partial a_1} \cdot L$, is a component of the marginal benefit of undertaking averting behaviour a_1. If undertaking a_1 generates utility, then marginal utility is a component of the marginal benefit of undertaking averting behaviour; if undertaking a_1 generates disutility, then marginal disutility is a component of the marginal cost. In both cases, equating the marginal benefit of undertaking averting behaviour to the marginal cost will lead to an optimal point such as A in Figure 2.1. This is because the level of averting behaviour that satisfies the first-order condition (equation 2.5) when averting behaviour generates utility is the same level that satisfies the first-order condition when the averting behaviour generates disutility.

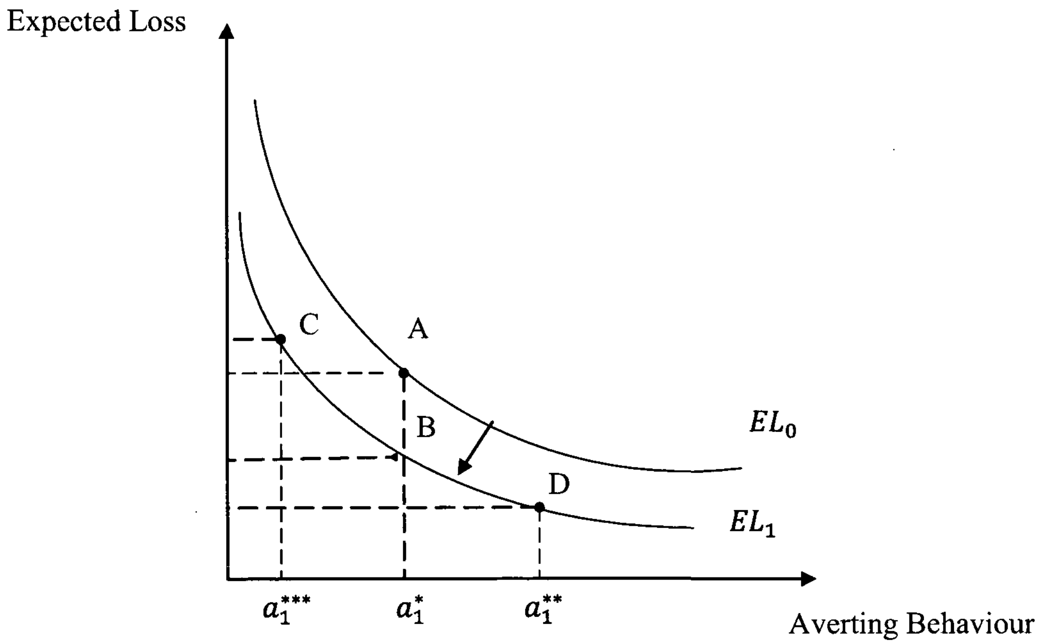

Figure 2. 1 Averting behaviour and expected loss

The second possible solution to the expected utility maximization problem is a corner solution where the individual does not undertake the averting behaviour, $a_1^* = 0$. In this solution scenario, the shadow value, λ, is greater than zero. Analogous to the interior solution scenario, the individual equates the marginal benefit of undertaking averting behaviour a_1 to the marginal cost to determine the optimal level of averting behaviour, a_1^*, however, in the case of a corner solution, the marginal cost of undertaking averting behaviour is greater than the marginal benefit for all levels of a_1 (i.e. there is a negative net marginal benefit for all levels of a_1). To equate the marginal benefit and marginal cost, the shadow value, $\lambda > 0$, is subtracted from the marginal cost. The individual then optimally chooses not to undertake averting behaviour.

The second-order conditions are sufficient for the optimal solution to the expected utility maximization problem to be a maximum (Chiang 1984) and in the case of a constrained maximization problem, are only evaluated when the inequality constraint is binding (see Novshek 1993 p. 91). The Lagrangian (equation 2.4) is re-written ignoring the inactive constraint (i.e. $a_1 > 0$):

$$\mathcal{L}^* = I + w(T - a_1^*) - V(a_1^*) - C(a_1^*, p_1) - \pi_1^k(a_1^*, e_1) \cdot L \tag{2.7}$$

Which has the corresponding first-order condition:

$$\frac{\partial \mathcal{L}^*}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1^*)}{\partial a_1} - \frac{\partial \pi_1^k(a_1^*, e_1)}{\partial a_1} \cdot L = 0 \tag{2.8}$$

The second-order condition for a maximum, $\frac{\partial^2 \mathcal{L}}{\partial a_1^2} < 0$, is then verified:

$$\frac{\partial^2 \mathcal{L}}{\partial a_1^2} = -\frac{\partial^2 V(a_1)}{\partial a_1^2} - \frac{\partial^2 \pi_1^k(a_1, e_1)}{\partial a_1^2} \cdot L \tag{2.9}$$

Equation (2.9) is negative as it has been assumed that disutility and expected loss functions are both convex and so $\frac{\partial^2 V(a_1)}{\partial a_1^2} > 0$ and $\frac{\partial^2 \pi_1^k(a_1, e_1)}{\partial a_1^2} \cdot L > 0$. The negative sign of $\frac{\partial^2 \mathcal{L}}{\partial a_1^2}$ is sufficient to establish that a_1^* maximizes expected utility.

2.3.2 Comparative Static Analysis

The comparative static analysis will illustrate the impact of changes in exogenous variables on the optimal level undertaken of averting behaviour, a_1^*. Comparative static analysis will also help to derive empirically testable hypotheses. In the one-behaviour analytical framework, there are five exogenous variables: effectiveness, e_1, price, p_1, non-labour or salaried income, I, wage rate, w and size of loss, L. To investigate the impact of a change in one of the five exogenous variables on a_1^*, the optimal level of averting behaviour is assumed to be positive, that is $a_1^* > 0$. This assumption is made because, if the optimal level of averting behaviour is zero, it cannot be further reduced and so a comparative static result that showed that the optimal level of averting behaviour decreases with some change in an exogenous variable would not make intuitive sense.

The implicit function theorem implies that the optimal level of averting behaviour, a_1^*, is a function of the exogenous parameters e_1, p_1, I, w, L and will hold if: (1) equation (2.8) has continuous partial derivatives with respect to a_1, e_1, p_1, I, w, L; and (2) there exists a point that satisfies equation (2.8) for which its partial derivative with respect to a_1 is not equal to zero (Chiang 1984). Assumptions about the differentiability of equation (2.8) with respect to the exogenous variables are implicit in the curvature assumptions made earlier about the income, disutility, cost and expected loss functions. Equation (2.8) is satisfied at the optimal solution, a_1^*, which has a second-derivative less than zero by the second-order condition (equation 2.9). To investigate the impact of a change in one of the five exogenous variables on the optimal level of averting behaviour, a_1^*, equation (2.8) is totally differentiated with respect to a_1 and the exogenous parameter of interest, while holding the other four exogenous parameters constant.

(a) Effectiveness

The effectiveness variable is similar to the stringency variable in Viscusi's (1984) model as an increase in either variable will result in a downward shift of the expected loss curve. In terms of Figure 2.1, an increase in the effectiveness of averting behaviour would shift the expected loss curve from EL_0 to EL_1. Totally differentiating equation (2.8) with respect to a_1 and e_1, while holding the other four exogenous parameters constant results in:

$$-\frac{\partial^2 V(a_1^*)}{\partial a_1^2} \cdot da_1 - \frac{\partial^2 V(a_1^*)}{\partial a_1 \partial e_1} \cdot de_1 - \frac{\partial p_1}{\partial a_1} \cdot da_1 - \frac{\partial p_1}{\partial e_1} \cdot de_1$$

$$-\frac{\partial^2 \pi_1^k(a_1^*,e_1)}{\partial a_1^2} \cdot L \cdot da_1 - \frac{\partial^2 \pi_1^k(a_1^*,e_1)}{\partial a_1 \partial e_1} \cdot L \cdot de_1 = 0 \qquad (2.10)$$

Which can be rearranged and solved as:

$$\frac{da_1^*}{de_1} = -\frac{\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial e_1} + \frac{\partial^2 \pi_1^k(a_1^*,e_1)}{\partial a_1 \partial e_1} \cdot L}{\frac{\partial^2 V(a_1^*)}{\partial a_1^2} + \frac{\partial^2 \pi_1^k(a_1^*,e_1)}{\partial a_1^2} \cdot L} \qquad (2.11)$$

The numerator of equation (2.11) is negative as the first component of the numerator, $\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial e_1}$, is equal to zero since effectiveness does not impact marginal disutility, while the second component of the numerator, $\frac{\partial^2 \pi_1^k(a_1^*,e_1)}{\partial a_1 \partial e_1} \cdot L$, is negative based on the assumption that the reduction in the probability of illness from increased averting behaviour is larger following an increase in effectiveness than before the increase. The convexity assumptions of the disutility and expected loss functions imply that both components of the denominator are positive and so $\frac{da_1^*}{de_1} > 0$. The positive sign of equation (2.11) implies that an increase in the effectiveness of an averting behaviour will increase the level undertaken, moving to a point such as *D* in Figure 2.1. Although an increase in effectiveness has a similar impact on the expected loss curve as an increase in the stringency of a regulation (i.e. the curve shifts), the result here is opposite of Viscusi's (1984) comparative static result for the impact of an increase in the stringency of a regulation on the level of precautionary effort undertaken by an individual. This is because Viscusi (1984) assumed that safety regulation reduces the marginal safety benefits from precautionary efforts while the present study assumes that effectiveness increases the marginal reduction in the probability of illness from averting behaviour.

(b) Price

To investigate the impact of a change in the price of an averting behaviour on the optimal level undertaken, equation (2.8) was totally differentiated with respect to a_1 and p_1 while holding the other four parameters constant, resulting in:

$$-\frac{\partial^2 V(a_1^*)}{\partial a_1^2} \cdot da_1 - \frac{\partial^2 V(a_1^*)}{\partial a_1 \partial p_1} \cdot dp_1 - \frac{\partial p_1}{\partial a_1} \cdot da_1 - \frac{\partial p_1}{\partial p_1} \cdot dp_1$$

$$-\frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2} \cdot L \cdot da_1 - \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial p_1} \cdot L \cdot dp_1 = 0 \qquad (2.12)$$

Which can be rearranged and solved as:

$$\frac{da_1^*}{dp_1} = -\frac{\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial p_1} + 1 + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial p_1} \cdot L}{\frac{\partial^2 V(a_1^*)}{\partial a_1^2} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2} \cdot L} \qquad (2.13)$$

The sign of the numerator of equation (2.13) is positive and equal to one as the first and third components of the numerator, $\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial p_1}$ and $\frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial p_1} \cdot L$, are equal to zero since price does not impact the marginal disutility or the marginal reduction in expected loss from undertaking averting behaviour. The convexity assumptions of the disutility and expected loss functions imply that both components of the denominator are positive and so $\frac{da_1^*}{de_1} < 0$. This implies that an increase in the price of an averting behaviour will decrease the optimal level undertaken. This result is not unexpected as the Law of Demand predicts that quantity demanded decreases as price increase. In the context of the present analytical framework, it is the level undertaken of an averting behaviour that decreases following a price increase.

(c) Salaried or Non-Labour Income

Previous studies examining individual response to regulatory protection (Peltzman 1975; Viscusi 1984; Hause 2006) have incorporated salaried or non-labour income into their models; however they did not investigate the impact of a change in that variable on the optimal level undertaken of an averting behaviour. To investigate the impact of a change in salaried or non-labour income on the optimal level undertaken of an averting behaviour, equation (2.8) was totally differentiated with respect to a_1 and I while holding the other four parameters constant, resulting in:

$$-\frac{\partial^2 V(a_1^*)}{\partial a_1^2}\cdot da_1 - \frac{\partial^2 V(a_1^*)}{\partial a_1 \partial I}\cdot dI - \frac{\partial p_1}{\partial a_1}\cdot da_1 - \frac{\partial p_1}{\partial I}\cdot dI$$
$$-\frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2}\cdot L\cdot da_1 - \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial I}\cdot L\cdot dI = 0 \qquad (2.14)$$

Which can be rearranged and solved as:

$$\frac{da_1^*}{dI} = -\frac{\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial I} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial I}\cdot L}{\frac{\partial^2 V(a_1^*)}{\partial a_1^2} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2}\cdot L} \qquad (2.15)$$

The numerator of equation (2.15) is equal to zero as both components of the numerator, $\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial I}$ and $\frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial I}\cdot L$ are equal to zero. This is because non-labour or salaried income does not impact marginal disutility or marginal reduction in expected loss and so $\frac{da_1^*}{dI} = 0$; a change in salaried or non-labour income has no impact on the amount of averting behaviour undertaken by an individual. This result is not surprising as there is no budget constraint in the expected utility maximization problem and so salaried or non-labour income is not a limiting factor to undertaking an averting behaviour. This result is also not surprising as the disutility function reflects an underlying quasi-linear utility function and there is no income effect when preferences are quasi-linear (Varian 1992).

(d) Wage Rate

To investigate the impact of a change in the wage rate on the optimal level undertaken of an averting behaviour, equation (2.8) was totally differentiated with respect to a_1 and w while holding the other four parameters constant, resulting in:

$$-dw - \frac{\partial^2 V(a_1^*)}{\partial a_1^2} \cdot da_1 - \frac{\partial^2 V(a_1^*)}{\partial a_1 \partial w} \cdot dw - \frac{\partial p_1}{\partial a_1} \cdot da_1 - \frac{\partial p_1}{\partial w} \cdot dw - \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2} \cdot L \cdot da_1 - \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{a_1 \partial w} \cdot L \cdot dw = 0 \quad (2.16)$$

Which can be rearranged and solved as:

$$\frac{da_1^*}{dw} = -\frac{1 + \frac{\partial^2 V(a_1^*)}{\partial a_1 \partial w} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial w} \cdot L}{\frac{\partial^2 V(a_1^*)}{\partial a_1^2} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2} \cdot L} \quad (2.17)$$

The numerator of equation (2.17) is equal to one as the wage rate does not influence the marginal disutility nor the marginal reduction in expected loss and so the last two components of the numerator, $\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial w}$ and $\frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial w} \cdot L$ are both equal to zero. The convexity assumptions of the disutility and expected loss functions imply that both components of the denominator are positive and so $\frac{da_1^*}{dw} < 0$. This comparative static result implies that an increase in the wage rate will decrease the amount of averting behaviour undertaken by an individual. An interpretation of the wage rate is that it is the opportunity cost of an individual's time and the negative sign of the comparative static result could be interpreted as an increase in the opportunity cost of one's time resulting in a decrease in the amount of time devoted to undertaking averting behaviour.

The comparative static results for the impact of a change in salaried or non-labour income and a change in the wage rate are akin to economists preferring lump-sum taxes and transfers over per unit taxes and transfers as the latter are distortionary. A change in salaried or non-labour income, similar to a lump-sum tax or transfer, does not affect the optimal level of averting behaviour. This is because salaried or non-labour income is independent of the level of averting behaviour undertaken by the individual (Rosen et al 2003). However, a change in the wage rate, similar to a per-unit tax or transfer, does have an impact on the optimal level of averting behaviour as it changes the opportunity cost of time. An increase in the wage rate increases the opportunity cost of time spent on averting behaviour and thus an individual will reduce the amount of time spent on averting behaviour.

(e) Loss

Although Viscusi (1984), unlike Peltzman (1975) and Hause (2006), held the size of the loss associated with an accident fixed, he did not investigate the impact of a change in the size of the loss on the optimal level of precautionary effort. To investigate the impact of a change in the size of loss on the optimal level undertaken of an averting behaviour, equation (2.8) was totally differentiated with respect to a_1 and L while holding the other four parameters, resulting in:

$$-\frac{\partial^2 V(a_1^*)}{\partial a_1^2}\cdot da_1-\frac{\partial^2 V(a_1^*)}{\partial a_1\partial L}\cdot dL-\frac{\partial p_1}{\partial a_1}\cdot da_1-\frac{\partial p_1}{\partial L}\cdot dL-\frac{\partial^2\pi_1^k(a_1^*,e_1)}{\partial a_1^2}\cdot L\cdot da_1$$
$$-\frac{\partial^2\pi_1^k(a_1^*,e_1)}{\partial a_1\partial L}\cdot L\cdot dL-\frac{\partial\pi_1^k(a_1^*,e_1)}{\partial a_1}\cdot dL=0 \qquad (2.18)$$

Which can be rearranged and solved as:

$$\frac{da_1^*}{dL} = -\frac{\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial L} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial L} \cdot L + \frac{\partial \pi_1^k(a_1^*, e_1)}{\partial a_1}}{\frac{\partial^2 V(a_1^*)}{\partial a_1^2} + \frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1^2} \cdot L} \qquad (2.19)$$

The first two components of the numerator $\frac{\partial^2 V(a_1^*)}{\partial a_1 \partial L}$ and $\frac{\partial^2 \pi_1^k(a_1^*, e_1)}{\partial a_1 \partial L} \cdot L$ are equal to zero as the size of loss does not impact marginal disutility nor the marginal reduction in the probability of illness. The third component of the numerator is negative based on the assumption that undertaking an averting behaviour reduces the probability of acquiring illness k and so the numerator of equation (2.19) is negative. The convexity assumptions of the disutility and expected loss functions imply that both components of the denominator are positive and so $\frac{da_1^*}{dL} > 0$. The positive sign of the comparative static result implies that an increase in the size of the loss associated with an illness will increase the amount of averting behaviour undertaken by individual. The intuition behind this result is that as the size of loss associated with an illness increases, an individual will undertake more averting behaviour to reduce the probability of acquiring the illness.

Comparative Static Results

The comparative static exercise for the five exogenous variables in the one-behaviour analytical framework resulted in five hypotheses that can be tested empirically. The hypotheses are:

(H.1) An increase (decrease) in the effectiveness of an averting behaviour will increase (decrease) the optimal level of the averting behaviour that is undertaken;

(H.2) An increase (decrease) in the price of an averting behaviour will decrease (increase) the optimal level of the averting behaviour that is undertaken;

(H.3) An increase (decrease) in the salaried or non-labour income will have no impact on the optimal level of the averting behaviour that is undertaken;

(H.4) An increase (decrease) in the wage rate will decrease (increase) the optimal level of the averting behaviour that is undertaken;

(H.5) An increase (decrease) in the size of loss will increase (decrease) the optimal level of the averting behaviour that is undertaken.

2.4 TWO-BEHAVIOUR ANALYTICAL FRAMEWORK

The one-behaviour analytical framework determined how an individual chooses the optimal level of an averting behaviour for a specific illness, k. In this section of the conceptual framework, the one-behaviour analytical framework will be expanded to investigate how the availability of a second averting behaviour influences the optimal levels of the two averting behaviours, the impacts of changes in exogenous variables on the optimal levels and the impact of the adoption of the second averting behaviour on the optimal level undertaken of the original averting behaviour. The two-behaviour analytical framework extends from studies that have investigated individual response to regulatory protection by treating the two averting behaviours as separate rather than aggregating the two behaviours (Peltzman 1975; Viscusi 1984; Hause 2006).

2.4.1 Selection of the Optimal Levels of the Two Averting Behaviours

Initially, one averting behaviour, a_1, was available to reduce the probability of acquiring illness k and to minimize the associated expected loss. Assuming that an individual is undertaking a positive amount of the original averting behaviour, he or she now has the option to undertake a second averting behaviour a_2 and can choose some combination of the two averting behaviours to reduce the probability of acquiring illness k and to minimize the associated expected loss. The new averting behaviour a_2 may differ from the original averting behaviour, a_1 in price, (dis)utility and/or effectiveness. It is assumed, similar to the one-behaviour analytical framework, that a_2 only works to reduce the probability of illness k and does not affect the probability of acquiring an illness other than k. With the availability of a second averting behaviour, the expected loss can be represented as:

$$EL_2^k(a_1, a_2, e_1, e_2) = \pi_2^k(a_1, a_2, e_1, e_2) \cdot L \tag{2.20}$$

Where $EL_2^k(a_1, a_2, e_1, e_2)$ is the value of an individual's expected loss from illness k, $\pi_2^k(a_1, a_2, e_1, e_2)$ is the probability of acquiring illness k, a_i is the level of averting behaviour i, i ={1,2}, e_i is the effectiveness of averting behaviour i, and L is the size of the loss associated with illness k.

Similar to the one-behaviour analytical framework, assume that, ceteris paribus, an increase in the level or effectiveness of either averting behaviour will decrease the probability of acquiring illness k, $\frac{\partial \pi_2^k(a_1,a_2,e_1,e_2)}{\partial a_i} < 0$, $\frac{\partial \pi_2^k(a_1,a_2,e_1,e_2)}{\partial e_i} < 0$. With the availability of the second averting behaviour, the second-order or curvature assumptions of the probability function become more complicated. It is assumed that the probability function is convex and the Hessian matrix of second-order partials of the probability function is positive definite with all four principal minors greater than zero. This means that $\frac{\partial^2 \pi_2^k(a_1,a_2,e_1,e_2)}{\partial a_1^2} > 0$ as it is the first principal minor. The signs of the other cross-partials of the probability function are unknown (i.e. $\frac{\partial^2 \pi_2^k(a_1,a_2,e_1,e_2)}{\partial e_i^2}$, $\frac{\partial^2 \pi_2^k(a_1,a_2,e_1,e_2)}{\partial a_i \partial e_i}$ and $\frac{\partial^2 \pi_2^k(a_1,a_2,e_1,e_2)}{\partial a_i \partial e_j}$), with the exception of $\frac{\partial^2 \pi_2^k(a_1,a_2,e_1,e_2)}{\partial a_2^2} > 0$ which must be true for the second principal minor to be greater than zero. The expected loss function is also convex as it is the product of the convex probability function and a scalar, the size of the loss L.

That is $\frac{\partial EL_2^k(a_1,a_2,e_1,e_2)}{\partial a_i} < 0$, $\frac{\partial EL_2^k(a_1,a_2,e_1,e_2)}{\partial e_i} < 0$, $\frac{\partial^2 EL_2^k(a_1,a_2,e_1,e_2)}{\partial a_i^2} > 0$. All four principal minors of the expected loss function are greater than zero, however with the exception of $\frac{\partial^2 EL_2^k(a_1,a_2,e_1,e_2)}{\partial a_i^2} > 0$, the signs of the other cross-partials of the expected loss function (i.e. $\frac{\partial^2 EL_2^k(a_1,a_2,e_1,e_2)}{\partial e_i^2}$, $\frac{\partial^2 EL_2^k(a_1,a_2,e_1,e_2)}{\partial a_i \partial e_i}$ and $\frac{\partial^2 EL_2^k(a_1,a_2,e_1,e_2)}{\partial a_i \partial e_j}$) are unknown.

With the availability of a second averting behaviour, the disutility function behaviour becomes $V(a_1, a_2)$, which is assumed to be convex in both averting behaviours with $\frac{\partial V(a_1,a_2)}{\partial a_i} \gtrless 0$, $\frac{\partial^2 V(a_1,a_2)}{\partial a_i^2} > 0$.[7] The cost function becomes $C(a_1, a_2, p_1, p_2) = a_1 \cdot p_1 + a_2 \cdot p_2$ and the total income function becomes $M = I + w(T - a_1 - a_2)$.

Following the availability of a second averting behaviour, the individual's expected utility equation becomes:

$$EU = I + w(T - a_1 - a_2) - V(a_1, a_2) - C(a_1, a_2, p_1, p_2) - \pi_2^k(a_1, a_2 . e_1, e_2) \cdot L \tag{2.21}$$

The individual selects the optimal level of the two averting behaviours, a_1^* and a_2^* to maximize expected utility. The individual is assumed to undertake a positive level of the original averting behaviour, $a_1 > 0$ and a non-negative amount of the second averting behaviour, $a_2 \geq 0$. The expected utility maximization problem can be expressed as:

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[7] A convex function has a positive definite Hessian matrix. This implies that all principal minors are greater than zero. The disutility function has a 2 by 2 matrix and thus 2 principal minors. The first principal minor is $\frac{\partial^2 V(a_1,a_2)}{\partial a_1^2}$ which must be greater than or equal to zero. The second principal minor is $\frac{\partial^2 V(a_1,a_2)}{\partial a_1^2} \cdot \frac{\partial^2 V(a_1,a_2)}{\partial a_2^2} - \left[\frac{\partial^2 V(a_1,a_2)}{\partial a_1 \partial a_2}\right]^2$ which must also be greater than or equal to zero. For the second principal minor to be greater than zero, $\frac{\partial^2 V(a_1,a_2)}{\partial a_2^2} > 0$ and $\frac{\partial^2 V(a_1,a_2)}{\partial a_1^2} \cdot \frac{\partial^2 V(a_1,a_2)}{\partial a_2^2} > \left[\frac{\partial^2 V(a_1,a_2)}{\partial a_1 \partial a_2}\right]^2$ must also be true. Although $\frac{\partial^2 V(a_1,a_2)}{\partial a_1 \partial a_2} = \frac{\partial^2 V(a_1,a_2)}{\partial a_2 \partial a_1}$ by Young's Theorem, the sign of the cross-partial of disutility with respect to a_1 and a_2 it is not known as only its square matters for the convexity assumption.

$$\underset{a_1 > 0, a_2 \geq 0}{Max}\ EU = I + w(T - a_1 - a_2) - V(a_1, a_2) - C(a_1, a_2, p_1, p_2) - \pi_1^k(a_1, a_2, e_1, e_2) \cdot L \tag{2.22}$$

To account for the restrictions placed on the two averting behaviours as well as to account for a potential corner solution (i.e. $a_2^* = 0$) the two-behaviour expected utility problem is set up as a constrained maximization problem:

$$\underset{a_1, a_2, \lambda_2}{Max}\ \mathcal{L} = I + w(T - a_1 - a_2) - V(a_1, a_2) - C(a_1, a_2, p_1, p_2) - \pi_1^k(a_1, a_2, e_1, e_2) \cdot L - \lambda_2 \cdot a_2 \tag{2.23}$$

Where λ_2 is the Lagrange multiplier or shadow value associated with the non-negativity constraint $a_2 \geq 0$ and $\lambda_2 \geq 0$. Maximizing equation (2.23) with respect to a_1, a_2 and λ_2 results in the following first-order (Kuhn-Tucker) conditions:

$$\frac{\partial \mathcal{L}}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1, a_2)}{\partial a_1} - \frac{\partial \pi_1^k(a_1, a_2, e_1, e_2)}{\partial a_1} \cdot L = 0 \tag{2.24}$$

$$\frac{\partial \mathcal{L}}{\partial a_2} = -w - p_2 - \frac{\partial V(a_1, a_2)}{\partial a_2} - \frac{\partial \pi_1^k(a_1, a_2, e_1, e_2)}{\partial a_2} \cdot L - \lambda_2 = 0 \tag{2.25}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_2} = a_2 \geq 0, \lambda_2 \geq 0, \lambda_2 \cdot a_2 = 0 \tag{2.26}$$

Similar to the one-behaviour analytical framework, there are two potential solution scenarios for a_2: interior and corner. In an interior solution, the individual undertakes a positive level of the second averting behaviour, $a_2^* > 0$, so $\lambda_2 = 0$. Equation (2.25) can then be re-written as:

$$\frac{\partial \mathcal{L}}{\partial a_2} = -w - p_2 - \frac{\partial V(a_1, a_2)}{\partial a_2} - \frac{\partial \pi_1^k(a_1, a_2, e_1, e_2)}{\partial a_2} \cdot L = 0 \tag{2.27}$$

In a corner solution, an individual does not undertake the second averting behaviour so $a_2^* = 0$ and $\lambda_2 > 0$. Regardless of whether the optimal solution is an interior solution or a corner solution for a_2, an individual equates the marginal reduction in expected loss from undertaking averting behaviour a_i to the marginal cost of undertaking that behaviour. Moreover, in selecting the optimal levels of the two averting behaviours, a_1^* and a_2^* , an individual equates the marginal effects or the net marginal benefits of the two averting behaviours. Note that if a_2^* is a corner solution, then for the equi-marginal principle to apply, the net marginal benefit for the second averting behaviour reflects the value of λ_2.

The second-order conditions must be verified to ensure that the result to the two-behaviour expected utility problem to be a maximum. Following Novshek (1993 p.91), it is assumed that a_2^* is an interior solution and equation (2.23) is re-written, ignoring the inactive constraint:

$$\underset{a_1, a_2}{Max}\ \mathcal{L}^* = I + w(T - a_1^* - a_2^*) - V(a_1^*, a_2^*) - C(a_1^*, a_2^*, p_1, p_2) - \pi_1^k(a_1^*, a_2^*, e_1, e_2) \cdot L \qquad (2.28)$$

A sufficient condition for a maximum is concavity of equation (2.28), which implies that the Hessian matrix of second-order partial derivatives of the Lagrangian function is negative definite. Alternatively, it can be verified that the optimal solution to the expected utility problem is a maximum using the three theorems on concavity and convexity (Chiang 1984). The first theorem states that a linear function is concave as well as convex, but not strictly so. The second theorem states that the negative of a (strictly) concave function is (strictly) convex and vice versa. The third theorem states that that sum of concave (convex) functions is also concave (convex). In terms of the Lagrangian, the disutility function, $V(a_1, a_2)$, and the expected loss function $\pi_2^k(a_1, a_2. e_1, e_2) \cdot L$, are convex by assumption and thus the negative of each function (as they appear in equation 2.28) is concave. The income function $I + w(T - a_1 - a_2)$ and cost function

$C(a_1, a_2, p_1, p_2)$ are both linear in the choice variables and thus are both concave and convex. The sum of the disutility function, the expected loss function, the cost function, and the income function is therefore concave and thus the Lagrangian is concave. This verifies that the solution to the expected utility maximization problem for two averting behaviours is indeed a maximum and the Hessian matrix of second-order partial derivatives is negative definite.

Additionally, the third theorem on concavity and convexity states that if at least one function in the sum of concave functions is strictly concave, then the sum of the concave functions is also strictly concave. Therefore, if it is assumed that the negative of the disutility function and/or the expected loss function are strictly concave, then the expected utility function is strictly concave and the determinant of the Hessian matrix of second-order partial derivatives, $|H|$, is greater than zero. This result is important for the comparative static exercise.

2.4.2 Comparative Static Analysis

Similar to the case when only one averting behaviour is available, it is important to investigate the impact of change in an exogenous variable on the optimal levels undertaken of the two averting behaviours a_1^* and a_2^*. Analogous to the one-behaviour analytical framework, it is assumed that the individual is undertaking a positive level of both averting behaviours and so $\lambda_2 = 0$ in equation (2.25).

In the two-behaviour analytical framework, there are seven exogenous variables: the effectiveness of the two averting behaviours, e_1 and e_2, the price of the two averting behaviours p_1 and p_2, salaried or non-labour income I, the wage rate, w and the size of the loss L. However, as there are now two endogenous variables, a_1 and a_2, the comparative static exercise becomes more complicated than in the one-behaviour analytical framework. Following Novshek (1993), after distinguishing between the exogenous and endogenous variables in the model, the first step in the comparative static exercise is to treat the first-order conditions, equations (2.24) and (2.25) (with $\lambda_2 = 0$) as a system of equations.

The second step in the comparative static exercise is to verify the three conditions of the implicit function theorem (Novshek 1993). First, the equations in the system must be differentiable. Assumptions about the differentiability of the first order conditions were made earlier when curvature assumptions about the four components of the expected utility function (the income function, the disutility function, the cost function and the expected loss function) were made. Second, the system of first order conditions must be satisfied at the optimal solution. Third, the determinant of the Jacobian matrix must be non-zero. The Jacobian matrix is the matrix of partial derivatives of the system of equations with respect to the endogenous variables. For the expected utility maximization problem, the Jacobian matrix is equal to the Hessian matrix of the second-order partial derivatives. Earlier it was shown that the expected utility function is strictly concave and thus it is negative definite and the determinant of the Hessian matrix is greater than zero.

The third step in the comparative static exercise is to write out the comparative static results using differentials. Taking the total differential of equation (2.24) gives:

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1^2}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1^2}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1^2}\cdot L\right)\cdot da_1$$

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial a_2}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial a_2}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial a_2}\cdot L\right)\cdot da_2$$

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial e_1}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial e_1}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial e_1}\cdot L\right)\cdot de_1$$

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial e_2}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial e_2}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial e_2}\cdot L\right)\cdot de_2$$

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial p_1}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial p_1}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial p_1}\cdot L\right)\cdot dp_1$$

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial p_2}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial p_2}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial p_2}\cdot L\right)\cdot dp_2$$

$$-\left(\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial I}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial I}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial I}\cdot L\right)\cdot dI$$

$$-\left(1+\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial w}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial w}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial w}\cdot L\right)\cdot dw$$

$$-\left(\begin{array}{c}\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_1 \partial L}+\frac{\partial^2 C(a_1^*,a_2^*,p_1,p_2)}{\partial a_1 \partial L}+\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1 \partial L}\cdot L\\ +\frac{\partial \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_1}\end{array}\right)\cdot dL=0 \qquad (2.29)$$

This can be written more compactly as:

$$\frac{\partial^2 \mathcal{L}}{\partial a_1^2}\cdot da_1+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial a_2}\cdot da_2+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial e_1}\cdot de_1+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial e_2}\cdot de_2+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial p_1}\cdot dp_1+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial p_2}\cdot dp_2+$$

$$\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial I}\cdot dI+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial w}\cdot dw+\frac{\partial^2 \mathcal{L}}{\partial a_1 \partial L}\cdot dL=0 \qquad (2.30)$$

Now taking the total differential of equation (2.25) (with $\lambda_2 = 0$) gives:

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial a_1} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial a_1} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial a_1} \cdot L\right) \cdot da_1$$

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2^2} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2^2} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2^2} \cdot L\right) \cdot da_2$$

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial e_1} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial e_1} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial e_1} \cdot L\right) \cdot de_1$$

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial e_2} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial e_2} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial e_2} \cdot L\right) \cdot de_2$$

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial p_1} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial p_1} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial p_1} \cdot L\right) \cdot dp_1$$

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial p_2} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial p_2} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial p_2} \cdot L\right) \cdot dp_2$$

$$-\left(\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial I} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial I} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial I} \cdot L\right) \cdot dI$$

$$-\left(1 + \frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial w} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial w} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial w} \cdot L\right) \cdot dw$$

$$-\left(\begin{array}{c}\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_2 \partial L} + \frac{\partial^2 C(a_1^*, a_2^*, p_1, p_2)}{\partial a_2 \partial L} + \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2 \partial L} \cdot L \\ + \frac{\partial \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2}\end{array}\right) \cdot dL = 0 \qquad (2.31)$$

Again, this can be written more compactly as:

$$\frac{\partial^2 \mathcal{L}}{\partial a_2 \partial a_1} \cdot da_1 + \frac{\partial^2 \mathcal{L}}{\partial a_2^2} \cdot da_2 + \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial e_1} \cdot de_1 + \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial e_2} \cdot de_2 + \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial p_1} \cdot dp_1 + \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial p_2} \cdot dp_2 +$$

$$\frac{\partial^2 \mathcal{L}}{\partial a_2 \partial I} \cdot dI + \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial w} \cdot dw + \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial L} \cdot dL = 0 \qquad (2.32)$$

Equations (2.30) and (2.32) can be rearranged into the following format:

$$-\begin{bmatrix} \frac{\partial^2 \mathcal{L}}{\partial a_1^2} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial a_2} \\ \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial a_1} & \frac{\partial^2 \mathcal{L}}{\partial a_2^2} \end{bmatrix} \begin{bmatrix} da_1 \\ da_2 \end{bmatrix} = \begin{bmatrix} \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial e_1} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial e_2} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial p_1} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial p_2} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial I} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial w} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial L} \\ \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial e_1} & \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial e_2} & \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial p_1} & \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial p_2} & \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial I} & \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial w} & \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial L} \end{bmatrix} \begin{bmatrix} de_1 \\ de_2 \\ dp_1 \\ dp_2 \\ dI \\ dw \\ dL \end{bmatrix} \tag{2.33}$$

Where $\begin{bmatrix} \frac{\partial^2 \mathcal{L}}{\partial a_1^2} & \frac{\partial^2 \mathcal{L}}{\partial a_1 \partial a_2} \\ \frac{\partial^2 \mathcal{L}}{\partial a_2 \partial a_1} & \frac{\partial^2 \mathcal{L}}{\partial a_2^2} \end{bmatrix}$ is the Hessian matrix, H, of second-order partial derivatives with respect to the choice variables. The final step in the comparative static exercise is to solve for the effect of a change in an exogenous variable on the endogenous variables. In this model, there are two endogenous variables and seven exogenous variables and thus 14 comparative static results: $\frac{da_i^*}{de_i}, \frac{da_i^*}{de_j}, \frac{da_i^*}{dp_i}, \frac{da_i^*}{dp_j}, \frac{da_i^*}{dI}, \frac{da_i^*}{dw}, \frac{da_i^*}{dL}$ where i={1,2} and j={1,2}.

To solve for the impact of a change in an exogenous variable on the optimal level of an averting behaviour, Cramer's rule will be applied. The denominator of all the comparative static effects is the determinant of the Hessian matrix, which is greater than zero by the second-order conditions.

(a) Own-effectiveness

In the one-behaviour analytical model, the own-effectiveness comparative static result was positive which implies that when one averting behaviour is available, an increase in its effectiveness increases the optimal level undertaken. To investigate the own-effectiveness comparative static in the two behaviour analytical framework, Cramer's rule was applied to equation (2.33), resulting in:

$$\frac{da_i^*}{de_i} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_i} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial e_i}}{|H|} \tag{2.34}$$

The first component of the numerator of equation (2.34), $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_i}$, depends on the sign of $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_i} = -\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_i \partial e_i} - \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_i \partial e_i} \cdot L$ since $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} < 0$ by the convexity assumptions of the disutility and expected loss functions. The first component of $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_i}$ is equal to zero since marginal disutility does not depend on effectiveness. Although in the one-behaviour analytical framework it was assumed that the reduction in the probability of illness from increased averting behaviour is larger following an increase in own-effectiveness than before the increase, this is not necessarily the case in the two-behaviour analytical framework and thus the signs of $\frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_i \partial e_i} \cdot L$, $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_i}$ and $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_i}$ are indeterminate. The sign of the numerator of equation (2.34) is indeterminate as is the sign of the impact of a change in own-effectiveness of the optimal level undertaken of an averting behaviour.

(b) *Cross-effectiveness*

To investigate the impact of a change in cross-effectiveness, Cramer's rule was applied to equation (2.33), resulting in:

$$\frac{da_i^*}{de_j} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial e_j} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial e_j}}{|H|} \tag{2.35}$$

Similar to the own-effectiveness comparative static result, the sign of the cross-effectiveness comparative static result is indeterminate. This is because this sign of the second component of the numerator, $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial e_j}$ is indeterminate as $\frac{\partial^2 \mathcal{L}}{\partial a_j \partial e_j} =$

$-\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_j \partial e_j} - \frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_j \partial e_j} \cdot L$ and the sign of $\frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_j \partial e_j} \cdot L$ is indeterminate. Thus, from the comparative static exercise, it is not clear what impact a change in cross-effectiveness has on the optimal level undertaken of an averting behaviour.

(c) *Own-price*

In the one-behaviour analytical framework, the own-price comparative static effect was negative implying that an increase in the price of an averting behaviour reduces the optimal level undertaken. To determine if this is also the case in the two-behaviour analytical framework, Cramer's rule was applied to equation (2.33), resulting in:

$$\frac{da_i^*}{dp_i} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \frac{\partial^2 \mathcal{L}}{\partial a_i \partial p_i} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \frac{\partial^2 \mathcal{L}}{\partial a_j \partial p_i}}{|H|} \qquad (2.36)$$

The numerator of equation (2.36) is positive. The first component of the numerator is positive as $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} = -\frac{\partial^2 V(a_1^*,a_2^*)}{\partial a_j^2} - \frac{\partial^2 \pi_2^k(a_1^*,a_2^*,e_1,e_2)}{\partial a_j^2} \cdot L < 0$ and $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial p_i} = -1$, where both disutility and expected loss are convex functions with positive second-order partials with respect to both averting behaviours and neither disutility nor expected loss depend on own-price. The second component of the numerator, $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial p_i}$, is equal to zero as $\frac{\partial^2 \mathcal{L}}{\partial a_j \partial p_i} = 0$, since marginal disutility, reduction in expected loss and cost do not depend on cross-price. This means that the sign of $\frac{da_i^*}{dp_i}$ is negative and, similar to the one-behaviour analytical framework and following from the Law of Demand, an increase in the price of an averting behaviour will decrease the level optimal undertaken of that behaviour.

(d) *Cross-price*

To investigate the impact of a change in cross-price on the optimal level undertaken of an averting behaviour, Cramer's rule was applied to equation (2.33), resulting in:

$$\frac{da_i^*}{dp_j} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial p_j} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial p_j}}{|H|} \tag{2.37}$$

The first component of the numerator of equation (2.37), $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial p_j}$, is equal to zero.

This is because $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial p_j} = 0$ since marginal disutility, marginal reduction in expected loss and marginal cost do not depend on cross-price. The second component of the numerator, $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial p_j}$, and thus the sign of $\frac{da_i}{dp_j}$ depends on the sign of $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} = -\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_i \partial a_j} - \frac{\partial^2 \pi_2^j(a_1^*, a_2^*, e_i, e_j)}{\partial a_i \partial a_j} \cdot L$ since $\frac{\partial^2 \mathcal{L}}{\partial a_j \partial p_j} = -1$. If at least one averting behaviour generates disutility then $\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_i \partial a_j} > 0$ and if both averting behaviours generate utility, then $\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_i \partial a_j} < 0$. With respect to expected loss, if the two averting behaviours are complements in reducing the probability of illness, then $\frac{\partial^2 \pi_2^j(a_1^*, a_2^*, e_i, e_j)}{\partial a_i \partial a_j} \cdot L < 0$; if the two averting behaviours are substitutes, then $\frac{\partial^2 \pi_2^j(a_1^*, a_2^*, e_i, e_j)}{\partial a_i \partial a_j} \cdot L > 0$. If at least one averting behaviour generates disutility, and the two behaviours are substitutes or if both behaviours generate utility and the two behaviours are complements, then the numerator of equation (2.37) is positive and $\frac{da_i^*}{dp_j} < 0$. The latter scenario is intuitive as microeconomic theory predicts that if two goods are complements, then the increase in price of one of the goods will decrease the quantity demanded of the other. The first scenario under which $\frac{da_i^*}{dp_j} < 0$, is less intuitive and could be explained by substitution away from the averting behaviour that generates disutility.

If at least one averting behaviour generates disutility and the two behaviours are complements, or if both behaviours generate utility and the two behaviours are substitutes, then the numerator of equation (2.37) is negative and $\frac{da_i^*}{dp_j} > 0$. The latter scenario is intuitive and as microeconomic theory predicts that if two goods are substitutes, an increase in cross-price will increase the quantity demanded.

(e) *Non-Labour or Salaried Income*

In the one-behaviour analytical framework, an increase in non-labour or salaried income has no impact on the optimal level undertaken of an averting behaviour. To investigate the impact of a change in salaried or non-labour income in the two-behaviour analytical framework, Cramer's rule was applied to equation (2.33) resulting in:

$$\frac{da_i^*}{dI} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial I} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial I}}{|H|} \tag{2.38}$$

The numerator of equation (2.38) is equal to zero as $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial I} = 0$ and $\frac{\partial^2 \mathcal{L}}{\partial a_j \partial I} = 0$ since marginal disutility, marginal cost and marginal reduction in expected loss do not depend on salaried or non-labour income. This means that an increase in non-labour or salaried income has no impact on the optimal level undertaken of an averting behaviour. This result is identical to the comparative static effect of non-labour or salaried income in the one-behaviour analytical framework and is not surprising since there is no income or budget constraint. This result is also not surprising as the disutility function reflects an underlying quasi-linear utility function and there is no income effect when preferences are quasi-linear (Varian 1992).

(f) *Wage Rate*

In the one-behaviour analytical framework, an increase in the wage rate decreases the optimal level undertaken of an averting behaviour. To investigate the impact of a change in the wage rate in the two-behaviour analytical framework, Cramer's rule was applied to equation (2.33) resulting in:

$$\frac{da_i^*}{dw} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial w} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial w}}{|H|} \tag{2.39}$$

The first component of the numerator of equation (2.39) $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_i \partial w}$ is positive since $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} < 0$ by the convexity assumptions of the disutility and probability of illness functions and $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial w} = -1$ as marginal disutility, marginal cost and marginal reduction in the probability of illness do not depend on the wage rate. The second component of the numerator $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} \cdot \frac{\partial^2 \mathcal{L}}{\partial a_j \partial w}$ depends on the sign of $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j} = -\frac{\partial^2 V(a_1^*, a_2^*)}{\partial a_i \partial a_j} - \frac{\partial^2 \pi_2^k(a_1^*, a_2^*, e_i, e_j)}{\partial a_i \partial a_j} \cdot L$ since $\frac{\partial^2 \mathcal{L}}{\partial a_j \partial w} = -1$. If at least one of the two averting behaviours generates disutility and the two behaviours are substitutes, or if both behaviours generate utility and the two behaviours are complements, then the numerator of equation (2.39) is indeterminate as is the sign of $\frac{da_i^*}{dw}$. If at least one averting behaviour generates disutility and the two behaviours are complements or if both behaviours generate utility and the two behaviours are substitutes, then the numerator of equation (2.39) is negative and $\frac{da_i^*}{dw} > 0$. This result is the opposite of what was obtained in the one-behaviour analytical framework.

However, the positive comparative static effect could be explained by the assumption that undertaking an averting behaviour is a normal good and an increase in income via an increase in the wage rate would increase the optimal level of an averting behaviour.

(g) *Loss*

In the one-behaviour analytical framework, an increase in the size of loss associated with illness k increased the optimal level of an averting behaviour that is undertaken. To investigate the impact of a change in the size of loss in the two-behaviour analytical framework, Cramer's rule was applied to equation (2.33) resulting in:

$$\frac{da_i^*}{dL} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial a_j^2}\cdot\frac{\partial^2 \mathcal{L}}{\partial a_i \partial L} - \frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j}\cdot\frac{\partial^2 \mathcal{L}}{\partial a_j \partial L}}{|H|} \tag{2.40}$$

The first component of the numerator of equation (2.40) $\frac{\partial^2 \mathcal{L}}{\partial a_j^2}\cdot\frac{\partial^2 \mathcal{L}}{\partial a_i \partial L}$ is negative since $\frac{\partial^2 \mathcal{L}}{\partial a_j^2} < 0$ by convexity assumptions of the disutility and probability of illness functions and $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial L} > 0$ as the size of loss does neither impact disutility nor the reduction in the probability of illness on the margin, but it does impact expected loss. The sign of the second component of the numerator and thus the sign of the numerator as a whole depends on the sign of $\frac{\partial^2 \mathcal{L}}{\partial a_i \partial a_j}$, since $\frac{\partial^2 \mathcal{L}}{\partial a_j \partial L} > 0$. If at least one averting behaviour generates disutility and the two behaviours are complements or if both behaviours generate utility and the two behaviours are substitutes, then the numerator of equation (2.40) is indeterminate as is the sign of $\frac{da_i^*}{dL}$. If at least one of the two averting behaviours generate disutility and the two behaviours are substitutes, or if both behaviours generate utility and the two behaviours are complements, then the numerator of equation (2.40) is negative and $\frac{da_i^*}{dL} > 0$. Thus, where a comparative static result was obtained for the impact of a change in the size of loss, it was positive similar to the one-behaviour analytical framework.

Comparative Static Results

A summary of the comparative static effects for the two-behaviour analytical framework is presented in Table 2.1. In the two-behaviour analytical framework, unlike the one-behaviour analytical framework, many of the comparative static results are indeterminate. The impact of change in own-effectiveness or cross-effectiveness on the optimal level undertaken of an averting behaviour are always indeterminate. Additionally, under certain scenarios, the impact of a change in the wage rate or in the size of loss is indeterminate. The indeterminate signs of many of the comparative static effects in the two-behaviour analytical framework provide motivation for empirical analysis. Only two comparative static results had the same effects across all scenarios: own-price and salaried or non-labour income leading to the following two testable hypotheses:

(H.6) An increase (decrease) in own-price when two averting behaviours are available will decrease (increase) the optimal level of the averting behaviour that is undertaken;

(H.7) An increase (decrease) in salaried or non-labour income when two averting behaviours are available will have no effect on the optimal level of the averting behaviour that is undertaken.

Table 2.1 Summary of comparative static effects for the two-behaviour analytical framework

	At least one behaviour generates disutility	*Both behaviours generate utility*
The two behaviours are complements in reducing the probability of illness	$\frac{da_i^*}{de_i} \lesseqgtr 0, \frac{da_i^*}{de_j} \lesseqgtr 0,$ $\frac{da_i^*}{dp_i} < 0, \frac{da_i^*}{dp_j} > 0,$ $\frac{da_i^*}{dI} = 0, \frac{da_i^*}{dw} > 0,$ $\frac{da_i^*}{dL} \lesseqgtr 0$	$\frac{da_i^*}{de_i} \lesseqgtr 0, \frac{da_i^*}{de_j} \lesseqgtr 0,$ $\frac{da_i^*}{dp_i} < 0, \frac{da_i^*}{dp_j} < 0,$ $\frac{da_i^*}{dI} = 0, \frac{da_i^*}{dw} \lesseqgtr 0,$ $\frac{da_i^*}{dL} > 0$
The two behaviours are substitutes in reducing the probability of illness	$\frac{da_i^*}{de_i} \lesseqgtr 0, \frac{da_i^*}{de_j} \lesseqgtr 0,$ $\frac{da_i^*}{dp_i} < 0, \frac{da_i^*}{dp_j} < 0,$ $\frac{da_i^*}{dI} = 0, \frac{da_i^*}{dw} \lesseqgtr 0,$ $\frac{da_i^*}{dL} > 0$	$\frac{da_i^*}{de_i} \lesseqgtr 0, \frac{da_i^*}{de_j} \lesseqgtr 0,$ $\frac{da_i^*}{dp_i} < 0, \frac{da_i^*}{dp_j} > 0,$ $\frac{da_i^*}{dI} = 0, \frac{da_i^*}{dw} > 0,$ $\frac{da_i^*}{dL} \lesseqgtr 0$

2.5 IMPACT OF ADOPTION OF THE SECOND AVERTING BEHAVIOUR

The two-behaviour analytical framework determined how an individual chooses the optimal levels of two averting behaviours and how the optimal levels of averting behaviour change following a change in an exogenous factor. It is not clear from the comparative static analysis, however, what impact undertaking the second averting behaviour has on the optimal level undertaken of the original behaviour, that is, the sign of $\frac{da_1^*}{da_2}$. In this section, to sign $\frac{da_1^*}{d\overline{a_2}}$, the second averting behaviour is fixed (i.e. $\overline{a_2}$) and treated like an exogenous variable. Comparative static analysis similar to the one-behaviour analytical framework is then undertaken. The intuition is that prior to the availability of the second averting behaviour, an individual undertakes no amount of the second behaviour (i.e. $a_2 = 0$), however following adoption of the second averting behaviour they undertake a positive amount (i.e. $a_2 > 0$), which is an increase in the level undertaken of the second averting behaviour. By treating the second averting behaviour like an exogenous variable, the impact of an increase in $\overline{a_2}$ from zero to a positive amount on the optimal level undertaken of the original averting behaviour can be investigated. After fixing the second averting behaviour to $\overline{a_2}$, the expected utility equation becomes:

$$EU = I - w(T - a_1 - \overline{a_2}) - V(a_1, \overline{a_2}) - C(a_1, \overline{a_2}, p_1, p_2) \; - \pi_2^k(a_1, \overline{a_2}, e_1, e_2) \cdot L \quad (2.41)$$

Following the two-behaviour analytical framework, an individual is assumed to undertake a positive level of the original averting behaviour, $a_1 > 0$. The expected utility maximization problem can be expressed as:

$$Max\ EU = I + w(T - a_1 - \overline{a_2}) - V\left(a_{1,}\overline{a_2}\right) - C(a_1, \overline{a_2}, p_1, p_2) - \pi_1^k(a_1, \overline{a_2}, e_1, e_2) \cdot L$$
$$a_1 > 0$$

(2.42)

The first-order condition for the maximization problem in equation (2.42) is:

$$\frac{\partial \mathcal{L}}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1,\overline{a_2})}{\partial a_1} - \frac{\partial \pi_1^k(a_1,\overline{a_2},e_1,e_2)}{\partial a_1} \cdot L = 0 \quad (2.43)$$

Equation (2.43) is then totally differentiated with respect to a_1 and $\overline{a_2}$ resulting in:

$$-\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1^2} \cdot da_1 - \frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1 \partial \overline{a_2}} \cdot d\overline{a_2} - \frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1^2} \cdot da_1 - \frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1 \partial \overline{a_2}} \cdot d\overline{a_2} \; -$$

$$\frac{\partial^2 \pi_2^k(a_1^*,\overline{a_2},e_1,e_2)}{\partial a_1^2} \cdot L \cdot da_1 \; - \frac{\partial^2 \pi_2^k(a_1^*,\overline{a_2},e_1,e_2)}{\partial a_1 \partial \overline{a_2}} \cdot L \cdot d\overline{a_2} = 0 \quad (2.44)$$

Which can be rearranged to solve for:

$$\frac{da_1^*}{d\overline{a_2}} = -\frac{\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1 \partial \overline{a_2}} + \frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1 \partial \overline{a_2}} + \frac{\partial^2 \pi_2^j(,a_1^*\overline{a_2},e_1,e_2)}{\partial a_1 \partial \overline{a_2}} \cdot L}{\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1^2} + \frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1^2} + \frac{\partial^2 \pi_2^j(a_1^*,\overline{a_2},e_1,e_2)}{\partial a_1^2} \cdot L} \quad (2.45)$$

The denominator of equation (2.45) is positive. This is based on the assumptions made earlier in the analysis, namely that the disutility function and expected loss function are convex and the cost function is linear: $\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1^2} > 0$, $\frac{\partial^2 \pi_2^j(a_1^*,\overline{a_2},e_1,e_2)}{\partial a_1^2} \cdot L > 0$ and $\frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1^2} = 0$. The numerator of equation (2.45) depends on the signs of $\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1 \partial \overline{a_2}}$ and $\frac{\partial^2 \pi_2^j(a_1^*,\overline{a_2},e_1,\overline{e_2})}{\partial a_1 \partial \overline{a_2}} \cdot L$ as the cost function is assumed to be linear and so $\frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1 \partial \overline{a_2}} = 0$. If at least one of the two averting behaviours generates disutility and the two averting behaviours are substitutes, then the numerator of equation (2.45) is positive and $\frac{da_1^*}{d\overline{a_2}} < 0$, which implies that offsetting occurs because an individual reduces his or her optimal level of the original averting behaviour following the introduction of a second averting behaviour. The intuition behind offsetting behaviour in this scenario is that if an individual is undertaking an averting behaviour that he or she does not enjoy and a second averting behaviour becomes available which is a substitute for the original behaviour, it is not unexpected that an individual would substitute away from the averting behaviour that generates disutility.

If both averting behaviours generate utility and the two behaviours are complements, the numerator of equation (2.45) is negative and $\frac{da_1^*}{d\overline{a_2}} > 0$. The intuition behind this result is that if an individual enjoys undertaking an averting behaviour and a complementary averting behaviour becomes available that he or she also enjoys undertaking, it is not surprising that he or she would increase the level undertaken of the original averting behaviour. If at least one averting behaviour generates disutility and the two averting behaviours are complements or if both averting behaviours generate utility and the two behaviours are substitutes, then the numerator of equation (2.45) and thus the sign of $\frac{da_1^*}{d\overline{a_2}}$ is indeterminate. A summary of the impact of the adoption of second averting behaviour on the optimal level undertaken of the original behaviour are presented in Table 2.2.

Table 2.2 Impact of the adoption of a second averting behaviour on the optimal level undertaken of the original averting behaviour

	At least one behaviour generates disutility	*Both behaviours generate utility*
The two behaviours are complements in reducing the probability of illness	$\frac{da_1^*}{d\overline{a_2}} \lesseqgtr 0$	$\frac{da_1^*}{d\overline{a_2}} > 0$
The two behaviours are substitutes in reducing the probability of illness	$\frac{da_1^*}{d\overline{a_2}} < 0$	$\frac{da_1^*}{d\overline{a_2}} \lesseqgtr 0$

2.6 INNOVATIONS IN THE CONCEPTUAL FRAMEWORK

The one-behaviour and two-behaviour analytical frameworks make a number of contributions to the literature on offsetting behaviour. First, most applications of the offsetting behaviour hypothesis have been with respect to mandatory regulations. This is one of the first applications of the offsetting behaviour hypothesis to voluntary behaviours undertaken to avert ill health (see for example Dickie and Gerking 1997; Kahn 1999). Second, the two analytical frameworks derived a general set of comparative static results for undertaking averting behaviour. Previous studies (Peltzman 1975; Viscusi 1984) have only performed the comparative static exercise for exogenous variables thought to be driving offsetting behaviour, not for other exogenous variables that may affect the optimal level undertaken of an averting behaviour. Third, while previous studies (Viscusi 1984) have assumed that undertaking averting behaviour generates disutility, this present analytical framework explicitly accounts for the possibility that undertaking an averting behaviour may generate utility. Fourth, the models developed in the two analytical frameworks include the price of averting behaviour, which has not been incorporated directly in previous theoretical models (Viscusi 1984; Peltzman 1975; Hause 2006). Finally, the present model compares the impact of a change in salaried or non-labour income on the optimal level of averting behaviour to the impact of a change in the wage rate, the result of which, although different in the two analytical frameworks, is akin to the non-distortionary effect of lump-sum transfers compared to per unit taxes and subsidies.

2.7 SUMMARY

In this chapter, two analytical frameworks were developed to investigate how an individual selects the optimal level of averting behaviour, how the optimal level undertaken is impacted by changes in exogenous variables and how the adoption of a second behaviour impacts the optimal level undertaken of the original averting behaviour. The following chapter will outline how the hypotheses and theoretical results obtained in this chapter will be tested and investigated experimentally.

Chapter 3

Methods and Data

3.1 INTRODUCTION

This chapter will provide an outline of the methods and data used to test the hypotheses developed in the conceptual framework. This chapter will first describe the testable hypotheses and other theoretical results from the two analytical frameworks developed in the conceptual framework. It will then provide a discussion of the empirical frameworks that guide empirical analysis and hypothesis testing. This chapter will conclude with a description of the development of the experimental design according to which data was collected for the empirical analysis and which addresses the second objective of this study.

3.2 TESTABLE HYPOTHESES AND THEORETICAL RESULTS

Two analytical frameworks were developed in the conceptual framework. The one-behaviour analytical framework investigates how an individual chooses the optimal level of an averting behaviour and how that optimal level changes following a change in one of five exogenous variables: effectiveness, price, salaried or non-labour income, wage and size of loss. Comparative static results from the one-behaviour analytical framework generated the following five testable hypotheses:

(H.1) An increase (decrease) in the effectiveness of an averting behaviour will increase (decrease) the optimal level of the averting behaviour that is undertaken;

(H.2) An increase (decrease) in the price of an averting behaviour will decrease (increase) the optimal level of the averting behaviour that is undertaken;

(H.3) An increase (decrease) in salaried or non-labour income will have no impact on the optimal level of the averting behaviour that is undertaken;

(H.4) An increase (decrease) in the wage rate will decrease (increase) the optimal level of the averting behaviour that is undertaken;

(H.5) An increase (decrease) in the size of loss will increase (decrease) the optimal level of the averting behaviour that is undertaken.

The two-behaviour analytical framework built on the one-behaviour analytical framework and investigates how an individual chooses the optimal level of an averting behaviour given that they are already undertaking a different averting behaviour for the same illness and how changes in exogenous variables influence the optimal level of an averting behaviour that is undertaken. Although the signs of some impacts are known under certain circumstances, the comparative static results for the two-behaviour analytical framework are indeterminate, with the exception of the effect of an increase in own-price and salaried or non-labour income, which generated the following two testable hypotheses:

(H.6) An increase (decrease) in own-price when two averting behaviours are available will decrease (increase) the optimal level undertaken;

(H.7) An increase (decrease) in salaried or non-labour income when two averting behaviours are available will have no effect on the optimal level undertaken

The comparative static results for the two-behaviour analytical framework are presented in Table 3.1. Of the seven comparative static results derived in the two-behaviour framework, only two comparative static results are not also derived in the one-behaviour analytical framework: cross-effectiveness and cross-price. The cross-effectiveness comparative static result is indeterminate across all four utility/substitutability scenarios, providing a motivation for empirical analysis. The cross-price comparative static effect is positive under two scenarios (disutility and complements and utility and substitutes) and negative under the other two scenarios (disutility and substitutes and utility and complements). Nevertheless, the indeterminate signs of five of the seven comparative static effects provide motivation for empirical analysis.

Table 3. 1 Summary of comparative static results for the two-behaviour analytical framework

Comparative statics	At least one behaviour generates disutility		Both behaviours generate utility	
	Complements	Substitutes	Complements	Substitutes
Own-effectiveness $\left(\frac{da_i^*}{de_i}\right)$	+/-	+/-	+/-	+/-
Cross-effectiveness $\left(\frac{da_i^*}{de_j}\right)$	+/-	+/-	+/-	+/-
Own-price $\left(\frac{da_i^*}{dp_i}\right)$	-	-	-	-
Cross-price $\left(\frac{da_i^*}{dp_j}\right)$	+	-	-	+
Income $\left(\frac{da_i^*}{dI}\right)$	0	0	0	0
Wage $\left(\frac{da_i^*}{dw}\right)$	+	+/-	+/-	+
Size of loss $\left(\frac{da_i^*}{dL}\right)$	+/-	+	+	+/-

The two-behaviour analytical framework is used also to investigate how adoption of a second averting behaviour might impact the optimal level of the original averting behaviour that is undertaken after adoption of the second behaviour. The impact of the adoption of the second averting behaviour on the optimal level of the original behaviour depends on the degree of substitutability between the two averting behaviours and whether either behaviour generates disutility (Table 3.2). As no clear hypothesis could be derived from the comparative static results, empirical analysis is required to determine how adoption of a second averting behaviour impacts the optimal level undertaken of the original averting behaviour.

Table 3. 2 Impact of the adoption of the second averting behaviour

Comparative static	At least one behaviour generates disutility		Both behaviours generate utility	
	Complements	Substitutes	Complements	Substitutes
Second averting behaviour $\left(\frac{da_1^*}{d\bar{a}_2}\right)$	+/-	-	+	+/-

3.3 EMPIRICAL MODEL

In the conceptual framework, the levels of two averting behaviours are modeled as continuous variables: the amount of time devoted to an averting behaviour. Although it is preferable to model the levels of the two averting behaviours as continuous variables, it is difficult to collect such data as continuous data is not always observable. In this section, the levels of the two averting behaviours are transformed into discrete variables where an individual either undertakes an averting behaviour or does not.

Transforming the two averting behaviours from continuous variables into discrete variables has an impact on the manner in which hypotheses (H.1) to (H.7) are tested and empirical analysis undertaken. Empirical hypotheses will not test the impact of a change in an exogenous variable on the level undertaken of an averting behaviour (i.e. time devoted to an averting behaviour) but rather the impact of a change in an exogenous variable on the decision to undertake the averting behaviour. Although changes in the optimal level of an averting behaviour cannot be observed when averting behaviour is a discrete variable, decisions which reflect changes in the optimal level (i.e. the decision to undertake an averting behaviour) are observable.

3.3.1 One-Behaviour Empirical Framework

In the one-behaviour analytical framework, an individual selects the optimal level of averting behaviour, a_1 to maximize expected utility, EU. Recall from the one-behaviour analytical framework that the first-order conditions for the expected utility maximization problem are, in the case of a potential corner solution:

$$\frac{\partial \mathcal{L}}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1^*)}{\partial a_1} - \frac{\partial \pi_1^k(a_1^*, e_1)}{\partial a_1} \cdot L - \lambda = 0 \qquad (3.1)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = a_1^* \geq 0, \lambda \geq 0, \lambda \cdot a_1^* = 0 \qquad (3.2)$$

It is the shadow value or Lagrange multiplier that drives whether the individual undertakes the averting behaviour, a_1. If the shadow value is equal to zero (i.e. $\lambda = 0$), then the individual is at an interior solution and undertakes a positive level of the averting behaviour ($a_1^* > 0$ and $\lambda \cdot a_1^* = 0$), resulting in an optimal solution such as point A in Figure 3.1 where the individual undertakes a_1^* and the marginal benefit of undertaking averting behaviour equals the marginal cost. If, however, the shadow value is positive (i.e. $\lambda > 0$), then the level of averting behaviour undertaken by the individual equals zero ($a_1^* = 0$ and $\lambda \cdot a_1^* = 0$). If no averting behaviour is undertaken, this means that for all levels of a_1, the marginal cost of undertaking averting behaviour, $w + p_1$ is greater than the marginal benefit, $-\left(\frac{\partial V(a_1^*)}{\partial a_1} + \frac{\partial \pi_1^k(a_1^*, e_1)}{\partial a_1} \cdot L\right)$, with the difference between the two equal to the value of the shadow value in the optimal solution[8]

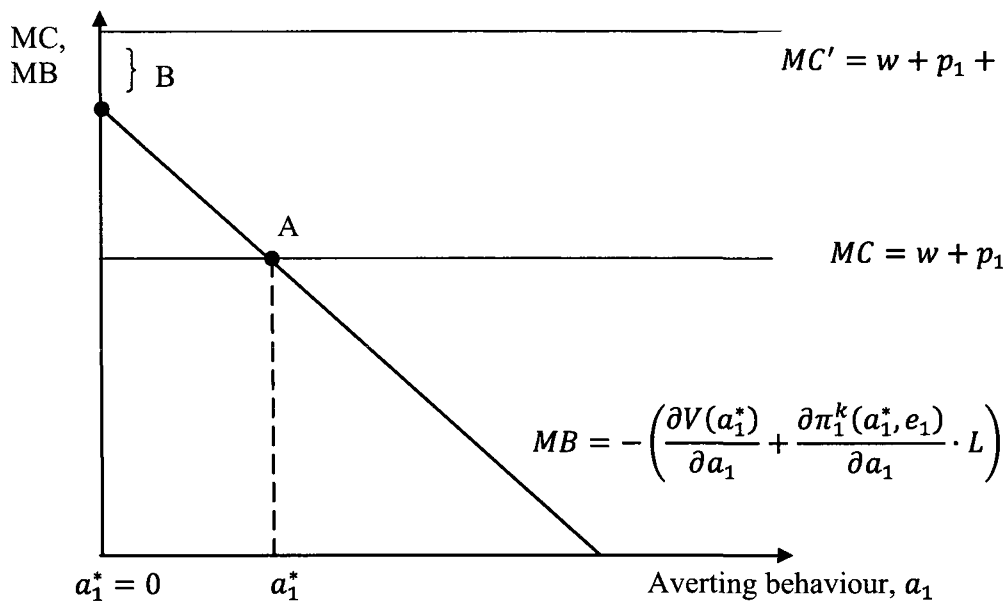

Figure 3. 1 Determining the optimal level of averting behaviour a_1

Although the shadow value is unobservable, it can be represented using a latent variable approach (See Greene 1997, p. 880) where $y_m^* = \lambda$ is the latent variable and the index m denotes observations. If averting behaviour is undertaken, $a_1^* > 0$, the shadow value is equal to zero and the latent variable is positive; if averting behaviour is not

[8] The marginal benefit curve is downward sloping based on the following assumptions: $\frac{\partial \pi_1^k(a_1, e_1)}{\partial a_1} \cdot L < 0$ and $\left|\frac{\partial V(a_1)}{\partial a_1}\right| < \left|\frac{\partial \pi_1^k(a_1, e_1)}{\partial a_1} \cdot L\right|$. Additionally, both the disutility function and the expected loss functions are convex which means that $\frac{\partial^2 \pi_1^k(a_1, e_1)}{\partial a_1^2} \cdot L > 0$ and $\frac{\partial^2 V(a_1)}{\partial a_1^2} > 0$.

undertaken, $a_1^* = 0$, the shadow value is greater than zero and the latent variable is non-positive:

$$y_m^* \begin{cases} > 0 \; if \; \lambda = 0 \\ \leq 0 \; if \; \lambda > 0 \end{cases} \tag{3.3}$$

Where y_m^* is a continuous but not observable latent variable, represented as follows:

$$y_m^* = \beta' x_m + \epsilon_m \tag{3.4}$$

The latent variable y_m^* is composed of a deterministic component, $\beta' x_m$ also called the index function, and a random component, ϵ_m that can either have a standard logistic or a normal distribution with mean zero and variance one. Although the shadow value is not observable, an individual's decision to undertake the averting behaviour is observable. The vector x_m contains the exogenous variables from the expected utility equation: effectiveness, price, salaried or non-labour income, wage rate and size of loss as well other non-experimental control variables such as demographic information. The parameters in β are used to calculate the impact of changes in x_m on the probability of undertaking averting behaviour (i.e. the marginal effects). The probability that averting behaviour is undertaken (i.e. $y_m = 1$) can be written as:

$$Prob(y_m = 1) = Prob(y_m^* > 0) = Prob(\beta' x_m > \epsilon_m) = Prob(-\epsilon_m < \beta' x_m) = F(\beta' x_m) \tag{3.5}$$

If it is assumed that ϵ_m has a standard normal distribution, then the estimated model is probit model; if a logistic distribution is assumed, then the estimated model is a logit model. As the distributions are similar, the results derived from the two models will be similar. Greene (1997) argues that is difficult to justify the choice of one distribution over the other on theoretical grounds and so a normal distribution is used to characterize

ϵ_m, in which case the probability function in equation (3.5) is a probit model and $F(\beta' x_m)$ is the cumulative density function .

Once the parameters of the probit model are estimated, it is possible to compute the probability of undertaking averting behaviour, as well as the marginal effects or changes in the probability of undertaking averting behaviour resulting from a change in an exogenous variable. The signs of the marginal effects for the five exogenous variables will be used to test hypotheses (H.1) to (H.5).

3.3.2 Two-Behaviour Empirical Framework

In the one-behaviour empirical framework, the probability of undertaking an averting behaviour was derived based on how an individual chooses the optimal level of an averting behaviour from the one-behaviour analytical framework. This is built upon in the two-behaviour empirical framework where the probability of undertaking a second averting behaviour, given that the individual is already undertaking a positive amount of the original averting behaviour, is derived. Similar to the one-behaviour analytical framework, in the two-behaviour analytical framework an individual selects the optimal levels of the two averting behaviours, a_1^* and a_2^* to maximize expected utility. Recall from the two-behaviour analytical framework that the first-order conditions from the two-behaviour analytical framework can be expressed as:

$$\frac{\partial \mathcal{L}}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1^*, a_2^*)}{\partial a_1} - \frac{\partial \pi_1^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_1} \cdot L = 0 \qquad (3.6)$$

$$\frac{\partial \mathcal{L}}{\partial a_2} = -w - p_2 - \frac{\partial V(a_1^*, a_2^*)}{\partial a_2} - \frac{\partial \pi_1^k(a_1^*, a_2^*, e_1, e_2)}{\partial a_2} \cdot L - \lambda_2 = 0 \qquad (3.7)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_2} = a_2^* \geq 0, \lambda_2 \geq 0, \lambda_2 \cdot a_2^* = 0 \qquad (3.8)$$

The same set-up that was used to transform the level of averting behaviour in the one-behaviour analytical framework from a continuous variable to a latent variable and then to a discrete variable is used for the two-behaviour empirical framework (equations 3.3 to 3.5). This allows for estimation of a probit model investigating the probability of undertaking a second averting behaviour given that an individual is already undertaking a positive amount of the original averting behaviour. Once the probit model is estimated, the probability of undertaking the second averting behaviour as well as the marginal effects can be calculated. The signs of the marginal effects of the exogenous variables in the two-behaviour analytical framework can be used to test hypotheses (H.6) and (H.7) and to investigate the impact of changes in the other exogenous variables on the decision to undertake a second averting behaviour. Similar to the one-behaviour empirical framework, it is not possible to observe changes in the optimal level of an averting behaviour, however it is possible to observe decisions (i.e. the decision to undertake an averting behaviour) that reflect changes in the optimal level following a change in an exogenous variable.

3.3.3 Impact of Adoption of the Second Averting Behaviour

In the current section, an empirical framework is developed to test the impact of the adoption of a second averting behaviour on the optimal level undertaken of the original averting behaviour, that is, to test for one form of offsetting behaviour empirically. Note that offsetting behaviour is not directly observable but decisions that reflect offsetting behaviour are. In the context of the present model, testing for offsetting behaviour implies testing whether, following adoption of a second averting behaviour, an individual reduces the optimal level undertaken of the original averting behaviour. Recall from the conceptual framework that the first-order condition for this problem can be expressed as:

$$\frac{\partial \mathcal{L}}{\partial a_1} = -w - p_1 - \frac{\partial V(a_1^*,\overline{a_2})}{\partial a_1} - \frac{\partial \pi_1^k(a_1^*,\overline{a_2},e_1,e_2)}{\partial a_1} \cdot L = 0 \tag{3.9}$$

Where the level undertaken of the second averting behaviour, $\overline{a_2}$ is held constant and treated like an exogenous variable. To investigate the impact of the adoption of the second averting behaviour on the optimal level undertaken of the original averting behaviour equation (3.9) is totally differentiated with respect to a_1 and $\overline{a_2}$ resulting in:

$$\frac{da_1^*}{d\overline{a_2}} = -\frac{\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1 \partial \overline{a_2}} + \frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1 \partial \overline{a_2}} + \frac{\partial^2 \pi_2^j(,a_1^*\overline{a_2},e_1,e_2)}{\partial a_1 \partial \overline{a_2}} \cdot L}{\frac{\partial^2 V(a_1^*,\overline{a_2})}{\partial a_1^2} + \frac{\partial^2 C(a_1^*,\overline{a_2},p_1,\overline{p_2})}{\partial a_1^2} + \frac{\partial^2 \pi_2^j(a_1^*,\overline{a_2},e_1,e_2)}{\partial a_1^2} \cdot L} \tag{3.10}$$

Recall from the conceptual framework that the sign of $\frac{da_1^*}{d\overline{a_2}}$ is indeterminate and depends on the degree of substitutability between the two averting behaviours as well as whether averting behaviour generates disutility. The change in the second averting behaviour, $d\overline{a_2}$, is positive as it represents the level undertaken of the second averting behaviour prior to adoption, $\overline{a_2} = 0$ and following its adoption, $\overline{a_2} > 0$. If offsetting behaviour occurs, that is, if the individual reduces the optimal level undertaken of the original averting behaviour following adoption of the second averting behaviour, then $\frac{da_1^*}{d\overline{a_2}} < 0$, otherwise, $\frac{da_1^*}{d\overline{a_2}} \geq 0$ and no offsetting occurs. However, there are two possible situations when no offsetting behaviour occurs: $\frac{da_1^*}{d\overline{a_2}} = 0$ and the adoption of the second averting behaviour has no impact on the optimal level undertaken of the original averting behaviour and $\frac{da_1^*}{d\overline{a_2}} > 0$ and an individual increases the optimal level undertaken of the original averting behaviour following adoption of the second averting behaviour. Recall from the conceptual framework that an individual increases the optimal level undertaken of the original averting behaviour following adoption of the second averting behaviour when both averting behaviours generate utility and the two averting behaviours are complements. Thus, although an individual increasing the optimal level undertaken of the original averting behaviour following adoption of the second averting behaviour is possible, the present study focuses of offsetting behaviour and aggregates all situations when offsetting behaviour does not occur.

The change in the level undertaken of the original averting is not observable, however, it can be represented using a latent variable approach (see Greene 1997, p. 880) where $y_m^* = \frac{da_1^*}{d\bar{a}_2}$ is the latent variable and the index m denotes observations. If the level undertaken of the original averting behaviour after the adoption of the second averting behaviour is less than the level undertaken prior to adoption, then $\frac{da_1^*}{d\bar{a}_2} < 0$ and the latent variable is positive; if the level undertaken of the original averting behaviour after the introduction of the second averting behaviour, is greater than or equal to the level undertaken prior to the introduction, then $\frac{da_1^*}{d\bar{a}_2} \geq 0$ and the latent variable is non-positive:

$$y_m^* \begin{cases} > 0 \; if \; \frac{da_1^*}{d\bar{a}_2} < 0 \\ \leq 0 \; if \; \frac{da_1^*}{d\bar{a}_2} \geq 0 \end{cases} \tag{3.11}$$

The same set-up that was used to transform the choice variables in both the one-behaviour and two-behaviour analytical frameworks from continuous variables to latent variables and then to discrete variables is used for the impact of adoption of the second averting behaviour (equations 3.3 to 3.5). This will allow for the estimation of a probit model investigating the probability of discontinuing the original averting behaviour following adoption of the second averting behaviour. Once the probit model is estimated, the probability of discontinuing the original averting behaviour as well as the marginal effects of variables that may influence the decision to discontinue the original behaviour can be calculated. Similar to the one-behaviour empirical framework, it is not possible to observe changes in the optimal level of an averting behaviour, however it is possible to observe decisions (i.e. the decision to discontinue an averting behaviour following adoption of a second averting behaviour) that reflect the changes in the optimal level following a change in an exogenous variable.

3.3.4 Data

The three probability models developed in this section need data to be estimated and to test the hypotheses derived in the conceptual framework empirically. Two surveys were developed to collect data for this purpose. The development process of the experimental design for the surveys is described below.

3.4 EXPERIMENTAL DESIGN

According to Lusk and Shogren (2007, p.61), "the purpose of experimental design is to collect data in a way so as to identify all the 'effects' one is interested in." To gather data to test the hypotheses, to determine the impacts of changes in exogenous variables on the decision to undertake a second averting behaviour and to determine the impact of adopting the second averting behaviour on the decision to discontinue the original averting behaviour, two separate discrete choice experiments were conducted using self-administered online surveys. The first experiment corresponds to the one-behaviour empirical framework and investigates the decision to undertake an averting behaviour. The second experiment corresponds to the two-behaviour empirical framework and examines what influences the decision to undertake a second averting behaviour and how adoption of the second behaviour impacts the decision to discontinue the original averting behaviour. As the second experiment builds on the first (analogous to the second analytical and empirical frameworks building on the first), the two experiments address the same health outcome and use the same sample frame, although respondents only completed one survey corresponding to one of the two experiments.

A hypothetical product was developed and used as an averting behaviour in the two experiments and surveys. The use of a hypothetical product as the averting behaviour implies that the type of data that collected in the experiment is stated preference, where, rather than inferring preferences from market transactions, individuals are asked their preferences directly. The advantage of using a stated preference experiment over a revealed preference experiment, where data is collected on existing market conditions, is that a stated preference experiment provides the ability to vary attributes to levels that do not exist in the market and thus allows the researcher greater control over attributes (Hensher et al 2005 p. 96; Louviere et al 2000 pp.21-24). Additionally, by developing a hypothetical product, respondents are less likely to be influenced by opinions and biases about the product then if the product used in the experiments was already in existence.

There are, however, a number of potential problems with using stated preference data. The first is that individuals who are asked their preferences (i.e. survey respondents) may not understand the question. However, even if they do understand the question, they may not respond truthfully as they may know that they are valuing or deciding to consume a hypothetical problem and thus are not bound to their response (Lusk and Shogren 2007 p.2). The second potential problem is called 'hypothetical bias', where individuals overstate their willingness to pay when asked a hypothetical problem (Lusk and Shogren 2007 p. 229). In the present study, respondents were not asked a willingness to pay question although they are presented with prices of the hypothetical product. 'Hypothetical bias' would occur in the context of the present study if an individual indicated that he or she would undertake a hypothetical product at a given price that is higher than what he or she would pay in the market.

3.4.1 Health Outcome

The two analytical frameworks were developed assuming that an individual undertakes an averting behaviour to reduce the probability of developing a specific illness, condition, or health outcome. The health outcome or specific illness selected for the two experimental designs and thus empirical analysis is hypertension or high blood pressure. Although hypertension is only a risk factor for disease, such as cardiovascular disease, rather than a health outcome in itself, it was selected as the health outcome for the experiments for three primary reasons. First, there are large costs associated with hypertension as it is one of the most important modifiable risk factors for cardiovascular disease which is the most costly disease in Canada (Public Health Agency of Canada 2002) and the second leading cause of death (Statistics Canada 2008b). Hypertension is also the number one modifiable risk factor for stroke, the number one reason for Canadians to visit a doctor and the top diagnosis for which medication is prescribed (Public Health Agency of Canada 2008). The direct costs of hypertension are estimated to be approximately $2.3 billion per year (Public Health Agency of Canada 2008). In addition to the present costs of hypertension in Canada, according to the Canadian Community Health Survey the proportion of the population affected by high blood pressure increased from 15 percent of the population in 2005 to 16 percent of the population in 2007 (Statistics Canada 2008a).

The second reason for selecting hypertension as the health outcome for the experiments is that there are a number of averting behaviours that an individual can undertake to reduce the risk of developing high blood pressure such as reducing sodium intake, limiting alcohol intake, not using products containing nicotine, reducing stress and maintaining a healthy weight through diet and exercise (Public Health Agency of Canada 2008). This is important for the second experiment as two different averting behaviours must be available to reduce the risk of developing or acquiring the same illness.

Finally, unlike many other diseases and health outcomes, there is no time delay from undertaking an averting behaviour to reduce the risk of developing high blood pressure and seeing the results. Blood pressure machines are available in many pharmacies and for purchase for home use which allows one to check his or her blood pressure often and easily to see if it is within a healthy range. This is an important characteristic of the health outcome as neither of the analytical frameworks incorporate a time delay between undertaking an averting behaviour and the reduction in the probability of acquiring a specific illness k.

The averting behaviours for hypertension listed in the preceding paragraph can be used to treat or prevent high blood pressure. The present study will focus on the health outcome of preventing hypertension for three main reasons. First, the two analytical frameworks assume that an individual undertakes averting behaviour to reduce the probability of acquiring a specific illness k and thus implicitly assumes that the individual does not already have the condition. Second, the conceptual framework assumes that acquiring a specific illness k is a discrete event and so an individual who already has the illness would be trying to minimize the loss, which was assumed to be constant, rather than trying to reduce the probability of acquisition. Finally, if treating high blood pressure is the health outcome, then only respondents previously diagnosed with hypertension could complete the survey. As the sample frame contains individuals with and without high blood pressure, individuals previously diagnosed with hypertension will not be excluded but controlled for experimentally.

3.4.2 Sample Frame

The Guelph Food Panel, a representative consumer panel in the City of Guelph, Ontario, Canada, was selected as the sample frame for the two experiments. The Guelph Food Panel is comprised of 1,947 randomly-selected residents of Guelph between the ages of 20 and 69 who complete periodic self-administered surveys on food quality, food safety, and health issues (International Food Economy Research Group 2008; Cranfield et al 2009). The members of the Guelph Food Panel were recruited through random digital dialling by a market research company. The panel is stratified by age, gender and educational status to reflect the demographic profile of the City of Guelph based on the 2006 Census (Cranfield et al 2009), which is broadly representative of Canada as a whole (CBC 2007). Prior to the availability of the two experiments, members of the Guelph Food Panel completed seven surveys beginning in February 2008. This was helpful in the survey design as some relevant information did not need to be re-collected.

An advantage of using the Food Panel instead of another sample frame is that it reflects the demographic profile of the City of Guelph, which is broadly representative of Canada as a whole (CBC 2007). Additionally Food Panel surveys are Internet-based and thus have advantages such as being less time-intensive (Wright 2005; Duffy et al 2005), less costly (Wright 2005; Duffy et al 2005), absence of interviewer bias (Duffy et al 2005), removal of the need for data entry and cleaning (Hadley 2006) and convenience for respondents. A weakness of online surveys is that the respondent pool is limited to those who regularly use a computer (Hadley 2006; Kay and Johnson 1999; Crawford et al 2001; Duffy et al 2005). Additionally, questions in online surveys cannot be overly detailed and respondents can search the Internet for information while responding to the survey which is not possible in a face-to-face survey.

3.4.3 The Framing of the Two Experiments

The purpose of the first experiment is to determine the impact of a change in one of the exogenous variables from the one-behaviour analytical framework (e.g. price, effectiveness, salaried or non-labour income, wage rate and size of loss) on the decision to undertake an averting behaviour. The second experiment differs from the first as its purpose is to determine the impact of change in one of the exogenous variables from the two-behaviour analytical framework (e.g. own-price, own-effectiveness, cross-price, cross-effectiveness, salaried or non-labour income, wage rate and size of loss) on the decision to undertake a second averting behaviour. The purpose of the second experiment is also to determine how adoption of a second averting behaviour impacts the decision to discontinue the original averting behaviour.

The averting behaviour selected for the first experiment and as the second averting behaviour in the second experiment is a hypothetical cheddar cheese developed to reduce the risk of developing hypertension. The original averting behaviour selected for the second experiment is salt/sodium reduction. In the first experiment, respondents were presented with a script describing the cheddar cheese developed to reduce the risk of hypertension and asked directly if they would purchase and consume it. However, respondents to the second experiment could not be asked directly if they would purchase and consume the hypothetical cheddar as investigating the impact of the decision to consume the hypothetical cheddar on a respondent's salt reduction requires that the respondent must be reducing his or her salt/sodium intake prior to responding to the survey.

In the first Guelph Food Panel survey, undertaken in February 2008, two questions were asked with respect the extent to which the respondent had or planned to limit salt intake. The first question asked respondents the extent to which, in the past year, they had abided by the recommendation to limit the amount of salt added in cooking or at the table measured on a seven-point scale from (1) 'Not at all' to (7) 'Completely'. The second question asked respondents the likelihood that they would abide by the recommendation to limit the amount of salt added in cooking or at the table in the following year measured on a seven-point scale from (1) 'Very Unlikely' to (7) 'Very Likely'. Originally the survey for the second experiment for the present study was only going to be sent to individuals who indicated they had completely (or fairly completely) abided by the recommendation to limit salt intake in food or at the table in the past year as the result to this question revealed actual behaviour rather than intended behaviour. However, the question on previous salt-limiting behaviour was asked more than a year previous to the current survey and so the extent to which a respondent limits salt added in cooking or at the table may have changed. Additionally it was not known how many respondents indicated that they have completely abided by the recommendation to limit salt intake in cooking or at the table in the past year or if they had done so for reasons other than reducing the risk of developing hypertension. Splitting the sample based on the response to the question about abiding by the recommendation to limit salt could reduce the sample size, which could cause problems in the empirical analysis. Respondents may also have chosen not to limit salt added in cooking or at the table, but to limit it elsewhere in their diet (e.g. buying low-sodium products, avoiding salty snacks, eating more fresh fruits and vegetables). Therefore it was decided to not assign the survey for the second experiment based on responses to the question about limiting salt intake in the previous year.

Another method considered to determine if the respondent currently limits his or her salt/sodium intake to reduce the risk of hypertension was to ask the question directly in the survey. This question could be followed by the stated preference question about consuming the hypothetical cheddar cheese and if the respondent indicated that he or she would consume the hypothetical cheddar, he or she would then be asked how the extent to which he or she follows a low-salt diet would change. This method of questioning had disadvantages similar to the option of splitting the Guelph Food Panel as it could reduce the sample size significantly.

To avoid the problem of reduced sample size stemming from the requirement that respondents limited or are currently limiting salt intake, a third-person scenario was used in the second experiment. It differs from first experiment in that it asks respondents what someone else should do rather than what the respondent would do. Third-person or indirect questioning has been used in social science and marketing literature to avoid social desirability bias, where an individual self-reports untruthfully to avoid embarrassment or to present a better image (Fisher 1993; Lusk and Norwood 2009; Bolton et al 2008). Avoiding social desirability bias is important in the context of the second experiment as individuals may not admit to discontinuing the original averting behaviour (i.e. consuming more salt) following adoption of the second averting behaviour. By using a third-person scenario, the respondent does not have to self-report any changes in the original averting behaviour following the adoption of the second averting behaviour but rather predict how another individual would change his or her behaviour.

3.4.4 Experiment One

The first experiment tests the five hypotheses (H.1) to (H.5) generated in the one-behaviour analytical framework. In the experiment one survey, respondents were asked whether they would undertake a specific averting behaviour with experimental parameters varied across respondents. The hypothetical product selected as the averting behaviour was a cheddar cheese developed to reduce the risk of hypertension. Cheese was identified as a more acceptable carrier of a functional ingredient by Canadians (Decima Research 2006). A Canadian study of CLA-enriched dairy products found that an enriched cheese had the highest likelihood of being accepted by consumers (Peng et al 2006). Additionally, the consumption of cheese in Canada has steadily increased since 1987 (Canadian Dairy Information Centre 2009). In Canada, cheddar cheese is the second most purchased cheese category behind speciality cheeses, which is a grouping of a number of different cheeses (Agriculture and Agri-Food Canada 2007).

Cheese is one of the top ten sources of sodium in the Canadian diet (Statistics Canada 2007) and a high-fat food which may increase the risk of other health issues such as high blood cholesterol. The fact that cheese is high in sodium and fat is important for the present study as a cheddar cheese developed to reduce the risk of developing hypertension may encourage an individual to consume more cheese and possibly increase his or her risk of developing other health conditions. An individual consuming more cheese following adoption of a cheddar cheese developed to reduce the risk of hypertension would be an example of offsetting behaviour as they may offset the benefit of reduced risk of hypertension with increased risk of other health conditions.

In the one-behaviour analytical framework, five empirically testable hypotheses were derived for the impact of changes in effectiveness, price, salaried or non-labour income, wage rate and size of loss on the optimal level undertaken of averting behaviour. The first experiment investigates the impact of changes in the five exogenous variables on the decision to undertake an averting behaviour. Wage and salaried or non-labour income can be observed but not varied experimentally and are treated as control variables. Thus the first experiment had three different attributes varied across treatments: price, effectiveness and size of loss. The first two attributes, price and effectiveness, each have three attribute levels: low, medium and high. The third attribute has two levels: low and high. The attributes and their associated levels are presented in Table 3.3.

Table 3. 3 Experiment one attributes and attribute levels

Attribute Level	Attribute		
	Price	*Effectiveness*	*Size of Loss*
Low	$5.59/300g	The product is effective at reducing the risk of developing hypertension	No discussion of the size of loss associated with hypertension
Medium	$5.99/300g	Evidence gained from a clinical trial indicated that product is effective at reducing the risk of developing hypertension	N/A
High	$6.49/300g	Scientific evidence obtained from several clinical trials involving thousands of participants clearly indicated that product is very effective at reducing the risk of developing hypertension	Hypertension, or high blood pressure, is the number one risk factor for death. According to the Public Health Agency of Canada, it is one of the most important risk factors for cardiovascular diseases, is the number one modifiable risk factor for stroke, the number one reason for Canadians to visit a doctor and the top diagnosis for which medication is prescribed. Uncontrolled blood pressure can lead to artery damage and hardening of the arteries which can cause heart disease and heart attacks, strokes, kidney failure, loss of eye sight, reduced blood supply to the brain and aneurysms.

Price data was collected during a supermarket scan in Guelph on March 4, 2009. A package price was computed assuming a 300g package size, which is one of the most common package sizes available in Guelph and is the package size of a similar product (Kraft Canada 2008). The three price levels used in the experiment are all higher than the average price of a 300g package of cheese in Guelph. This is because the hypothetical cheese has an additional ingredient/different formulation and past studies (West et al 2002; Maynard and Franklin 2003; Larue et al 2004) have found that consumers are willing to pay a premium for functional foods/ingredients.

The three effectiveness attribute levels were created based on a scan of effectiveness claims of current anti-hypertensive products (see Appendix A). To vary the size of the loss, a cheap talk script outlining the health impacts of hypertension, as described by the Public Health Agency of Canada (2008; 2009) was developed. In treatments where the cheap talk script was presented to respondents, the size of the loss is 'High', otherwise the size of the loss is 'Low'.

The three attributes and their levels resulted in a 3x3x2 full factorial design with 18 different treatment combinations. Although using the full factorial design provides information on interaction effects between the attributes and guarantees that all attribute effects of interest can be estimated independently of one another (Louviere et al 2007, pp.85-86), the full factorial design places a large burden on respondents. In addition, interaction effects typically only explain five to 20 percent of the explained variance (Louviere et al 2007 p.94). A fractional factorial design was used to estimate the effects of the three attributes. Fractional factorial designs involve the selection of a subset of treatment combinations from the complete factorial using a sampling method that leads to a design with particular statistical properties, so that effects of interest can be estimated as efficiently as possible (Louviere et al 2007 p. 90). The most common fractional factorial design is a main effects design (Lusk and Shogren 2007 p.48). In addition, it is important to ensure that a fractional factorial design is orthogonal, that is, one in which each of the attributes are uncorrelated with one another (Lusk and Shogren 2007 p. 50).

SPSS 16.0 was used to generate an orthogonal main effects design for the first experiment. The nine resulting treatment combinations are presented in Table 3.4.

Table 3. 4 Experiment one treatment combinations

Treatment	Price	Effectiveness	Size of Loss
1	Medium	Medium	Low
2	Medium	Low	High
3	Low	High	High
4	Medium	High	Low
5	High	Low	Low
6	High	Medium	High
7	High	High	Low
8	Low	Medium	Low
9	Low	Low	Low

In addition to salaried or non-labour and the wage rate, other control variables were included in the first experiment such as demographics and hypertension-related variables. Although much of the control variable information had been collected in previous Guelph Food Panel surveys, some of the information was re-collected in the experiment one survey to ensure accuracy.

To test hypotheses developed in the one-behaviour analytical framework, variables representing the five experimental parameters are included in the estimated probit model with the decision to purchase and consume the hypothetical cheddar cheese as the dependent variable. As the dependent variable and four of the five experimental parameters are discrete in the probit model and not continuous as in the theoretical model the testable hypotheses were transformed into empirically testable hypotheses. Comparisons between the theoretical and empirical hypothesis as well as the expected signs for marginal effects of variables included to represent the experimental parameters are presented in Table 3.5.

Table 3. 5 Comparison of theoretical and empirical hypotheses for experiment one

Exogenous Variable	Theoretical Hypothesis	Empirical Hypothesis	Expected Sign
Effectiveness	An increase (decrease) in the effectiveness of an averting behaviour will increase (decrease) the amount of an averting behaviour undertaken	A high (low) effectiveness label on a cheddar cheese developed to reduce the risk of hypertension, relative to a medium effectiveness label, increases (decreases) the probability that an individual will purchase and consume a cheddar cheese developed to reduce the risk of hypertension	High: + Low: -
Price	An increase (decrease) in the price of an averting behaviour will decrease (increase) the amount of an averting behaviour undertaken	An increase (decrease) in the price of a cheddar cheese developed to reduce the risk of hypertension will decrease (increase) the probability of purchasing and consuming the cheddar cheese	-
Salaried or non-labour income	An increase (decrease) in salaried or non-labour income will have no impact on the amount of an averting behaviour undertaken	Having a higher salaried or non-labour income relative to a lower salaried or non-labour income has no effect the probability of purchasing and consuming a cheddar cheese developed to reduce the risk of hypertension	0
Wage rate	An increase (decrease) in the wage rate will decrease (increase) the amount of an averting behaviour undertaken	Having a higher wage rate relative to a lower wage rate decreases the probability of purchasing and consuming a cheddar cheese developed to reduce the risk of hypertension	-
Size of loss	An increase (decrease) in the size of loss will increase (decrease) the amount of an averting behaviour undertaken	Being presented with the health impacts of hypertension relative to not being presented with the health impacts increases the probability of purchasing and consuming a cheddar cheese developed to reduce the risk of hypertension	+

3.4.5 Experiment Two

The purpose of the second experiment is to investigate what influences the decision to undertake a second averting behaviour, including testing hypotheses (H.6) and (H.7) as well as how adopting a second averting behaviour influences the decision to discontinue the original averting behaviour. In the second experiment, respondents were presented with a scenario about a hypothetical third-person who is currently minimizing his or her salt intake to reduce the risk of developing hypertension. The respondents were then presented with the hypothetical cheddar cheese used in the first experiment and were asked if the hypothetical third-person should consume it. If the responded indicated that the hypothetical third-person should consume the cheddar cheese, the respondent was then asked if the hypothetical person would continue to minimize his or her salt intake.

The control variables used in the second experiment are the same as those used in the first experiment. The experimental parameters for the second experiment were similar to the parameters used in the first experiment; however, the size of loss was not varied experimentally in the second experiment while disutility of the second averting behaviour, substitutability between the two averting behaviours and gender of the hypothetical third person were varied experimentally. The disutility of the second averting behaviour, the hypothetical cheddar cheese, is in comparison to conventional cheddar cheese (i.e. one that does not work to affect high blood pressure) and has three attribute levels where the hypothetical third-person finds the new cheddar cheese more, as, or less satisfying than conventional cheddar cheese. The degree of substitutability between the hypothetical cheddar cheese and a low-salt diet has two attribute levels: substitutes and complements. The gender of the hypothetical third person was also varied as males are more likely to have high blood pressure than females (National Heart Lung and Blood Institute n.d.).

Similar to the first experiment, price and effectiveness were varied experimentally; however, in the second experiment relative effectiveness and prices were varied rather than absolute effectiveness and prices as the hypothetical cheddar cheese is compared to the low-salt diet. There are three levels of cheddar cheese prices with respect to a low-salt diet: more than the weekly cost of (higher), the same weekly cost as (same) and less than the weekly cost of (lower). There are two levels of effectiveness of the cheddar cheese with respect to the low-salt diet: as effective as (same) and more effective than (higher). There are two reasons for why a treatment where the cheddar cheese is less effective than the low-salt diet was not included. First, one can anticipate that an individual would respond that a hypothetical third person should not consume the hypothetical cheddar if he or she is presented with a scenario where the cheese is less effective than the low-salt diet, particularly if it is presented in a treatment where the cheddar cheese is also more expensive than and/or is consumed in addition to a low-salt diet. The second reason for not including a treatment where the cheddar cheese is less effective than the low-salt diet was the need for a more manageable experimental design with fewer treatments and less burden placed on the respondents. The experimental parameters and their attribute levels for the second experiment are presented in Table 3.6.

Table 3. 6 Experiment two attributes and attribute levels

Attribute	**Attribute level**
Gender	Michael (male) / Michelle (female)
Relative price	Less than the weekly cost of ($5.59) / Same weekly cost as ($5.99) / More than the weekly cost of ($6.49)
Relative effectiveness	As effective as / More effective than
Substitutability	Instead of (substitutes) / In addition to (complements)
Utility	Less satisfying than / As satisfying as / more satisfying than

The full factorial design for the second experiment resulted in a 3x3x2x2x2 experimental design with 72 different treatment combinations. Similar to the first experiment, the number of treatment combinations was reduced using an orthogonal main effects design. SPSS 16.0 was used to generate a main effects orthogonal design for the second experiment and the 16 resulting treatment combinations are presented in Table 3.7.

Table 3. 7 Experiment two treatment combinations

Treatment	Gender	Relative price	Relative effectiveness	Substitutability	Utility
1	Michael	Less than the weekly cost of ($5.59)	As effective as	Instead of	Less satisfying than
2	Michelle	Less than the weekly cost of ($5.59)	As effective as	In addition to	Less satisfying than
3	Michael	More than the weekly cost of ($6.49)	More effective than	Instead of	Less satisfying than
4	Michael	More than the weekly cost of ($6.49)	As effective as	In addition to	More satisfying than
5	Michael	Less than the weekly cost of ($5.59)	More effective than	Instead of	Less satisfying than
6	Michelle	Same weekly cost as ($5.99)	More effective than	Instead of	More satisfying than
7	Michael	Same weekly cost as ($5.99)	As effective as	Instead of	Less satisfying than
8	Michael	Less than the weekly cost of ($5.59)	As effective as	In addition to	As satisfying as
9	Michelle	More than the weekly cost of ($6.49)	More effective than	In addition to	Less satisfying than
10	Michelle	Less than the weekly cost of ($5.59)	More effective than	Instead of	As satisfying as
11	Michael	Same weekly cost as ($5.99)	More effective than	In addition to	As satisfying as
12	Michelle	More than the weekly cost of ($6.49)	As effective as	Instead of	As satisfying as
13	Michelle	Same weekly cost as ($5.99)	As effective as	In addition to	Less satisfying than

14	Michelle	Less than the weekly cost of ($5.59)	More effective than	In addition to	Less satisfying than
15	Michael	Less than the weekly cost of ($5.59)	More effective than	In addition to	More satisfying than
16	Michelle	Less than the weekly cost of ($5.59)	As effective as	Instead of	More satisfying than

The indeterminate results of the comparative static analysis for two-behaviour analytical framework provided motivation for empirical analysis. The experimental parameters (relative price, relative effectiveness, substitutability, utility and gender of hypothetical third-person) will be varied experimentally using a series of dichotomous variables, the signs of the estimated coefficients of which will provide insight on the impact of the parameters. Additionally, as the degree of substitutability and utility impacted the comparative static results, the model could be parsed into four subsets and the experimental parameters tested.

3.5 SUMMARY

This chapter outlined the methods and data that will be used in the empirical analysis of the hypotheses and other theoretical results derived in the conceptual framework. The following chapter will be devoted to empirical results, which will be based on the empirical frameworks and data collected within the experimental design developed in this chapter.

Chapter 4

Results

4.1 INTRODUCTION

This chapter will present and provide an interpretation of the empirical results of this study. This chapter will first provide a discussion of the data collected based on the two experimental designs developed in the previous chapter as well as a description of the data. It will then present results of the first experiment which tests hypotheses that were developed in the one-behaviour analytical framework and investigates what influences the decision to undertake an averting behaviour. The first experiment also addresses the third objective of this study by investigating whether the addition of a functional ingredient to a food, such as cheddar cheese, leads to increased overall consumption of that food. This chapter then presents the results of the second experiment which investigates what factors influence the decision to undertake a second averting behaviour and address the fourth objective of this study by examining whether consumption of a functional food reduces the propensity to make broader healthy dietary choices.

4.2 DATA COLLECTION

The majority of the data used in the empirical analysis of this study was collected using two surveys conducted from June 22, 2009 to July 20, 2009 using the Guelph Food Panel, a representative consumer panel in the City of Guelph, Ontario, Canada. Other data used in the empirical analysis were collected in six online surveys completed by members of the Guelph Food Panel from February 2008 to February 2009.

4.2.1 Survey Development and Implementation

From March to June 2009, two surveys (Appendix B and Appendix C) were developed corresponding to the analytical frameworks, empirical frameworks and experimental designs. The first step in the development of the two surveys was to create a list of the variables that would need to be collected in each survey to conduct the empirical analysis. Two types of variables were included: experimental parameters and control variables. The experimental parameters correspond to the choice and experimental variables from the one-behaviour and two-behaviour analytical frameworks. Two types of control variables were identified: those relating to the health outcome of hypertension and demographic variables. Although demographic information was collected in previous Guelph Food Panel surveys, it was updated using the two surveys conducted from June 22, 2009 to July 20 2009.

The second step in the development of the two surveys was to develop draft questions based on the variables that needed to be collected. The two surveys were separated into five sections. The first section in both surveys is common to all Guelph Food Panel surveys and describes the survey. In the present surveys, the first section also included a paragraph on how the results of the survey would be used for a Master of Science thesis at the University of Guelph and informed respondents that they had a chance to win one of two $700 prizes if they submitted the survey by July 15, 2009. The second section was a general question asking about diagnosis of self, a family member, or a close friend with ten different diseases. The third section asked questions relating to hypertension, the fourth section was devoted to the experiment and the fifth section was devoted to wage, salaried or non-labour income and demographic variables. The first three sections as well as the fifth section were identical in both surveys; the only difference between the two surveys was the experiment or fourth section. The draft survey questions closely followed the format and wording of past Guelph Food Panel surveys.

The draft surveys went through a series of reviews by three primary reviewers between March and May 2009 and were piloted between April and May 2009. After hard copies of the surveys were finalized, the two surveys were made available online using StatPac, an online survey software. The online version of the two surveys went through another series of reviews before being finalized on June 18, 2009 and sent to Guelph Food Panel members on June 22, 2009.

To account for the nine experimental treatments in the first experiment and the 16 experimental treatments in the second experiment, a different survey was created for each experimental treatment for a total of 25 different surveys. StatPac randomly assigned the different versions of the surveys to members of the Guelph Food Panel with each member being assigned and receiving a link to one of the 25 versions of the surveys. An email describing the survey was sent to the Guelph Food Panel members on June 22, 2009 including a link to the version of the survey that they had been randomly assigned. Reminder emails were sent to Panel members on July 7, 2009 and July 17, 2009.

4.2.2 Data

A total of 449 respondents completed the online surveys out of a possible 1,947 Guelph Food Panel members resulting in a completion rate of 23 percent. There were 248 completed surveys corresponding to experiment one and 201 completed surveys corresponding to experiment two. Previous studies investigating online and email survey completion rates have found rates a wide range of survey completion rates from under 20 percent to over 70 percent (Sheehan 2001; Cook et al 2000; Kaplowitz et al 2004; Schaefer and Dillman 1998; Couper et al 1999). The survey completion rate for the two surveys conducted as part of this study is lower than the response rate to previous Guelph Food Panel surveys. This may be because the surveys were administered to Guelph Food Panel members in late June which is the beginning of summer vacation for elementary and high school students in Ontario. After dropping respondents where variables of interest were missing, specifically the dependent variables, the final sample contained 191 observations for the first experiment and 166 observations for the second experiment.

The demographics of respondents to the two surveys conducted as part of this study are somewhat representative of the city of Guelph, the province of Ontario and Canada across gender, age and education (Table 4.1). Females, age groups over 40 and those who completed college or university were over-represented while males and those with a high school education or less were under-represented. The over-representation of females cannot be accounted for by Internet use as the Canadian Internet Use Survey (Statistics Canada 2009a) shows a small difference in Internet use across gender, with 74 percent of males and 72 percent of females using the Internet in 2007. In terms of education, 92.5 percent of those with a university education and 76.8 percent of those with a college or high school diploma used the Internet as compared to 43.2 percent with less than high school, which may explain the over-representation of those with college or university and the under-representation of those with less than high school in the survey sample. With respect to education, 93 percent of those between the ages of 16 and 34, 80 percent of those between the ages of 35 and 54 and 61 percent of those between the ages of 55 and 64 used the Internet in 2007, which does not explain the over-representation of older age groups and the under-representation of younger age groups. A possible explanation for the under-representation of younger age groups (20-50) could be that individuals in that age group have children of elementary and high school age who began summer vacation at the time of the survey.

Table 4.1 Comparison of survey respondents to Guelph Food Panel, City of Guelph, Province of Ontario and Canada across gender, age and education level[a]

Description		Panel Response	Guelph Food Panel	Guelph	Ontario	Canada
Total population (20-69)		449	1,947	75,530	7,933,435	20,791,880
Gender	Male	151 (34%)	866 (44%)	36,925 (49%)	3,874,800 (49%)	10,232,070 (49%)
	Female	267 (59%)	1081 (56%)	38,605 (51%)	4,058,640 (51%)	10,561,820 (51%)
Age	20-29	50 (11%)	369 (19%)	17,745 (23%)	1,540,950 (19%)	4,065,965 (20%)
	30-39	80 (18%)	461 (24%)	17,090 (23%)	1,675,945 (21%)	4,228,500 (20%)
	40-49	99 (22%)	513 (26%)	18,510 (25%)	2,024,385 (26%)	5,231,050 (25%)
	50-59	113 (25%)	381 (20%)	13,995 (19%)	1,643,930 (21%)	4,441,925 (21%)
	60-69	76 (17%)	223 (11%)	8,190 (11%)	1,048,225 (13%)	2,824,440 (14%)
Education[b]	Less than high school	8 (2%)	45 (2%)	7,480 (12%)	899,525 (14%)	2,683,505 (15%)
	High school	88 (20%)	515 (26%)	15,950 (25%)	1,660,665 (25%)	4,156,735 (24%)
	Trades certificate or diploma	26 (6%)	143 (7%)	4,880 (8%)	581,130 (9%)	2,156,010 (12%)
	College	112 (25%)	514 (26%)	12,750 (20%)	1,461,625 (22%)	3,533,375 (20%)
	University	184 (41%)	730 (37%)	21,510 (34%)	2,035,375 (31%)	4,852,480 (28%)

a. Numbers above parentheses are absolute population numbers and number in parentheses are percentages
b. Education numbers for Guelph, Ontario and Canada for total population aged 25-64
Source: Statistics Canada. 2008c. 2006 Community Profiles. Statistics Canada Catalogue Number 92-591-XWE. Released July 24, 2008.

4.3 EXPERIMENT ONE

A probit model was estimated to investigate how price, effectiveness, size of loss, salaried or non-labour income, wage rate, demographics and hypertension-related variables influence the propensity of an individual to purchase and consume a cheddar cheese developed to reduce the risk of developing high blood pressure. Summary statistics, descriptions of the dependent and independent variables included in the model and expected signs (where available) are presented in Table 4.2.

Table 4.2 Description of and summary statistics for dependent and independent variables included in the experiment one probit model

Variable	Description	N	Mean	Std. Dev.
UNDERTAKE	1 if respondent would purchase and consume cheddar cheese developed to reduce the risk of hypertension, 0 otherwise	191	0.5916	0.4928
PRICE	Price treatment presented to respondent Expected sign: negative	191	5.9989	0.3752
EFFLOW	1 if respondent presented with treatment containing low effectiveness level, 0 otherwise Expected sign: negative	191	0.3508	0.4785
EFFHIG	1 if respondent presented with treatment containing high effectiveness level, 0 otherwise Expected sign: positive	191	0.3037	0.4610
HLOSS	1 if respondent presented with cheap talk script outlining health impacts of hypertension, 0 otherwise Expected sign: positive	191	0.2827	0.4515
INCMT65	1 if respondent had an annual household income of $65,000 or more in 2008 and no one in the household earned an hourly wage, 0 otherwise Expected sign: 0	191	0.6754	0.4695
WAGEMT20	1 if respondent or another adult in household earned an hourly wage, 0 otherwise Expected sign: negative	191	0.9686	0.1749
HBP_SELF	1 if respondent has ever been diagnosed with high blood pressure, 0 otherwise	191	0.6806	0.4675
HBP_OTHER	1 if respondent has a friend or family member that has been diagnosed with high blood pressure, 0 otherwise	191	0.7539	0.4318
HBP_FAMHIS	1 if respondent has a family history of high blood pressure, 0 otherwise	191	0.4503	0.4988
MALE	1 if respondent is male, 0 if respondent is female	191	0.3560	0.4801

A2029	1 if respondent is between the ages of 20 and 29, 0 otherwise	191	0.0890	0.2855
A3039	1 if respondent is between the ages of 30 and 39, 0 otherwise	191	0.1937	0.3962
A5059	1 if respondent is between the ages of 50 and 59, 0 otherwise	191	0.2827	0.4515
A6069	1 if respondent is between the ages of 60 and 69, 0 otherwise	191	0.1780	0.3835
LESSHS	1 if respondent has completed less than high school, 0 otherwise	191	0.0157	0.1247
TRADES	1 if respondent has completed trades certificate, 0 otherwise	191	0.0733	0.2613
COLLEGE	1 if respondent has completed college, 0 otherwise	191	0.2775	0.4489
UNIV	1 if respondent has completed university, 0 otherwise	191	0.4503	0.4988
RISK[a]	Perceived risk of developing high blood pressure compared to average person	191	3.6806	1.5035
VULNER[b]	Perceived importance of being vulnerable to high blood pressure	191	5.0419	1.4173
REDUCE_SALT	1 if respondent limited the amount of salt consumed in the past year to avert and/or manage hypertension, 0 otherwise	191	0.6963	0.4610
SPECIFIC_ACTIONS	1 if respondent undertook a specific action to avert and/or manage hypertension in the past year, 0 otherwise	191	0.7173	0.4515
QUIT_NICOTINE	1 if respondent quit the use of nicotine in past year to avert and/or manage hypertension, 0 otherwise	191	0.0471	0.2124
PEFF_LIMITSALT[c]	Perceived effectiveness of limiting salt consumption to avert and/or manage hypertension	191	5.8416	0.8797
PEFF_ACTIONS[c]	Perceived effectiveness of actions to avert and/or manage hypertension	191	5.9309	0.7723
PEFF_SMOKEALCO[c]	Perceived effectiveness of limiting smoking and alcohol to avert and/or manage hypertension	191	5.6060	1.1640

a. Measured on a seven-point scale from ‘Extremely Low’ (1) to ‘Extremely High’ (7)
b. Measured on a seven-point scale from ‘Extremely Unimportant’ (1) to ‘Extremely Important’ (7)
c. Measured on a seven-point scale from ‘Not at all effective’ (1) to ‘Extremely effective’ (7)

Dependent Variable

The dependent variable, UNDERTAKE, is a dichotomous variable representing the decision to purchase and consume a cheddar cheese developed to reduce the risk of hypertension. Respondents were presented with a script describing the hypothetical cheddar cheese with price, effectiveness and size of loss varied across respondents and were asked 'would you purchase and consume the cheddar cheese developed to reduce the risk of hypertension?', measured on a three-point scale as follows: 'Yes' (1), 'No' (2) and 'Don't know' (3). For the probit model, the responses were converted into a dichotomous variable with a value of one if the respondent indicated that they would purchase and consume the cheddar cheese developed to reduce the risk of hypertension and zero otherwise.

Experimental Parameters

The main independent variables included in the UNDERTAKE model were the experimental parameters, namely price, effectiveness and size of loss. The sign and significance of the estimated coefficients and marginal effects for the experimental parameters are used to test the hypotheses developed in the one-behaviour analytical framework. The theoretical hypotheses predict the impact of a change in the level of an exogenous variable on the level undertaken of an averting behaviour while, in the context of the probit model, the hypotheses tested are the signs of the marginal effects of the experimental parameters.

To test the hypothesis that an increase in the price of the hypothetical cheddar decreases the probability that an individual would purchase and consume it, the continuous variable PRICE was created and took the values \$5.59, \$5.99 and \$6.49, which represent the different price treatments presented to respondents. The expected sign for the PRICE marginal effect is negative. Two dichotomous variables were created to test the hypothesis that an increase (decrease) in the effectiveness of the hypothetical cheddar increases (decreases) the probability than an individual would purchase and consume it. The two dichotomous effectiveness variables are relative to the omitted group of respondents who were presented with an experimental treatment containing the medium effectiveness treatment. The dichotomous variable EFFHIG had a value of one if the respondent was presented with an experimental treatment containing the high effectiveness statement and zero otherwise and the expected sign of its marginal effect is positive. The dichotomous variable EFFLOW had a value of one if the respondent was presented with an experimental treatment containing the low effectiveness statement and zero otherwise and the expected sign of its marginal effect is negative. To test the hypothesis that being presented with the health impacts of hypertension increases the probability that an individual would purchase and consume the hypothetical cheddar, the dichotomous variable HLOSS was created which took a value of one if the respondent was presented with the cheap talk script on the health impacts of hypertension and zero otherwise. The expected sign for the HLOSS marginal effect is positive.

Although used to test hypotheses generated in the one-behaviour analytical framework, non-labour or salaried income and the wage rate were not varied experimentally, but rather treated as control variables. Two groups were created: those with no wage earners in the household and those with a least one wage earner in the household. To test the hypothesis that a change in salaried or non-labour income has no impact on the decision to purchase and consume the hypothetical cheddar, the dichotomous variable INCMT65 was created, using the group with no wage earners, which took a value of one if the respondent's household income in 2008 was greater than $65,000 and zero otherwise. A household income of $65,000 was selected as the average Canadian household income in 2007 was $68,800 (Statistics Canada 2009c), which is in the $65,000 - $74,999 income bracket in the survey. It is expected that the marginal effect for INCMT65 will not be statistically significant from zero. To test the hypothesis that an increase in the wage rate decreases the probability of purchasing and consuming the antihypertensive cheese, the dichotomous variable WAGEMT20 was created using the group with wage earners and took a value of one if an adult in the respondent's household earned an hourly wage greater than $20 in 2008, zero otherwise. The average hourly wage in Canada in 2008 was $20.16 (Statistics Canada 2009b) which is in the $20-$24.99 wage bracket in the experiment one survey. The expected sign of the marginal effect for WAGEMT20, as from the empirical hypothesis (Table 3.5) having a higher wage rate (i.e. having an hourly wage rate above $20 as opposed to below $20) decreases the probability of purchasing and consuming the hypothetical cheddar.

Control Variables

The variables REDUCE_SALT, SPECIFIC_ACTIONS and QUIT_NICOTINE capture averting behaviours the respondent has undertaken in the past year to reduce the risk of developing and/or to manage high blood pressure. Respondents were provided with a list of 16 different behaviours and asked what behaviours they had undertaken in the past year to avert and/or manage high blood pressure. Principal component analysis using VARIMAX rotation was employed to identify underlying constructs. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.86 which suggests that factor analysis is appropriate for these variables. Bartlett's test of sphericity, distributed as a chi-squared with 120 degrees of freedom, was statistically significant at the one percent level, rejecting the null hypothesis that the variables are not interrelated. Four factors had eigenvalues exceeding one. Dichotomous variables were created for three of the four factors for measures of whether the individual had reduced salt in the past year (REDUCE_SALT), undertaken a specific health behaviour (SPECIFIC_ACTIONS), or quit the use of products containing nicotine (QUIT_NICOTINE), which had Cronbach's alpha values of 0.77, 0.75 and 0.66 respectively, suggesting acceptable levels of internal reliability. The Cronbach's alpha for the fourth factor had a value of 0.37 which suggests an unacceptable level of internal reliability and so the fourth factor was not included in the probit estimation[9]. The rotated factor loadings matrix is presented in Table 4.3.

[9] Engage in regular activity was added to the fourth factor, however, the level of internal reliability was still unacceptable (0.5093) and thus the fourth factor was not included in the estimation.

Table 4.3 Experiment one rotated factor loadings matrix for averting behaviours undertaken in past year to reduce the risk of developing and/or to manage high blood pressure

Variable	REDUCE_ SALT	SPECIFIC_ ACTIONS	QUIT_ NICOTINE	Factor 4
Limit the amount of salt added at the table	**0.8025**	0.1633	0.0911	0.0881
Limit the amount of salt added while cooking	**0.7421**	0.1692	0.0885	0.0102
Avoid foods containing high levels of salt	**0.7296**	0.1521	0.0058	0.1574
Buy and eat processed foods with low salt or sodium levels	**0.6578**	0.1324	0.0706	-0.0206
Consume the daily recommended intake of whole grains and cereals	0.2811	**0.6982**	-0.0539	-0.0226
Consume the daily recommended intake of fruits and vegetables	0.2628	**0.6774**	0.0192	0.1781
Limit consumption of alcohol	0.0917	**0.6481**	0.0629	0.0777
Reduce exposure to second-hand smoke	0.0188	**0.6406**	0.3511	0.0228
Avoid foods contained trans fat	0.4619	**0.5056**	-0.1238	0.1405
Quit the use of products containing nicotine	0.1179	0.0202	**0.8392**	-0.0137
Quit smoking	0	0.0242	**0.8372**	0.0415
Reduce stress	0.0105	0.0693	0.0661	**0.7772**
Lose weight	0.1710	0.0807	-0.0104	**0.6801**
Engage in regular physical activity	0.2651	0.4975	-0.1031	0.4553
Limit consumption of foods containing high levels of saturated fat	0.3899	0.4916	-0.0232	0.2817
Did not do anything	-0.4950	-0.2870	0.0289	-0.2932
Eigenvalue	4.9127	1.5811	1.2968	1.0838
Cronbach's alpha	0.7736	0.7457	0.6524	0.3676
Percent of variation explained by each factor	0.1900	0.1695	0.0993	0.0958
KMO	0.8588			
Bartlett's test of sphericity	1058.602 (distributed as chi-squared with 120 df) Statistically significant at the one percent level			

The variables PEFF_LIMITSALT, PEFF_ACTIONS and PEFF_SMOKEALCO capture the perceived effectiveness of health behaviours that help to reduce the risk of developing and/or to manage high blood pressure. Respondents were provided with a list of 15 different behaviours and asked to rate the effectiveness of each behaviour in averting and/or managing high blood pressure on a seven-point scale from 'Not at all effective' (1) to 'Extremely effective' (7). Principal component analysis using VARIMAX rotation was employed to identify underlying constructs. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.89. Bartlett's test of sphericity, distributed as a chi-squared with 104 degrees of freedom was statistically significant at the one percent level, rejecting the null hypothesis that the variables are not interrelated. Three factors had eigenvalues exceeding one. Multi-item scales were developed for each of the constructs as measures of the perceived effectiveness of limiting salt intake (PEFF_LIMITSALT), the perceived effectiveness of undertaking health actions (PEFF_ACTIONS) and the perceived effectiveness of quitting smoking and limiting consumption of alcohol (PEFF_SMOKEALCO), which had Cronbach's alpha values of 0.81, 0.83 and 0.83 respectively, suggesting high levels of internal reliability. The rotated factor loadings matrix is presented in Table 4.4.

Table 4.4 Rotated factor loadings matrix for perceived effectiveness of averting behaviours to reduce the risk of developing and/or to manage high blood pressure

Variable	**PEFF_ LIMITSALT**	**PEFF_ ACTIONS**	**PEFF_ SMOKEALCO**
Perceived effectiveness of limiting the amount of salt added at the table	**0.8467**	0.1822	0.2121
Perceived effectiveness of limiting the amount of salt added while cooking	**0.8312**	0.1847	0.1445
Perceived effectiveness of avoiding foods containing high levels of salt	**0.7476**	0.2767	0.2624
Perceived effectiveness of buying and eating processed foods with low salt or sodium labels	**0.6537**	0.1956	-0.1300
Perceived effectiveness of avoiding foods containing trans fat	0.2862	**0.7084**	0.1293
Perceived effectiveness of engaging in regular physical activity	0.0719	**0.7443**	0.1730
Perceived effectiveness of limiting consumption of foods containing high levels of saturated fat	0.3620	**0.6943**	0.1476
Perceived effectiveness of consuming the daily recommended intake of fruits and vegetables	0.2697	**0.6563**	0.2947
Perceived effectiveness of consuming the daily recommended intake of whole grains and cereals	0.3438	**0.6362**	0.1398
Perceived effectiveness of quitting the use of products containing nicotine	0.0815	0.1146	**0.8975**
Perceived effectiveness of quitting smoking	0.1130	0.1245	**0.8566**
Perceived effectiveness of reducing exposure to second hand smoke	0.2387	0.2244	**0.7215**
Perceived effectiveness of limiting consumption of alcohol	0.2731	0.1917	**0.6054**
Perceived effectiveness of reducing stress	0.2316	0.4561	0.3238
Perceived effectiveness of losing weight	0.2370	0.3843	0.3948
Eigenvalue	6.1761	1.7790	1.1485
Cronbach's alpha	0.8076	0.8289	0.8325
Percent of variation explained	0.2042	0.2018	0.2009
KMO	0.8650		
Bartlett's test of sphericity	1544.977 (distributed as chi-squared with 104 df) Statistically significant at the one percent level		

To capture the perceived risk of respondents to high blood pressure, the variable RISK was included in the UNDERTAKE model, which was based on the respondent's perceived risk of developing high blood pressure compared to the average person and was measured on a seven-point scale from 'Extremely Low' (1) to 'Extremely High' (7). Respondents' perceived importance of being vulnerable to high blood pressure was captured by the variable VULNER which was measured on a seven-point scale from 'Extremely Unimportant' (1) to 'Extremely Important' (7).

The inclusion of psychographic variables as independent variables (e.g. perceived risk, importance of vulnerability, perceived effectiveness) in the model investigating the probability of purchasing and consuming the hypothetical cheddar cheese can be motivated by models of health behaviour such as Protection Motivation Theory, Theory of Planned Behaviour and the Health Belief model (Glanz et al 1997). These models suggest that the decision to undertake a health promoting behaviour, such as the decision to purchase and consume a hypothetical cheddar cheese developed to reduce the risk of hypertension depends on factors such as perceived risk or threat and perceived efficacy of averting behaviours perceived, perceptions of threat, etc. Previous studies investigating functional food consumption have applied health behaviour models such as Protection Motivation Theory (see for example Cox et al 2004; Cox and Bastiaans 2007; Henson et al 2008) and found that psychographic variables impact the decision to purchase and consume a functional food.

Three variables relating to experience with hypertension diagnosis were also included in the estimation: HBP_SELF which took a value of one if the respondent has ever been diagnosed with hypertension and zero otherwise; HBP_OTHER which took a value of one if a friend or family member of the respondent has ever been diagnosed with hypertension and zero otherwise; and HBP_FAMHIS which took a value of one if the respondent has a family history of hypertension and zero otherwise.

Three groups of variables were included to account for the impact of demographics (e.g. gender, education and age) on the probability of purchasing and consuming the hypothetical cheddar cheese. MALE took a value of one if the respondent is male and zero if the respondent is female. Four variables were included on the highest level of education completed by the respondent, relative to the omitted group of those who had completed high school: LESSHS took a value of one if the respondent has not completed high school and zero otherwise; TRADES took a value of one if the respondent has completed a trades certificate or diploma and zero otherwise, COLLEGE took a value of one if the respondent has completed college and zero otherwise and UNIV took a value of one if the respondent has completed university and zero otherwise. To account for the impact of age, four dichotomous variables were created relative to the omitted group of those between the ages of 40 and 49: A2029 took a value of one if the respondent is between the ages of 20 and 29, zero otherwise; A3039 took a value of one if the respondent is between the ages of 30 and 39, zero otherwise; A5059 took a value of one if the respondent is between the ages of 50 and 59, zero otherwise; and A6069 took a value of one if the respondent is between the ages of 60 and 69, zero otherwise.

The estimated model for experiment one took the following form, where the decision to purchase and consume the hypothetical cheddar cheese or the probability of the individual purchasing and consuming the hypothetical cheddar (i.e.

UNDERTAKE=1) is a function of the experimental parameters, hypertension experience variables, psychographic variables and demographics:

$$\begin{aligned}\text{Prob (UNDERTAKE=1)} = {} & \beta_{1} + \beta_2\text{PRICE} + \beta_3\text{EFFLOW} + \beta_4\text{EFFHIG} + \beta_5\text{HLOSS} \\ & + \beta_6\text{INCMT65} + \beta_7\text{WAGEMT20} + \beta_8\text{HBP\_SELF} \\ & + \beta_9\text{HBP\_OTHER} + \beta_{10}\text{HBP\_FAMHIS} + \beta_{11}\text{REDUCE\_SALT} \\ & + \beta_{12}\text{SPECIFIC\_ACTIONS} + \beta_{13}\text{QUIT\_NICOTINE} \\ & + \beta_{14}\text{PEFF\_LIMITSALT} + \beta_{15}\text{PEFF\_ACTIONS} \\ & + \beta_{16}\text{PEFF\_SMOKEALCO} + \beta_{17}\text{RISK} + \beta_{18}\text{VULNER} \\ & + \beta_{19}\text{MALE} + \beta_{20}\text{A2029} + \beta_{21}\text{A3039} + \beta_{22}\text{A5059} + \beta_{23}\text{A6069} \\ & + \beta_{24}\text{LESSHS} + \beta_{25}\text{TRADES} + \beta_{26}\text{COLLEGE} + \beta_{27}\text{UNIV} + \varepsilon_i\end{aligned} \tag{4.1}$$

4.3.1 Factors influencing the decision to undertake an averting behaviour

The estimated regression coefficients and marginal effects for the experiment one probit model (equation 4.1) are presented in Table 4.5. The model was estimated in STATA 9 using White's heteroskedastic-consistent standard errors. The Pseudo R^2 for the model was 0.24 which is relatively high for cross-sectional data. A joint Wald test that the estimated parameters are simultaneously equal to zero was rejected at the one percent level of significance which suggests that the estimated model has statistically significant explanatory power. The predicted probability of purchasing and consuming the cheddar cheese developed to reduce the risk of hypertension, evaluated at the means of the data, is 60 percent. This indicates a relatively high probability of purchasing and consuming the cheddar cheese developed to reduce the risk of hypertension.

Table 4.5 Probit regression coefficients and marginal effects for the intention to purchase and consume the hypothetical cheddar (robust standard errors in parentheses)

Variable	Regression Coefficient	Marginal Effect
	Experimental Parameters	
PRICE	-0.0626 (0.2812)	-0.0241 (0.1084)
EFFLOW	0.1312 (0.2744)	0.0503 (0.1044)
EFFHIG	-0.0025 (0.2670)	-0.0010 (0.1029)
HLOSS	**0.4399*** **(0.2545)**	**0.1635*** **(0.0894)**
INCMT65[a]	0.1079 (0.2394)	0.0414 (0.0913)
WAGEMT20[a]	**1.8060***** **(0.6114)**	**0.5565***** **(0.0896)**
	Control Variables	
HBP_SELF	-0.2835 (0.2697)	-0.1104 (0.1056)
HBP_OTHER	0.1373 (0.2645)	0.0533 (0.1035)
HBP_FAMHIS	-0.0599 (0.2253)	-0.0231 (0.0870)
REDUCE_SALT	**0.5563*** **(0.3158)**	**0.2167*** **(0.1220)**
SPECIFIC_ACTIONS	0.2985 (0.3492)	0.1164 (0.1369)
QUIT_NICOTINE	-0.2559 (0.5423)	-0.1008 (0.2159)
PEFF_LIMITSALT	**0.3036*** **(0.1569)**	**0.1170*** **(0.0603)**
PEFF_ACTIONS	0.0950 (0.1821)	0.0366 (0.0703)
PEFF_SMOKEALCO	-0.0660 (0.1016)	-0.0254 (0.0392)
RISK	**0.2846***** **(0.0769)**	**0.1097***** **(0.0295)**
VULNER	**0.1652**** **(0.0830)**	**0.0637**** **(0.0319)**
MALE	-0.1026 (0.2327)	-0.0397 (0.0903)
A2029	0.4883 (0.4548)	0.1737 (0.1446)

A3039	**-0.6021*** **(0.3335)**	**-0.2359*** **(0.1285)**
A5059	0.1896 (0.3217)	0.0721 (0.1206)
A6069	0.2986 (0.3799)	0.1114 (0.1360)
LESSHS	0.4819 (0.6027)	0.1689 (0.1851)
TRADES	**-1.0555**** **(0.4603)**	**-0.3959**** **(0.1449)**
COLLEGE	-0.1437 (0.3350)	-0.0558 (0.1309)
UNIV	-0.1683 (0.2982)	-0.0650 (0.1151)
Constant	**-5.5563**** **(2.3199)**	
Observations: 191 Wald chi^2 (26 df): 60.62*** Log pseudolikelihood : -98.1621 Pseudo R^2: 0.2400 Observed probability: 0.5916 Predicted probability (evaluated at the mean): 0.6032 a. Not varied experimentally * Denotes significance at the ten percent level ** Denotes significance at the five percent level *** Denotes significance at the one percent level		

Experimental Parameters

The signs of the marginal effects of the experimental parameters provide some support for the hypotheses derived in the one-behaviour analytical framework. As hypothesized, the sign of the marginal effect for PRICE was negative; however it was not statistically significant from zero. The marginal effects for the two variables included to capture effectiveness were both statistically insignificant and had opposite signs than what was hypothesized. The marginal effect for HLOSS was positive and significant at the 10 percent level, which suggests that being presented the health impacts associated with hypertension increases the probability of purchasing and consuming a cheddar cheese developed to reduce the risk of hypertension. The positive and significant marginal effect for HLOSS provides support for the empirical hypothesis that an individual is more likely to undertake an averting behaviour following exposure to information on the size of loss.

Although the marginal effect for INCMT65 was positive, it was not statistically significant from zero which provides support for the hypothesis that a change in income has no impact on the intention to undertake an averting behaviour. The marginal effect for WAGEMT20 was significant at the one percent level; however, the sign was opposite of the hypothesized sign[10]. This suggests that as the wage rate of an individual or another adult in his or her household increases, the probability of consuming the hypothetical cheddar cheese increases. Although this does not provide support for the theoretical and empirical hypotheses, it could be explained by the assumption that health is a normal good (Grossman 1972) and as income increases, via an increase in the wage rate, the demand for health and thus intention to undertake an illness-averting behaviour increases.

The empirical analysis provided support for two of the five hypotheses developed in the one-behaviour analytical framework which were subsequently transformed into empirically testable hypotheses, namely size of loss and salaried or non-labour income. However, only the marginal effect for size of loss was statistically significant. Comparisons between the expected sign of the marginal effects based on the hypotheses and the empirical results are presented in Table 4.6. The empirical results suggest that the price and level of effectiveness of the hypothetical cheddar presented to the respondent and having a household income greater than $65,000 has no impact on the probability of

[10] The data set for experiment one was split into two groups and two additional models were estimated: households who earn only a salary and household who earn a wage and the experiment one model run for each of the two sub-sets of data. The wage dummy variable was dropped from the income earners model and the income dummy variable dropped from the wage earners model. The results of the two estimated models are presented in Appendix D. Although variables with statistically significant marginal effects in one of the three models were not necessarily significant in the other two models, when variables had statistically significant marginal effects in more than one model, the marginal effects for the significant variables had the same sign.

purchasing and consuming the hypothetical cheddar cheese, while being exposed to the health impacts of hypertension and having an adult in the household who earns an hourly wage above $20 increases the probability of purchasing and consuming the hypothetical cheddar cheese.

Table 4.6 Comparison of expected marginal effect sign and empirical results for experimental parameters in experiment one

Variable	Expected Sign	Empirical Result
PRICE	-	-
EFFLOW	-	+
EFFHIG	+	-
HLOSS	+	+*
INCMT65	0	+
WAGEMT20	-	+***
* Denotes significance at the ten percent level *** Denotes significance at the one percent level		

Control Variables

The marginal effects for HBP_SELF, HBP_OTHER and HBP_FAMHIS were statistically insignificant, suggesting that past experience with high blood pressure diagnosis does not impact the intention to purchase and consume the hypothetical cheddar. REDUCE_SALT and SPECIFIC_ACTIONS had positive marginal effects and QUIT_NICOTINE had a negative marginal effect, however only REDUCE_SALT was statistically significant (at the 10 percent level). These results suggest that quitting the use of products containing nicotine and undertaking specific actions to avert and/or manage high blood pressure had no impact on the intention to purchase and consume the hypothetical cheddar. The statistically significant positive marginal effect for REDUCE_SALT suggests that individuals who reduced salt in the past year to avert and/or manage high blood pressure were more likely to purchase the hypothetical cheddar cheese than individuals who had not reduced salt in the previous year. This result may provide some evidence of an offsetting effect as cheese is one of the top ten sources of sodium (Statistics Canada 2007) and a major source of fat (Garriguet 2007) in Canadian diets. That is, the benefit of the hypothetical cheddar consumption may be offset by increased salt consumption. Also individuals may use the hypothetical cheddar cheese consumption as a rationale to not limit salt intake.

PEFF_LIMITSALT and PEFF_ACTIONS had positive marginal effects while PEFF_SMOKEALCO had a negative marginal effect, however, only PEFF_LIMITSALT was statistically significant from zero (at the 10 percent level). These results suggest that a change in the perceived effectiveness of undertaking specific health behaviours or quitting smoking and limiting consumption of alcohol to avert and/or manage hypertension had no impact on the intention to purchase and consume the hypothetical cheddar cheese. The positive marginal effect for PEFF_LIMITSALT suggests that as the perceived effectiveness of limiting salt to reduce the risk of developing high blood pressure increases, an individual is more likely to purchase and consume a cheddar cheese developed to reduce the risk of hypertension. Although it does not suggest an offsetting effect as the positive and statistically significant marginal effect for REDUCE_SALT does, the positive and statistically significant marginal effect PEFF_LIMITSALT is interesting as individuals were more likely to indicate that they would purchase and consume a cheddar cheese as their perceived effectiveness of limiting salt to avert and/or manage hypertension increases. This is interesting as cheese is a major source of sodium in Canadian diets (Statistics Canada 2007). These results may be because individuals are not aware of the sodium content in cheddar cheese and/or may consider the hypothetical cheddar as a complement to a low-salt diet.

Both RISK and VULNER had positive marginal effects and were statistically significant at the one percent and five percent levels respectively. These results suggest that an individual is more likely to purchase and consume a cheddar cheese developed to reduce the risk of hypertension as his or her perceived risk of or perceived importance of vulnerability towards hypertension increases. These results make intuitive sense as individuals who believe that they are at a higher risk for hypertension than average and/or places importance on being vulnerable to high blood pressure may be more likely to undertake behaviours to reduce the risk of developing or their vulnerability towards high blood pressure.

Of the demographic variables included in the estimation, only A3039 (at the 10 percent level) and TRADES (at the five percent level) were statistically significant, which suggests that, for the most part, demographics did not impact the intention to purchase and consume the hypothetical cheddar. Relative to females, males were less likely to purchase and consume the hypothetical cheddar, although this result was not statistically significant. This result coincides with previous studies investigating functional foods acceptance in Canada that found no impact of gender on acceptance (Labreque et al 2006; Peng et al 2006).

The age dichotomous variables were relative to the omitted group of those between the ages of 40 and 49. Those aged 20 to 29 (A2029) and those aged 50 to 69 (A5059 and A6069) were more likely than the omitted age group to purchase and consume the cheddar cheese developed to reduce the risk of hypertension, although these results were not statistically significant. The marginal effect for A3039 was negative and statistically significant at the 10 percent level suggesting that those aged 30 to 39 were less likely than those aged 40 to 49 to purchase and consume the hypothetical cheddar. Relative to those aged 40 to 49, those aged 30-39 are in a lower risk group for hypertension which may explain the negative marginal effect (National Health Lung and Blood Institute n.d.).

Relative to those whose highest level of education completed was high school, those with less than a high school education (LESSHS) were more likely to purchase and consume the hypothetical cheddar, while those who had completed an education level higher than high school (TRADES, COLLEGE, UNIV) were less likely to purchase and consume the hypothetical cheddar cheese. However, only the marginal effect for TRADES was statistically significant from zero (at the five percent level). Previous studies investigating acceptance of functional foods in Canada have found little impact of education level on acceptance (Peng et al 2006; Henson et al 2008). The constant was negative and statistically significant at the one percent level.

4.3.2 Offsetting Behaviour

The hypothetical product used in experiment one, a cheddar cheese developed to reduce the risk of hypertension, was conducive to investigating the possibility of one form of offsetting behaviour and addressing the third objective of this study. Offsetting behaviour would occur if a respondent indicated that he or she would increase total consumption of cheddar cheese following the purchase and consumption of the hypothetical cheddar cheese. An increase in total cheddar cheese consumption could exacerbate hypertension because of its sodium content (Statistics Canada 2007). It also could lead to other health problems because of its fat content as cheese is one of the top sources of fat in Canadian diets (Garriguet 2007). Of the 191 responses to the survey question that asked if they would consume the hypothetical cheddar cheese, 131 responded "Yes" and 78 responded "No" and "Don't know".

To address the third objective of this study, that is, to investigate whether addition of a functional ingredient to a food leads to increased overall consumption of that food, two questions were included in the experiment one survey to investigate cheddar cheese consumption following purchase and consumption of the hypothetical cheddar. The first question asked the frequency with which an individual would consume the hypothetical cheddar cheese, the results of which were compared to the frequency of cheese consumption indicated by members in previous Guelph Food Panel surveys (Figure 4.1). However, the difficulty in comparing the frequency of cheese consumption by Food Panel members across surveys is that for surveys completed in July 2008 (July 2008 in Figure 4.1) and January to February 2009 (Jan-Feb 2008 and Jan-Feb 2009 in Figure 4.1) the questions asked were revealed preference for frequency of cheese consumption, while for the experiment one survey (Experiment 1 Survey in Figure 4.1) the question was stated preference for the frequency of consumption of a hypothetical cheddar cheese developed to reduce the risk of hypertension. Although comparing the indicated frequency of cheese consumption across surveys does not inform the question of whether the respondent would increase (cheddar) cheese consumption, it does show that Food Panel members who responded to the experiment one survey were less likely to consume the hypothetical cheddar cheese rarely and more than four times per week and more likely to consume the hypothetical cheddar from a few times per month to two or three times per week relative to cheese consumption in general.

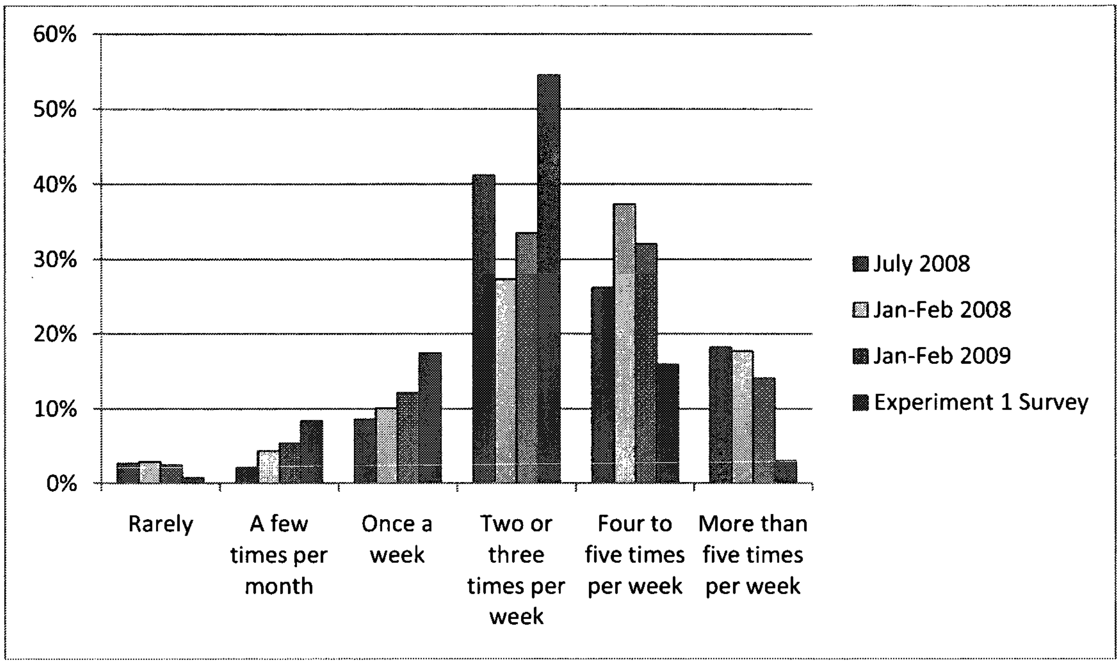

Figure 4.1 Frequency of cheese consumption

As the frequency of cheese consumption was not directly comparable across surveys, a second question in the experiment one survey asked respondents if their total cheddar cheese consumption would increase, decrease, or stay the same following the purchase and consumption of the hypothetical cheddar cheese. Of the 132 individuals who responded to this question, 23 percent (n=31) indicated that their total cheddar cheese consumption would increase, five percent (n=6) indicated that their total cheddar cheese consumption would decrease and 72 percent (n=95) indicated that their total cheddar cheese consumption would stay the same. The fact that a non-trivial number of respondents indicated that their total cheddar cheese consumption would increase following the purchase and consumption of the hypothetical cheddar provided motivation for an empirical investigation of the probability of increasing total cheddar cheese consumption.

The decision to increase total cheddar cheese consumption following the purchase and consumption of a cheddar cheese developed to reduce the risk of developing hypertension is not a random outcome and depends on the probability of purchasing and consuming the hypothetical cheddar. Estimating the probability of increasing total cheddar consumption without taking into account the fact that it is a not a random outcome could lead to sample selection bias. There are two estimation methods to account for potential sample selection bias: two-step and maximum likelihood (Heckman 1976). Following previous studies that estimated a probit model with sample selection (see for example Van de Ven and Van Praag 1981; Boyes et al 1989), the maximum likelihood method is used in the present study.

The estimated regressions coefficients and marginal effects for a probit model investigating the probability of increasing total cheddar consumption corrected for sample selection (i.e. maximum likelihood) and an uncorrected probit model, estimated in STATA 9, are presented in Table 4.7. The uncorrected model was estimated with White's heteroskedastic-consistent standard errors[11]. The variables in the two INCREASE models differed from the UNDERTAKE model. During estimation WAGEMT20, A2029 and LESSHS were dropped as they predicted failure perfectly. To investigate the impact of a change in the wage rate on the decision to increase total cheddar cheese consumption, another dichotomous variable was created and included in the estimation: WAGEMT25

[11] Note that the estimated parameters for corrected model in Table 4.7 were not estimated with robust standard errors. When estimated with robust standard errors the Wald test variable was not available. Estimated parameter significance and signs when significant did not change when estimated with robust standard errors and the Wald test that there is no sample selection problem is rejected at the five percent level.

with a value of one if at least one member in the household earns an hourly wage greater than $25, zero otherwise. To account for the impact of age, AGT40 was created and took a value of one if the respondent is between the ages of 40-69 and zero if the respondent is between the ages 20-39. To account for the impact of education, MTHS was created which took a value of one if the respondent has completed more than high school, zero otherwise. The variable INCR_FREQ, which took a value of one if the respondent's frequency of cheddar cheese consumption increased in the past two years, zero otherwise, was included in the INCREASE probit model. INCR_FREQ was included to examine how past cheddar cheese consumption influenced the decision to increase total cheddar cheese consumption following the purchase and consumption of the hypothetical cheddar. The hypertension diagnosis variables (HBP_SELF, HBP_OTHER, HBP_FAMHIS) were also not included in the INCREASE model as exclusion criteria to identify the UNDERTAKE probit model from the INCREASE probit model.

A joint Wald test that the estimated parameters are simultaneously equal to zero was rejected at the one percent level of significance for the corrected model and the ten percent level for the uncorrected model suggesting that the estimated models have explanatory power. A Lagrange multiplier test that there is no sample selection problem in the corrected model was rejected at the five percent level of significance but not at the one percent level suggesting that there may be statistically significant sample selection in the model. The predicted probability of increasing total cheddar cheese consumption was eight percent in the corrected model and sixteen percent in the uncorrected model suggesting that the purchase and consumption of the hypothetical cheddar cheese consumption may lead to increased total cheddar cheese consumption.

Table 4. 7 Probit regression coefficients and marginal effects for the decision to increase total cheddar cheese consumption (standard errors in parentheses)

	Corrected for sample selection		Not corrected for sample selection	
Variable	**Regression Coefficient**	**Marginal Effect**	**Regression Coefficient**	**Marginal Effect**
Experimental Parameters				
PRICE	-0.0006 (0.3666)	-0.0001 (0.0540)	0.1900 (0.4252)	0.0461 (0.1031)
EFFLOW	-0.1015 (0.3430)	-0.0146 (0.0483)	-0.0388 (0.3900)	-0.0094 (0.0937)
EFFHIG	-0.3068 (0.3937)	-0.0416 (0.0473)	-0.3318 (0.4091)	-0.0751 (0.0873)
HLOSS	**0.5914** (0.2950)**	**0.1047* (0.0597)**	**0.5994* (0.3120)**	**0.1615* (0.0869)**
INCMT65[a]	**0.6804** (0.3041)**	**0.1168** (0.0545)**	**0.6596* (0.3561)**	**0.1749* (0.1002)**
WAGEMT25[a]	0.5589 (0.3736)	0.1050 (0.0862)	0.5921 (0.4259)	0.1693 (0.1400)
Control Variables				
REDUCE_SALT	0.4108 (0.4411)	0.0544 (0.0531)	0.4047 (0.3802)	0.0867 (0.0708)
SPECIFIC_ACTIONS	0.2201 (0.4901)	0.0304 (0.0629)	0.0038 (0.5013)	0.0009 (0.1215)
QUIT_NICOTINE	0.2584 (0.6180)	0.0447 (0.1231)	0.3776 (0.8155)	0.1068 (0.2622)
PEFF_LIMITSALT	-0.0637 (0.2148)	-0.0094 (0.0318)	-0.1238 (0.2451)	-0.0301 (0.0586)
PEFF_ACTIONS	0.0230 (0.2377)	0.0034 (0.0350)	0.0310 (0.2519)	0.0075 (0.0612)
PEFF_SMOKEALCO	-0.0290 (0.1230)	-0.0043 (0.0182)	-0.0425 (0.1423)	-0.0103 (0.0347)
RISK	0.1426 (0.0983)	0.0210 (0.0148)	0.0899 (0.1026)	0.0218 (0.0242)
VULNER	-0.0516 (0.1090)	-0.0076 (0.0162)	-0.0811 (0.1085)	-0.0197 (0.0260)
MALE	**-1.0696*** (0.3642)**	**-0.1321*** (0.0358)**	**-1.3019*** (0.4075)**	**-0.2506*** (0.0614)**
AGT40	**0.7528* (0.3880)**	**0.0909** (0.0384)**	**0.7389* (0.4072)**	**0.1423* (0.0664)**
MTHS	0.0880 (0.3156)	0.0125 (0.0431)	0.0462 (0.3743)	0.0111 (0.0882)
INCR_FREQ	0.3792 (0.4042)	0.0688 (0.0858)	0.4725 (0.5458)	0.1358 (0.1787)

RHO	1 (2.96e-09)			
/atRHO	13.7395 (635.5866)			
Constant	**-5.1907**** **(2.6346)**		-2.1619 (3.2736)	
	Observations: 189 Censored observations: 78 Uncensored observations: 111 Wald chi^2 (19 df): 16783.15*** Log pseudolikelihood: -143.0688 Probability (INCREASE=1): 0.0790		Observations: 113 Wald chi^2 (19 df): 28.00* Log pseudolikelihood: -48.3246 Pseudo R^2: 0.1908 Observed probability: 0.2212 Predicted probability (at mean): 0.1596	
a. Not varied experimentally * Denotes significance at the ten percent level ** Denotes significance at the five percent level *** Denotes significance at the one percent level				

Experimental Parameters

Unlike the UNDERTAKE probit model, there were no a priori expected signs for the estimated coefficients of the INCREASE probit models. Similar to the UNDERTAKE model, the marginal effects for PRICE, EFFLOW and EFFHIG were not statistically significant from zero in either model suggesting that price and effectiveness do not impact the decision to purchase and consume the hypothetical cheddar cheese or the decision to increase total cheddar cheese consumption. The marginal effect for HLOSS was positive and statistically significant at the 10 percent level in both models suggesting that being presented with the health impacts of hypertension increases the probability of increasing total cheddar cheese consumption. This may be because being presented with the health impacts of hypertension also increased the probability of purchasing and consuming the hypothetical cheddar cheese. The marginal effect for INCMT65 was positive and statistically significant at the five percent level in the corrected model and at

10 percent level in the uncorrected model, suggesting that having an annual household income above $65,000 increased the probability of increasing total cheddar cheese consumption. WAGEMT25 was not statistically significant from zero in either model suggesting that changes in the wage rate did not impact the decision to increase total cheddar consumption while changes in salaried income did impact the decision. This result is opposite of what was predicted for the decision to undertake the averting behaviour, where a change in income was expected to have no impact.

Control Variables

The marginal effects for REDUCE_SALT, SPECIFIC_ACTIONS and QUIT_NICOTINE were all positive in both models, however none were statistically significant. These results suggest that quitting the use of products containing nicotine, undertaking specific behaviours to avert and/or manage high blood pressure and reducing salt intake in the past year had no impact on the intention to increase total cheddar consumption The marginal effects for PEFF_LIMITSALT, PEFF_ACTIONS and PEFF_SMOKEALCO were not statistically significant in either model suggesting that increases in the perceived effectiveness of antihypertensive averting behaviours did not impact the decision to increase total cheddar consumption. The marginal effects for RISK and VULNER were also not statistically significant in either model, suggesting that an increase in the perceived risk of hypertension or in the perceived importance of vulnerability to hypertension had no impact on the decision to increase cheddar cheese consumption.

MALE had a negative marginal effect which was significant at the one percent level in both models suggesting that males are less likely than females to increase total cheddar cheese consumption. This result is not surprising as women are more likely than men to consume cheddar in Canada (Agriculture and Agri-food Canada 2007). AGT40 had a positive marginal effect which was significant at the five percent level in the corrected model and at the ten percent level in the uncorrected model, which suggests that those aged between 40 and 69 are more likely to increase cheddar cheese consumption relative to those under aged 20 to 39. The marginal effect for MTHS was not statistically significant in either model suggesting that those who had completed more than high school were no more likely to those who had completed high school or less to increase total cheddar consumption. The marginal effect for INCR_FREQ was not statistically significant in either model suggesting that those who had increased their frequency of cheddar cheese consumption in the past two years were no more likely than those who had not to increase total cheddar cheese consumption.

4.3.3 Discussion of Experiment One Results

The primary objective of experiment one was to test the hypotheses derived in the one-behaviour analytical framework, which were transformed into empirical hypotheses in the preceding chapter. The empirical results provided some support for two of the hypotheses, namely that exposure to the size of loss or health impacts of illness increases the probability of undertaking an averting behaviour to avert that illness and that a change in salaried or non-labour income has no impact on the probability of undertaking an averting behaviour. However, the marginal effect for a change in salaried or non-labour income was not statistically significant. The empirical analysis refuted the hypotheses that an increase in price decreases the probability of undertaking an averting behaviour and that an increase in the effectiveness of an averting behaviour increases the probability of undertaking it; there was no empirical support that either experimental parameter influences the decision to undertake an averting behaviour. The empirical analysis also refuted the hypothesis that an increase in the wage rate decreases the probability of undertaking an averting behaviour as the empirical analysis found the opposite result. The result that an increase in the wage rate increases the probability of undertaking an averting behaviour can be explained by assuming that health is a normal good.

An increase in one's perceived risk or perceived importance of vulnerability towards hypertension increased the probability that an individual would purchase and consume the hypothetical cheddar. The empirical results for the control variables also provided some evidence of an offsetting effect as respondents who indicated that they had reduced salt intake in the past year were more likely to purchase and consume the hypothetical cheddar cheese, which is a source of sodium. The probability of purchasing and consuming the hypothetical cheddar cheese also increases as a respondents' perceived effectiveness of limiting salt to avert and/or manage hypertension increases.

There is some evidence to suggest that purchasing and consuming the hypothetical cheddar cheese could lead to increased cheddar cheese consumption, with being exposed to health impacts of hypertension, being female and being over 40 increasing the probability of increasing total cheddar cheese consumption. This result provides some evidence of offsetting behaviour in the form of increased consumption which suggests that the benefits of a functional food, such as the hypothetical cheddar, could potentially be offset. However, the probability of offset was low.

The second experiment builds on the first experiment by investigating what factors influence the decision to undertake a second averting behaviour. It also investigates whether adopting a second averting behaviour induces an individual to discontinue the original averting behaviour.

4.4 EXPERIMENT TWO

A probit model was estimated to investigate how relative prices, relative effectiveness, salaried or non-labour income, wage rate, degree of substitutability, utility, demographic variables and hypertension-specific variables influence the decision that a hypothetical third-person should purchase and consume a cheddar cheese developed to reduce the risk of developing high blood pressure given that he or she is already minimizing salt consumption. Summary statistics and descriptions of the dependent and independent variables in the model are presented in Table 4.8.

Table 4.8 Description of and summary statistics for dependent and independent variables included in the experiment two probit model

Variable	Description	N	Mean	Std. Dev.
UNDERTAKE2	1 if respondent thinks third-person should purchase and consume hypothetical cheddar cheese, 0 otherwise	166	0.3554	0.4801
LTWC	1 if respondent presented with treatment where hypothetical cheddar cheese is less than the weekly cost of minimizing salt intake, 0 otherwise	166	0.5120	0.5014
MTWC	1 if respondent presented with treatment where hypothetical cheddar cheese is more than the weekly cost of minimizing salt intake, 0 otherwise	166	0.2771	0.4489
MOREEFF	1 if respondent presented with treatment containing where hypothetical cheddar cheese is more effective than simply limiting salt intake, 0 otherwise	166	0.5181	0.5012
MICHAEL	1 if hypothetical third-person is a male, 0 otherwise	166	0.5602	0.4979
LESSSAT	1 if individual presented with a treatment where hypothetical cheddar cheese is less satisfying than conventional cheddar cheese, 0 otherwise	166	0.5482	0.4992
MORESAT	1 if individual presented with treatment where hypothetical cheddar cheese is less satisfying than conventional cheddar cheese, 0 otherwise	166	0.2108	0.4091
SUBS	1 if cheddar cheese and minimizing salt intake are substitutes, zero otherwise	166	0.4940	0.5015
INCMT65	1 if respondent had an annual household income of $65,000 or more in 2008 and no one in household earned an hourly wage, 0 otherwise Expected sign: 0	166	0.2771	0.4489

WAGEMT25	1 if an adult in respondent's household earned an hourly wage above $25, 0 otherwise	166	0.1687	0.3756
WAGELT19	1 if an adult in respondent's household earned an hourly wage below $19, 0 otherwise	166	0.2710	0.4459
HBP_SELF	1 if respondent has ever been diagnosed with high blood pressure, 0 otherwise	166	0.2470	0.4326
HBP_OTHER	1 if respondent has a friend or family member that has been diagnosed with high blood pressure, 0 otherwise	166	0.8012	0.4003
HBP_FAMHIS	1 if respondent has a family history of high blood pressure, 0 otherwise	166	0.4036	0.4921
MALE	1 if respondent is male, 0 if the respondent is female	166	0.2771	0.4489
A2029	1 if respondent is between the ages of 20 and 29, 0 otherwise	166	0.0903	0.2876
A3039	1 if respondent is between the ages of 30 and 39, 0 otherwise	166	0.1807	0.3860
A5059	1 if respondent is between the ages of 50 and 59, 0 otherwise	166	0.3133	0.4651
A6069	1 if respondent is between the ages of 60 and 69, 0 otherwise	166	0.1867	0.3909
LESSHS	1 if respondent has completed less than high school, 0 otherwise	166	0.0120	0.1094
TRADES	1 if respondent has completed trades certificate or diploma, 0 otherwise	166	0.0663	0.2945
COLLEGE	1 if respondent has completed college, 0 otherwise	166	0.1687	0.3756
UNIV	1 if respondent has completed university, 0 otherwise	166	0.4819	0.5012
RISK[a]	Perceived risk of developing hypertension compared to average person	166	3.7590	1.5578
VULNER[b]	Perceived importance of being vulnerable to high blood pressure	166	5.0301	1.4540
LIMIT	1 if respondent limited consumption in past year to avert and/or manage hypertension, 0 otherwise	166	0.8313	0.3756
DOING	1 if respondent undertook a behaviour in the past year to avert and/or manage hypertension, 0	166	0.6867	0.4652

	otherwise			
QUIT	1 if respondent quit smoking or use of nicotine products in past year to avert and/or manage hypertension, 0 otherwise	166	0.0602	0.2387
PEFF_SMOKEALCO[c]	Perceived effectiveness of limiting smoking and alcohol to avert and/or manage hypertension	166	5.6819	1.0212
PEFF_DIET[c]	Perceived effectiveness of undertaking dietary measures to avert and/or manage hypertension	166	5.6566	0.9837
PEFF_LIMITSALT[c]	Perceived effectiveness of limiting salt intake to avert and/or manage hypertension	166	5.8479	0.7938

a. Measured on a seven-point scale from 'Extremely Low' (1) to 'Extremely High' (7)
b. Measured on a seven-point scale from 'Extremely Unimportant' (1) to 'Extremely Important' (7)
c. Measured on a seven-point scale from 'Not at all effective' (1) to 'Extremely effective' (7)

Dependent Variable

The dichotomous dependent variable, UNDERTAKE2, is the decision that a hypothetical third-person should purchase and consume a cheddar cheese developed to reduce the risk of hypertension, given that he or she is already minimizing salt intake. Respondents were presented with a script describing the hypothetical third-person, his or her current low-salt diet and the cheddar cheese developed to reduce the risk of hypertension and were asked 'should (the hypothetical third-person) purchase and consume the cheddar cheese developed to reduce the risk of hypertension?' measured on a three-point scale as follows: 'Yes' (1), 'No' (2) and 'Don't know' (3). For the UNDERTAKE2 model, responses were converted into a dichotomous variable with a value of one if the respondent indicated that the third-person should purchase and consume the cheddar cheese developed to reduce the risk of hypertension and zero otherwise.

Experimental Parameters

A series of dichotomous variables were created to investigate the impact of changes in the experimental parameters (i.e. the exogenous variables in the two-behaviour analytical framework) on the decision that a third-person, who is currently minimizing his or her salt intake, should purchase and consume the hypothetical cheddar. Two dichotomous variables were created to investigate the impact of relative prices between the hypothetical cheddar cheese and minimizing salt intake. The two dichotomous variables were relative to the omitted group of respondents presented with a treatment where consuming the hypothetical cheddar cheese had the same weekly cost as following a low-salt diet: LTWC with a value of one if the hypothetical cheddar cheese is less than the weekly cost of a low-salt diet, zero otherwise; and MTWC with a value of one if the hypothetical cheddar cheese is more than the weekly cost of a low-salt diet, zero otherwise.

To capture the effect of relative effectiveness on the decision that a third-person should purchase and consume the hypothetical cheddar, the variable MOREEFF was created with a value of one is the respondent was presented with a treatment where the hypothetical cheddar cheese was more effective than minimizing salt intake, zero if the respondent was presented with a treatment where the hypothetical cheddar cheese was as effective as minimizing salt intake. Two dichotomous variables were created to capture the impact of the utility/disutility of the hypothetical cheddar in comparison to conventional cheddar cheese: LESSSAT which took a value of one if the respondent was presented with a treatment where the new cheddar cheese is less satisfying than conventional cheddar cheese, zero otherwise; and MORESAT which took value of one if the respondent was presented with a treatment where the new cheddar cheese is more satisfying than conventional cheddar cheese, zero otherwise. The two utility dichotomous variables are relative to the omitted group of respondents who were presented with treatments where the hypothetical cheddar cheese was as satisfying as conventional cheddar cheese.

The dichotomous variable SUBS took a value of one if the respondent was presented with a treatment where the hypothetical cheddar cheese was recommended to be consumed instead of a low-salt diet and zero if the respondent was presented with a treatment where the hypothetical cheddar was recommended to be consumed in addition to a low-salt diet. In the third-person script the phrase 'in addition to' was used to signify that the two averting behaviours were complements and the phrase 'instead of' was used in experimental treatments where the two averting behaviours were substitutes. The variable MICHAEL took a value of one if the respondent was presented with a treatment where the hypothetical person was male, zero if the hypothetical third-person was female.

Similar to the first experiment, non-labour or salaried income and the wage rate were not varied experimentally but rather treated like control variables. The household income and wage rate questions included in the experiment two survey were identical to those in the experiment one survey. Again, similar to the first experiment, households with wage-earners were separated from households with only income earners and two dichotomous variables created. INCMT65 took a value of one if the respondent had a household income of $65,000 or more in 2008 and no adult in the household earned a wage, zero otherwise. WAGEMT20 took a value of one if at least one adult in the household earned an hourly wage exceeding $20, zero otherwise. In the original estimation of the UNDERTAKE2 probit model, WAGEMT20 was dropped as it predicted failure perfectly and consequently two dichotomous variables were created to address this issue: WAGEMT25 with a value of one if at least one member in the household earns an hourly wage greater than $25, zero otherwise and WAGELT19 with a value of one if at least one member in the household earns an hourly wage less than $19.99, zero otherwise. The two wage variables are relative to the omitted group of households where at least one adult earned an hourly wage between $20 and $24.99.

Control Variables

The variables LIMIT, DOING and QUIT capture averting behaviours the respondent has undertaken in the past year to reduce the risk of developing and/or manage high blood pressure. Respondents were presented with a list of 16 different behaviours and asked what behaviours they had undertaken in the past year to avert and/or manage hypertension. Principal component analysis using VARIMAX rotation was employed to identify underlying constructs. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.86. Bartlett's test of sphericity, distributed as a chi-squared with 120 degrees of freedom, was statistically significant at the one percent level, rejecting the null hypothesis that the variables are not interrelated. Three factors had eigenvalues exceeding one. Dichotomous variables were created for measures of if the individual had undertaken a limiting behaviour in the past year (LIMIT), if the individual had undertaken a behaviour that was not a limiting behaviour in the past year (DOING), or if the individual had quit the use of products containing nicotine (QUIT), which had Cronbach's alpha values of 0.87, 0.73 and 0.66 respectively suggesting acceptable levels of internal reliability. The rotated factor loadings matrix is presented in Table 4.9.

Although identical questions regarding behaviours undertaken in the past year to avert and/or manage hypertension were included in the experiment one and experiment two surveys, the variables factored differently. In both experiments, the behaviours relating to quitting smoking and the use of nicotine products factored together. Additionally, all variables relating to limiting salt consumption factored together, although in the second experiment other variables factored with the limiting salt consumption variables.

Table 4.9 Experiment two rotated factor loadings matrix for averting behaviours undertaken in the past year to reduce the risk of developing and/or to manage high blood pressure

Variable	LIMIT	DOING	QUIT
Avoid foods containing high levels of salt	**0.8197**	0.1227	-0.022
Limit the amount of salt added at the table	**0.7813**	0.0971	0.0522
Limit consumption of foods containing high levels of saturated fat	**0.7403**	0.3383	-0.0294
Limit the amount of salt added while cooking	**0.7384**	0.302	0.1229
Avoid foods containing trans fat	**0.6993**	0.2619	0.0419
Buy and eat processed foods with low salt or sodium labels	**0.6416**	-0.0461	-0.0112
Reduce exposure to second-hand smoke	**0.5489**	0.0704	0.3884
Did not do anything	**0.5423**	0.3583	0.0141
Engage in regular physical activity	0.1567	**0.7981**	0.0489
Lose weight	0.0123	**0.6501**	0.1959
Consume the daily recommended intake of whole grains and cereals	0.4187	**0.6321**	-0.0697
Consume the daily recommended intake of fruits and vegetables	0.4289	**0.6111**	-0.0399
Quit the use of products containing nicotine	0.0727	0.1335	**0.8454**
Quit smoking	-0.0294	-0.0794	**0.8368**
Limit consumption of alcohol	0.3973	0.3321	0.2713
Reduce stress	02935	0.4119	-0.008
Eigenvalue	5.7988	1.6348	1.3502
Cronbach's alpha	0.8727	0.7337	0.6821
Percent of variation explained by each factor	0.2816	0.1607	0.1067
KMO	0.8631		
Bartlett's test of sphericity	1241.13 (chi-squared with 120 df) Statistically significant at the one percent level		

The variables PEFF_SMOKEALCO, PEFF_DIET and PEFF_LIMITSALT capture the perceived effectiveness of health behaviours that help to reduce the risk of developing and/or to manage high blood pressure. Respondents were provided with a list of 15 different behaviours and asked to rate the effectiveness of each of the behaviours in averting and/or managing hypertension on a seven-point scale from 'Not at all effective' (1) to 'Extremely effective' (7). Principal component analysis using VARIMAX rotation was employed to identify underlying constructs. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.87. Bartlett's test of sphericity, distributed as a chi-squared with 105 degrees of freedom, was statistically significant at the one percent level, rejecting the null hypothesis that the variables are not interrelated. Three factors had eigenvalues exceeding one. Multi-item scales for developed for each of the constructs as measures of the perceived effectiveness of quitting smoking and limiting consumption of alcohol (PEFF_SMOKEALCO), the perceived effectiveness of dietary measures (PEFF_DIET) and the perceived effectiveness of limiting salt (PEFF_LIMITSALT) which had Cronbach's alpha values of 0.85, 0.88 and 0.82 respectively, suggesting high levels of internal reliability. The rotated factor loadings matrix is presented in Table 4.10

Similar to the factor analysis undertaken on the list of 16 behaviours, the perceived effectiveness of 15 different behaviours factored differently in the second experiment than in the first experiment. The perceived effectiveness of the four behaviours relating to limiting salt consumption factored identically in the first and second experiments. PEFF_SMOKEALCO contained one additional variable in the second experiment, the perceived effectiveness of reducing stress. The difference between PEFF_ACTIONS in the first experiment and PEFF_DIET in the second experiment is that PEFF_DIET does not contain the perceived effectiveness of regular physical activity. The exclusion of the physical activity variable changed the interpretation of the factor as in the second experiment all the variables that loaded on PEFF_DIET were dietary behaviours.

Table 4.10 Experiment two rotated factor loadings matrix for perceived effectiveness of averting behaviours that help to reduce the risk of developing and/or to manage high blood pressure

Variable	PEFF_ SMOKEALCO	PEFF_ ACTIONS	PEFF_ LIMITSALT
Perceived effectiveness of quitting smoking	**0.8276**	0.2365	0.0259
Perceived effectiveness of quitting the use of products containing nicotine	**0.8039**	0.2857	0.1610
Perceived effectiveness of reducing exposure to second-hand smoke	**0.7738**	0.2372	0.1556
Perceived effectiveness of limiting consumption of alcohol	**0.5918**	0.3817	0.2269
Perceived effectiveness of reducing stress	**0.5732**	0.2511	0.224
Perceived effectiveness of consuming the daily recommended intake of fruits and vegetables	0.2410	**0.7978**	0.1488
Perceived effectiveness of limiting consumption of foods containing high levels of saturated fat	0.2394	**0.7885**	0.2820
Perceived effectiveness of consuming the daily recommended intake of fruits and vegetables	0.3213	**0.7884**	0.1190
Perceived effectiveness of avoiding foods containing trans fat	0.2263	**0.7703**	0.2671
Perceived effectiveness of avoiding foods containing high elves of salt	0.1485	0.2030	**0.8493**
Perceived effectiveness of limiting the amount of salt added while cooking	0.0693	0.2496	**0.8394**
Perceived effectiveness of limiting the amount of salt added at the table	0.1440	0.1402	**0.8143**
Perceived effectiveness of buying and eating processed foods with low salt or sodium labels	0.1442	0.1066	**0.5960**
Perceived effectiveness of engaging in regular physical activity	0.3500	0.2523	0.3051
Perceived effectiveness of losing weight	0.4653	0.3732	0.2759
Eigenvalue	6.5945	1.7860	1.0718
Cronbach's alpha	0.8498	0.8753	0.8188
Percent of variation explained by each factor	0.2191	0.2142	0.1969
KMO	0.8713		
Bartlett's test of sphericity	1416.399 (chi-squared with 105 df)		

	Statistically significant at the one percent level

The demographic variables MALE, A2029, A3039, A5059. A6069, LESSHS, TRADES, COLLEGE and UNIV included in the UNDERTAKE model were also included in the UNDERTAKE2 model. The hypertension-related variables HBP_SELF, HBP_OTHER, HBP_FAMHIS, RISK and VULNER were also included in the UNDERTAKE2 model.

The estimated model for experiment two took the following form, where the decision that a third-person should purchase and consume the hypothetical cheddar cheese or the probability of the respondent indicated that a third-person should purchase and consume the hypothetical cheddar (i.e. UNDERTAKE2=1) is a function of the experimental parameters, hypertension experience variables, psychographic variables and demographics:

$$
\begin{aligned}
\text{Prob (UNDERTAKE2=1)} = \beta_1 &+ \beta_2\text{LTWC} + \beta_3\text{MTWC} + \beta_4\text{MOREFF} + \beta_5\text{MICHAEL} \\
&+ \beta_6\text{LESSSAT} + \beta_7\text{MORESAT} + \beta_8\text{SUBS} + \beta_9\text{INCMT65} \\
&+ \beta_{10}\text{WAGEMT25} + \beta_{11}\text{WAGELT19} + \beta_{11}\text{HBP\_SELF} \\
&+ \beta_{13}\text{HBP\_OTHER} + \beta_{14}\text{HBP\_FAMHIS} + \beta_{15}\text{LIMIT} \\
&+ \beta_{16}\text{DOING} + \beta_{17}\text{QUIT} + \beta_{18}\text{PEFF\_SMOKEALCO} \\
&+ \beta_{19}\text{PEFF\_DIET} + \beta_{20}\text{PEFF\_LIMITSALT} + \beta_{21}\text{RISK} \\
&+ \beta_{22}\text{VULNER} + \beta_{23}\text{MALE} + \beta_{24}\text{A2029} + \beta_{25}\text{A3039} \\
&+ \beta_{26}\text{A5059} + \beta_{27}\text{A6069} + \beta_{28}\text{LESSHS} + \beta_{29}\text{TRADES} \\
&+ \beta_{30}\text{COLLEGE} + \beta_{31}\text{UNIV} + \varepsilon_i
\end{aligned}
\tag{4.2}
$$

4.4.1 Factors influencing the decision to undertake a second averting behaviour

The estimated regression coefficients and marginal effects for the experiment two probit model (equation 4.2) are presented in Table 4.11. The model was estimated in STATA 9 using White's heteroskedastic-consistent standard errors. The Pseudo R^2 for the model was 0.25 which is relatively high for cross-sectional data. A joint Wald test that the estimated parameters are simultaneously equal to zero was rejected at the one percent level of significance. The predicted probability of a respondent indicating that a third-person should purchase and consume the hypothetical cheddar cheese was 32 percent. As only five marginal effects were statistically significant, a variance inflation factor (VIF) analysis was performed to determine if multicollinearity may be driving the lack of significance. The largest VIF was 2.47 (PEFF_DIET), which suggests that multicollinearity is not a problem in the model and thus not driving the lack of significance.

Table 4.11 Probit regression coefficients and marginal effects for the intention to purchase and consume a cheddar cheese developed to reduce the risk of developing high blood pressure given that an individual is already minimizing salt intake (robust standard errors in parentheses)

Variable	Regression Coefficient	Marginal Effect
	Experimental Parameters	
LTWC	0.3594 (0.3013)	0.1277 (0.1054)
MTWC	-0.4800 (0.3604)	-0.1613 (0.1118)
MOREEFF	0.3698 (0.2465)	0.1313 (0.0867)
MICHAEL	-0.2418 (0.2422)	-0.0869 (0.0873)
LESSSAT	**-1.1864***** **(0.2738)**	**-0.4148***** **(0.0868)**
MORESAT	-0.0683 (0.3468)	-0.0242 (0.1215)
SUBS	0.0815 (0.2378)	0.0291 (0.0850)
INCMT65[a]	0.1094 (0.3116)	0.0396 (0.1137)
WAGEMT25[a]	0.2237 (0.3658)	0.0825 (0.1382)
WAGELT19[a]	0.4863 (0.3092)	0.1805 (0.1167)
	Control Variables	
HBP_SELF	0.3711 (0.3440)	0.1374 (0.1305)
HBP_OTHER	0.4123 (0.3368)	0.1375 (0.1033)
HBP_FAMHIS	-0.1593 (0.2449)	-0.0565 (0.0865)
LIMIT	0.1793 (0.3951)	0.0622 (0.1324)
DOING	-0.0465 (0.3208)	-0.0167 (0.1156)
QUIT	**-1.0752*** **(0.6320)**	**-0.2739*** **(0.0943)**
PEFF_SMOKEALCO	-0.0882 (0.1566)	-0.0316 (0.0562)
PEFF_DIET	0.1199 (0.1810)	0.0429 (0.0649)
PEFF_LIMITSALT	-0.1072 (0.1717)	-0.0383 (0.0613)

RISK	0.0026 (0.0863)	0.0009 (0.0309)
VULNER	-0.0273 (0.0967)	-0.0097 (0.0346)
MALE	0.0152 (0.2751)	0.0054 (0.0987)
A2029	-0.3972 (0.4663)	-0.1294 (0.1259)
A3039	**-0.6157*** **(0.3650)**	**-0.1953*** **(0.1020)**
A5059	-0.0016 (0.3448)	-0.0006 (0.1233)
A6069	-0.2912 (0.3682)	-0.0992 (0.1192)
LESSHS	1.1406 (1.0900)	0.4300 (0.3505)
TRADES	**0.9604*** **(0.5564)**	**0.3685*** **(0.2019)**
COLLEGE	-0.5138 (0.3743)	-0.1662 (0.1064)
UNIV	**-0.4567*** **(0.2779)**	**-0.1616*** **(0.0955)**
Constant	0.4445 (1.2054)	

Observations: 166
Wald chi^2 (30 df): 57.66***
Log pseudolikelihood: -80.8816
Pseudo R^2: 0.2513
Observed Probability: 0.3554
Predicted Probability (evaluated at the mean): 0.3202
a. Not varied experimentally
* Denotes significance at the ten percent level
** Denotes significance at the five percent level
*** Denotes significance at the one percent level

Experimental Parameters

The marginal effects for the variables included to account for cross-price and cross-effectiveness (LTWC, MTWC and MOREEFF) were not statistically significant, suggesting that relative prices and effectiveness do not impact the decision that a third-person should undertake a second averting behaviour[12]. Although the results for cross-price and cross-effectiveness are not directly comparable with the results for the impact of own-price and own-effectiveness from the first experiment, none of the variables included to account for prices and effectiveness were statistically significant, which suggests that prices and effectiveness do not impact the decision to undertake an averting behaviour.

The estimated coefficient for INCMT65 was not statistically significant from zero which provides support for the theoretical hypothesis that a change in salaried or non-labour income has no impact on the decision to undertake a second averting behaviour. The estimated coefficients and marginal effects for the two wage variables, WAGEMT25 and WAGELT19 were not statistically significant from zero suggesting that having an adult in the household who earns an hourly wage above $25 or below $19 does not impact the decision to indicate that a third-person should purchase and consume the hypothetical cheddar. This result contrasts with the result from the first experiment where having an adult in the household who earned an hourly wage above $20 increased the probability that an individual would purchase and consume the hypothetical cheddar. This suggests that the wage rate impacts whether an individual would undertake an averting behaviour but not whether an individual believes that a third-person should undertake a second averting behaviour.

[12] The UNDERTAKE2 probit model was also estimated with an absolute price variable both in addition to the relative price variables and instead of the relative price variables. The price of the hypothetical cheddar varied with the relative price and so the absolute price variable was dropped due to collinearity when included in addition to the relative price variables. When an absolute price variable was included instead of the relative prices variables, it had a negative marginal effect which was statistically significant at the one percent level. The absolute price variable was also interacted with the relative price variables and the interactions included in the estimation of the UNDERTAKE2 probit model, however, the estimated parameters for the interaction variables were not statistically significant nor did their inclusion change the significance of any of the other estimated parameters.

The marginal effect for the gender of the hypothetical third-person (MICHAEL) was not statistically significant from zero suggesting that it did not impact the decision that a third-person should purchase and consume the hypothetical cheddar. The estimated marginal effect for SUBS was also not statistically significant suggesting that being presented a treatment where the hypothetical cheddar cheese was recommended to be consumed instead of rather than in addition to a low-salt diet did not have an impact on the decision to indicate that a third-person should purchase and consume the hypothetical cheddar.

Of the 10 experimental parameters included in the UNDERTAKE2 model (including income and wage variables that were not varied experimentally), only LESSSAT was statistically significant (one percent). It had a negative marginal effect which suggests that individuals who were presented a treatment where the hypothetical cheddar cheese was less satisfying than conventional cheddar cheese, relative to being as satisfying as conventional cheddar cheese, were less likely to indicate that the third-person should purchase and consume the hypothetical cheddar. In contrast, the marginal effect for MOREEFF was not statistically significant suggesting that being presented a treatment where the hypothetical cheddar cheese was more satisfying than conventional cheddar cheese relative to being as satisfying as conventional cheddar cheese had no impact on the decision that a third-person should purchase and consume the hypothetical cheddar cheese. The results for the two variables to account for the utility of the hypothetical cheddar suggest that taste matters, particularly when a new product is liked less than its conventional counterpart.

Control Variables

Similar to the first experiment, the marginal effects for HBP_SELF, HBP_OTHER and HBP_FAMHIS were not statistically significant from zero. This suggests that experience with hypertension diagnosis had no impact on the decision that a third-person should purchase and consume the hypothetical cheddar.

The marginal effects for LIMIT and DOING were statistically insignificant while the marginal effect for QUIT was negative and statistically significant at the 10 percent level. These results suggests that those who had undertaken a limiting behaviour or a non-limiting behaviour in the past year were no more likely than those who had not to indicate that a third-person should purchase and consume the hypothetical cheddar while those who had quit smoking or the use of nicotine products in the past year were less likely to indicate that a third-person should purchase and consume the hypothetical cheddar. The results here contrast with the results of the first experiment where quitting smoking and/or the use of nicotine products had no impact on the decision to purchase and consume the hypothetical cheddar while limiting salt consumption had a positive impact on the probability of purchasing and consuming the hypothetical cheddar.

The marginal effects for PEFF_SMOKEALCO, PEFF_DIET and PEFF_LIMITSALT were all statistically insignificant. This suggests that changes in the perceived effectiveness of quitting smoking and limiting alcohol consumption, dietary measures and limiting salt to reduce to risk of developing and/or to manage hypertension had no impact on the decision that a third-person should purchase and consume the hypothetical cheddar. These results contrast with the results of first experiment, where PEFF_LIMITSALT contained identical variables and had a positive marginal effect.

The marginal effect for MALE was statistically insignificant suggesting that, similar to the first experiment, the gender of the respondent had no impact on the decision that a third-person should purchase and consume the hypothetical cheddar cheese. Relative to those aged 40 to 49, the marginal effects for A2029, A5059 and A6069 were statistically insignificant while the marginal effect for A3039 was negative and statistically significant at the 10 percent level. These results suggests that, with the exception of those aged between 30 and 39, the age of the respondent did not impact the decision that a third-person should purchase and consume the hypothetical cheddar. This result is similar to the first experiment where those aged 30 to 39 were less likely than those aged 40 to 49 to indicate that they personally would purchase and consume the hypothetical cheddar cheese, while being those 20-29 or 50-59 were no more likely to indicate that they would purchase and consume the hypothetical cheddar. The marginal effects for LESSHS and COLLEGE were statistically insignificant while the marginal effect for TRADES was positive and statistically significant at the 10 percent level and the marginal effect for UNIV was negative and statistically significant at the 10 percent level.

In the two-behaviour analytical framework, comparative static results for the exogenous variables depended on the degree of substitutability and whether the two averting behaviours generated utility or disutility. To test this empirically, the dataset for experiment two was parsed into four groups: disutility/complements, disutility/substitutes, utility/complements and utility/ substitutes and the cross-price, cross-effectiveness, income and wage effects were tested in the smaller models. Disutility was assumed if the respondent was presented with a treatment where the hypothetical cheddar cheese was less satisfying than conventional cheddar cheese, utility otherwise.

The four estimated coefficients and marginal effects for the four models are presented in Table 4.12. The variables MICHAEL, LIMIT, DOING, QUIT, PEFF_LIMITSALT, PEFF_DIET and PEFF_LIMITSALT were not included in the estimation of the four models as they either predicted failure or success perfectly. Additionally as A2029 and LESSHS were dropped during estimations, the variables AGT40 and MTHS were included to investigate the impact of age and education. A joint Wald test that the estimated parameters are simultaneously equal to zero was rejected at the ten percent level for three of the models and the five percent level for two of the models suggesting that three of the four models have explanatory power. The hypothesis that the estimated parameters are simultaneously equal to zero could not be rejected in the model where at least one behaviour generated disutility and the hypothetical cheddar cheese and the low-salt diet are substitutes. The Pseudo R^2 for the four models ranged from 0.25 (disutility/substitutes) to 0.47 (utility/substitutes), which is relatively high for cross-sectional data.

The predicted probability ranged from six percent (disutility/complements) to 75 percent (utility/ substitutes). The predicted probability was higher when the two behaviours generated utility (59 and 75 percent) compared to when at least one behaviour (the hypothetical cheese) generated disutility (six and 17 percent). This result suggests that taste matters. Additionally, whether at least one behaviour generated disutility or both behaviours generated utility the predicted probability was higher when the two behaviours were substitutes than when they were complements.

Table 4. 12 Impact of the degree of substitutability and utility/disutility on the estimated coefficients and marginal effects for the intention to purchase and consume a cheddar cheese developed to reduce the risk of developing hypertension (robust standard errors in parentheses)

	At least one behaviour generates disutility				**Both behaviours generate utility**			
	Complements		**Substitutes**		**Complements**		**Substitutes**	
	Regression Coefficient	Marginal Effect	Regression Coefficient	Marginal Effect	Regression Coefficient	Marginal Effect	Regression Coefficient	Marginal Effect
Experimental Parameters								
LTWC	a	a	**1.32*** **(0.71)**	**0.32*** **(0.16)**	-0.21 (0.67)	-0.08 (0.26)	1.23 (0.79)	0.39 (0.22)
MTWC	-0.90 (0.73)	-0.10 (0.07)	1.13 (0.90)	0.36 (0.32)	**-2.26**** **(1.11)**	**-0.72**** **(0.20)**	**-2.59*** **(1.43)**	**-0.80*** **(0.26)**
MOREFF	**2.78***** **(0.99)**	**0.33***** **(0.10)**	-0.60 (0.50)	-0.15 (0.13)	-0.54 (0.62)	-0.21 (0.24)	0.16 (0.77)	0.05 (0.24)
INCMT65	**-2.17**** **(0.91)**	**-0.13**** **(0.07)**	0.93 (0.57)	0.26 (0.17)	-0.01 (0.60)	-0.00 (0.23)	-2.22 (1.44)	-0.67 (0.31)
WAGEMT25	**-1.62***** **(0.62)**	**-0.11***** **(0.07)**	a	a	-0.62 (0.66)	-0.24 (0.25)	-1.80 (1.37)	-0.63 (0.38)
WAGELT19	-0.31 (0.75)	-0.03 (0.08)	**1.22**** **(0.55)**	**0.36**** **(0.17)**	0.84 (0.57)	0.30 (0.18)	1.52 (1.23)	0.34 (0.18)
Control Variables								
MALE	-0.98 (0.79)	-0.10 (0.09)	0.15 (0.49)	0.04 (0.13)	0.42 (0.58)	0.16 (0.21)	1.22 (0.98)	0.32 (0.18)
AGT40	**2.50**** **(1.08)**	**0.22**** **(0.09)**	**1.12*** **(0.63)**	**0.20*** **(0.08)**	-0.26 (0.54)	-0.10 (0.20)	**2.40***** **(0.82)**	**0.76***** **(0.16)**
MTHS	0.16 (0.58)	0.02 (0.07)	0.01 (0.47)	0.00 (0.12)	-0.81 (0.55)	-0.29 (0.18)	**-3.87**** **(1.64)**	**-0.82**** **(0.14)**

HBP_SELF	**-1.78** (0.88)**	**-0.14** (0.07)**	-0.53 (0.65)	-0.12 (0.13)	0.23 (0.72)	0.09 (0.27)	**3.25** (1.32)**	**0.56** (0.16)**
HBP_OTHER	0.65 (0.67)	0.06 (0.06)	a	a	-0.31 (0.63)	-0.12 (0.22)	2.35* (1.38)	0.71* (0.28)
HBP_FAMHIS	-0.33 (0.50)	-0.04 (0.07)	-0.61 (0.44)	-0.15 (0.11)	**1.35*** (0.51)**	**0.47*** (0.14)**	1.22 (0.90)	0.32 (0.18)
RISK	**0.56** (0.29)**	**0.07** (0.03)**	0.09 (0.17)	0.02 (0.04)	0.10 (0.16)	0.04 (0.06)	0.34 (0.22)	0.11 (0.07)
VULNER	-0.19 (0.29)	-0.02 (0.03)	-0.22 (0.13)	-0.06 (0.03)	-0.15 (0.14)	-0.06 (0.05)	**-0.92*** (0.35)**	**-0.29*** (0.11)**
Constant	**-4.60*** (0.29)**		-2.05 (1.31)		1.77 (1.48)		2.27 (2.42)	
Observation	43		58		47		38	
Wald chi^2 (df)	**24.54 (13)****		14.92 (12)		**21.21 (14)***		**24.50 (14)****	
Pseudo Log L	-13.2817		-24.1218		-21.4105		-13.5746	
Pseudo R^2	0.3979		0.2475		0.3064		0.4675	
Obs. P.	0.2093		0.2414		0.5532		0.6053	
Pred. P	0.0630		0.1715		0.5890		0.7548	

a. Dropped during estimation as it predicted failure perfectly

The marginal effect for LTWC was only significant in the disutility/substitutes model where it was positive; however the hypothesis that the estimated parameters are simultaneously equal to zero could not be rejected for that model. This result aligns with the prediction of the theoretical model that, in the case of disutility/substitutes, a decrease in cross-price increases the level of averting behaviour undertaken. The marginal effects for MTWC were only statistically significant in the models where both behaviours generated utility. The marginal effects were negative suggesting that, relative to being presented a treatment where the hypothetical cheddar cheese and the low-salt diet had the same weekly cost, being presented a treatment where the hypothetical cheddar cheese was more expensive than following a low-salt diet decreased the probability of indicating that a third-person should purchase and consume it. The theoretical model predicted that in the case of utility/substitutes an increase in cross-price would increase the level undertaken of the averting behaviour while in the case of utility/complements an increase in cross-price would decrease the level of averting behaviour undertaken. Thus, the sign for MTWC in the utility/complements model aligns with the theoretical prediction but the sign for MTWC in the utility/substitutes model does not.

The marginal effect for MOREEFF was only statistically significant (at the one percent level) in the disutility/ complements model, where it had a positive marginal effect. This result suggests that when the hypothetical cheddar was presented as less satisfying and recommended to be consumed in addition to a low-salt diet, being presented a treatment where the hypothetical cheddar cheese was more effective than the low-salt diet increased the probability that an individual would indicate that a third-person should purchase and consume the hypothetical cheddar cheese. In the theoretical model, the predicted sign for the cross-effectiveness comparative static was indeterminate in all four scenarios. The marginal effects for both INCMT65 and WAGEMT25 were statistically significant in the disutility/ complements model at the five percent and one percent levels respectively. The marginal effects for both INCMT65 and WAGEMT25 were negative in the disutility/ complements model suggesting that having a higher income, whether salaried or non-labour or wage, decreased the probability of indicating that a third-person should purchase and consume the hypothetical cheddar. The marginal effect for WAGELT19 was only statistically significant in the disutility/substitutes model (at the five percent level) and was positive, suggesting that, relative to having an adult in the respondent's household earning \$20 to \$24 per hour, having an adult earning an hourly wage less than \$19 decreased the probability of indicating that a third-person should purchase and consume the hypothetical cheddar. From the theoretical model, a change in income was predicted to have no impact on the level of averting behaviour undertaken across all four scenarios while the wage comparative static was predicted to have a negative effect in the disutility/complements scenario and the utility/substitutes scenario. Thus the sign of the estimated parameter of WAGEMT25 for the disutility/complements model does not align with the theoretical prediction.

The marginal effects for MALE were not significant in any of the four models. This result is similar to one the one obtained in Table 4.11, suggesting that the gender of the respondent does not impact the probability of indicating that a third-person should consume the hypothetical cheddar. The marginal effects for AGT40 were statistically significant at the one (utility/ substitutes), five (disutility/complements) and 10 percent (disutility and substitutes) levels and were positive. The positive marginal effects for

AGT40 suggests that being over the age of 40 increased the probability of indicating that a third-person should purchase and consume the hypothetical cheddar. The result could be explained by the fact that those over 40 are at higher risk for hypertension than those under 40 (National Heart Lung and Blood Institute n.d.). The marginal effect for MTHS was only statistically significant (at the 10 percent level) in the utility/ substitutes model, where it was negative, suggesting that having completed more than a high school decreased the probability of indicating that a third-person should purchase and consume the hypothetical cheddar.

Unlike the model presented in Table 4.11, the marginal effects for HBP_SELF were statistically significant at the five percent level in the disutility/complements model and the utility/substitutes model. In the disutility/complements model the marginal effect for HBP_SELF was negative while the marginal effect for HBP_SELF in the utility/substitutes model was positive. The marginal effect for HBP_OTHER was only statistically significant (at the five percent level) in the utility/substitutes model, where it was positive. The marginal effect for HBP_FAMHIS was positive and statistically significant at the one percent level in the utility/ complements model.

Although the marginal effect for RISK was positive in all four models, it was only statistically significant (at the five percent level) in the disutility/ complements models. Similarly, the marginal effect for VULNER was negative in all four models, however it was only statistically significant (at the one percent level) in the utility/ substitutes model. The constant was negative in the two disutility models and positive in the two utility models, however, it was only statistically significant (at the one percent level) in the disutility/complements model.

4.4.2 Offsetting Behaviour

Unlike the first experiment, a specific question relating to potential offsetting behaviour was asked in the survey for the second experiment to address the fourth objective of this study. The dependent variable in the offsetting behaviour model OFFSET takes a value of one if the respondent indicated that the third-person should discontinue minimizing salt intake after purchasing and consuming the hypothetical cheddar cheese and zero if the respondent indicated that the third-person should continue to minimize salt intake. The offsetting behaviour model is similar to the INCREASE model in the first experiment as the decision that a third-person should discontinue to minimize salt intake is not a random outcome and depends on the probability of indicating that the third-person should purchase and consume the cheddar cheese. Of the 166 individuals who responded to the question asking if the hypothetical third-person should purchase and consume the hypothetical cheddar cheese, 38 percent (n=72) responded 'Yes', and 62 percent (n=94) responded 'No' or 'Don't know'. Following Heckman (1976), the decision to discontinue minimizing salt intake (OFFSET) is estimated using a maximum-likelihood method and correcting for potential sample selection bias. The estimated coefficients and marginal effects for the corrected probit model are presented in Table 4.13 alongside estimates from an uncorrected model. Of the 70 individuals who responded to the question about continuing to minimize salt intake, 86 percent (n=60) indicated that the third-person should continue to minimize salt intake and 14 percent (n=10) indicated that the third-person should not continue to minimize salt intake

In the two probit models investigating the probability of offset, the variables MORESAT, RISK, VULNER, LIMIT, DOING, QUIT, PEFF_LIMITSALT,

PEFF_DIET, PEFF_SMOKEALCO, HBP_SELF, HBP_OTHER and HBP_FAMHIS were not included in the estimation as they predicted failure perfectly, the small sample size and as exclusion criteria to identify between the UNDERTAKE2 model and the OFFSET model. The two models (corrected and uncorrected) were estimated in STATA 9. The uncorrected model was estimated with White's heteroskedastic-consistent standard errors.[13] A joint Wald test that the estimated parameters are simultaneously equal to zero could not be rejected in either model, suggesting that neither model has explanatory power. A Lagrange multiplier test with a null of no statistical significance was rejected at the five percent level but not at the one percent level, suggesting that there may be a sample selection problem in the data. The predicted probability offset (calculated at the mean) was four percent in the corrected model and 11 percent in the uncorrected model.

[13] Note that the estimated parameters for corrected model in Table 4.13 were not estimated with robust standard errors. When estimated with robust standard errors the Wald test variable was not available. Estimated parameter significance and signs when significant did not change when estimated with robust standard errors and the Wald test that there is no sample selection problem is rejected at the five percent level.

Table 4.13 Probit regression coefficients and marginal effects for decision to offset (standard errors in parentheses)

	Corrected for sample selection		**Not corrected for sample selection**	
Variable	**Regression Coefficient**	**Marginal Effect**	**Regression Coefficient**	**Marginal Effect**
Experimental Parameters				
LTWC	0.7106 (0.5920)	0.0579 (0.0477)	0.7771 (0.5120)	0.1333 (0.0831)
MTWC	-0.1215 (0.6756)	-0.0092 (0.0494)	0.1952 (0.6475)	0.0409 (0.1461)
MOREFF	0.3248 (0.4160)	0.0258 (0.0312)	-0.0533 (0.3640)	-0.0104 (0.0706)
MICHAEL	0.3136 (0.3936)	0.0240 (0.0302)	0.2626 (0.3828)	0.0494 (0.0690)
LESSSAT	-0.3293 (0.4321)	-0.0272 (0.0381)	0.0292 (0.4383)	0.0057 (0.0857)
INCMT65	-0.7066 (0.6120)	-0.0437 (0.0316)	**-0.9019*** **(0.5254)**	**-0.1497*** **(0.0826)**
WAGEMT25	-0.5512 (0.6875)	-0.0320 (0.0307)	-0.1929 (0.5669)	-0.0345 (0.0934)
WAGELT19	-0.2151 (0.4917)	-0.0156 (0.0324)	-0.6720 (0.5068)	-0.1087 (0.0710)
SUBS	0.3143 (0.4500)	0.0253 (0.0388)	-0.0242 (0.4123)	-0.0047 (0.0797)
Control Variables				
MALE	0.0359 (0.4690)	0.0029 (0.0382)	0.1373 (0.4416)	0.0276 (0.0913)
AGT40	0.6685 (0.5946)	0.0416 (0.0275)	0.4993 (0.5652)	0.0791 (0.0742)
MTHS	-0.1062 (0.5326)	-0.0088 (0.0457)	-0.1827 (0.4258)	-0.0368 (0.0879)
/atrho	13.5562 (723.5793)			
rho	1 (4.86e-09)			
Constant	**-2.5214***** **(0.9523)**		**-1.6654**** **(0.7822)**	

	Observations: 162 Censored observations: 107 Uncensored observations: 55 Wald chi^2 (12 df): 17.53 Log likelihood: -98.7552 LR test of independent equations chi^2 : 4.38** (1 df) Probability (OFFSET=1): 0.0360	Observations: 70 Wald chi^2 (12 df): 11.26 Log pseudolikelihood: -25.6200 Pseudo R^2: 0.1076 Observed probability: 0.1429 Predicted probability: 0.1148
* Denotes significance at the ten percent level ** Denotes significance at the five percent level *** Denotes significance at the one percent level		

The marginal effects for all variables included in the corrected model were statistically insignificant. The constant in the uncorrected model was negative and statistically significant at the one percent level. In the uncorrected model, the only significant marginal effect was INCMT65 which was negative and statistically significant at the 10 percent level. The constant for the uncorrected model was negative and statistically significant at the five percent level.

4.4.3 Discussion of Experiment Two Results

Experiment two had two primary objectives: to investigate how relative prices, relative effectiveness, salaried or non-labour income, wage rate, degree of substitutability and utility impacted the decision that a third-person should purchase and consume the hypothetical cheddar and whether adopting the hypothetical cheddar would result in a discontinuing a low-salt diet. Across the five models estimated to address the first objective, relative prices and effectiveness, wage rate and salaried or non-labour income, degree of substitutability, gender, education and experience with diagnosis of hypertension had little impact on the decision that a third-person should purchase and consume the hypothetical cheddar. However, disutility of the second averting behaviour (measured by the variable LESSSAT) did have an impact as it was the only significant marginal effect in the OFFSET model and, when data was parsed on disutility, the probability of indicating that a third-person should purchase the hypothetical cheddar was significantly lower than when parsed on utility. This result suggests that taste or enjoyment from the product matters and is an important result from industry involved in functional food development and production.

Although 14 percent of individuals who responded to the question regarding discontinuing following a low-salt diet indicated that the third-person should discontinue minimizing salt intake, probit results were inconclusive as the null that the estimated parameters are jointly equal to zero could not be rejected in the model corrected for sample selection or in the uncorrected model. This could be due to the small sample size which did not allow for inclusion of some explanatory variables.

4.5 SUMMARY

Estimation of the four primary probit models (i.e. UNDERTAKE, INCREASE, UNDERTAKE2 and OFFSET) leads to a number of conclusions on factors influencing the decision to undertake an averting behaviour (i.e. purchase and consume the hypothetical cheddar cheese) and the decision to offset the benefit of an averting behaviour. In the first experiment, the results suggest that being exposed to health impacts of an illness increases the probability of purchase and of increased consumption. The result is important for policymakers in determining what health information can be used on product packaging as exposure to the health impacts may increase the probability of purchase and consumption. Empirical analysis in the first experiment also addressed the third objective of this study by predicting that the probability of increasing total cheddar cheese consumption to be eight percent. This result does provide some evidence of increased consumption of a product following the addition of a functional ingredient, although the probability is low. This result could be important for government when assessing new functional food products, particularly those where functional ingredients have been added to unhealthy products.

The overwhelming result from the second experiment is that taste matters. Individuals were less likely to indicate that a third-person should consume the hypothetical when presented with a treatment where the hypothetical cheddar cheese was less satisfying than conventional cheddar cheese relative to being presented a treatment where the hypothetical cheddar cheese was as or more satisfying. Similar results have been found in previous studies investigating functional food acceptance (Verbeke 2006). This result is particularly important for industry as it suggests that consumers are less willing to purchase and consume functional foods that are less satisfying than their conventional counterparts.

Chapter 5

Conclusion

5.1 INTRODUCTION

The present study used the offsetting behaviour hypothesis (Peltzman 1975) to investigate how functional food consumption influences broader dietary choices using data collected from a representative consumer panel. Empirical analysis of the data suggested that the addition of a functional ingredient to a food may result in increased overall consumption of that food, however, only the predicted probability of increased consumption was only eight percent suggesting that the majority of individuals would not undertake behaviours which resulted in an offset of the benefits of a hypothetical cheddar developed to reduce the risk of hypertension by increasing total consumption of cheddar cheese. This finding may help to inform the policy debate with respect to offsetting behaviour and functional foods. This concluding chapter will provide a comparison of the findings of the study with the objectives outlined in the introductory chapter as well as a discussion of the implications of the findings, the limitations of the results and recommendations for future related research.

5.2 SUMMARY OF FINDINGS

The first objective of this study was to develop a conceptual framework to investigate offsetting behaviour in voluntary health improvements based on previous analytical frameworks used to investigate individual response to regulatory and safety protection. In Chapter 2, two analytical frameworks were developed to meet the first objective. The first or one-behaviour analytical framework investigated how an individual selects the optimal level of an averting behaviour. Comparative static analysis of the one-behaviour analytical framework resulted in a general set of comparative static results, which had not been derived previously in the offsetting behaviour literature and a set of five testable hypotheses. The second or two-behaviour analytical framework built on the one-behaviour analytical framework to investigate how an individual selects the optimal level of a second averting behaviour and how the optimal level undertaken of the original averting behaviour changes following adoption of the second averting behaviour. The two-behaviour analytical framework is the first theoretical framework of offsetting behaviour to investigate separate averting behaviours rather than aggregating all averting behaviours together. Comparative static analysis of the two-behaviour analytical framework was, for the most part, indeterminate, providing motivation for empirical analysis.

The second objective of this study was to develop an experimental design within which offsetting behaviour in voluntary health improvements could be explored. Two separate experimental designs were developed in Chapter 3 based on the results of the comparative static exercises in the one- and two-behaviour analytical frameworks. The experimental designs guided survey development and data collection, in particular, the third-person elicitation method used in the second experiment.

The third objective of this study was to investigate whether addition of a functional ingredient to a food could result in increased overall consumption of the food. The product selected in the experimental design was a hypothetical cheddar cheese, which is a source of sodium and fat and over-consumption of which could lead to other health problems. A probit model was estimated with the decision to increase total cheddar cheese consumption following adoption of the hypothetical cheddar cheese as the dependent variable. The predicted probability of increasing total cheese consumption was eight percent, which suggests that the majority of individuals would not increase overall consumption of a food following the addition of a functional ingredient.

The fourth objective of this study was to investigate whether consumption of a functional food reduces the propensity to make broader healthy dietary choices. Results from a probit model corrected for sample selection, with the decision that a third-person would discontinue following a low-salt diet following adoption of the hypothetical cheddar as the dependent variable, suggest little evidence of reduced propensity to make healthy dietary choices (i.e. discontinuing low-salt diet) as the null that the estimated parameters of the model were jointly equal to zero could not be rejected. Although the model was lacking in explanatory power, the predicted probability of offset or reduced propensity to make healthy dietary choices was four percent, which is low and suggests that the majority of individuals would not offset the benefit of consuming the hypothetical cheddar by discontinuing a low-salt diet.

The final objective of this study was to make recommendations for future research on offsetting behaviour and the impact of functional food consumption on broader dietary choices and to discuss policy implications. Policy implications are discussed in the flowing section and recommendations for future research are made in section 5.4 of this chapter.

5.3 IMPLICATIONS AND POLICY RELEVANCE

The findings of this study make a significant contribution to the literature on offsetting behaviour and consumer acceptance of functional foods. With respect to offsetting behaviour, the two analytical frameworks provide a theoretical framework for future empirical research on offsetting behaviour in health improvements, particularly with respect to the comparative static results. The findings of this study also provided limited evidence of offsetting behaviour in health improvements in at least one context: increased consumption, suggesting that the addition of a functional ingredient to a food item does not result in increased consumption of that food item for the majority of individuals. The theoretical framework developed on this study also allows for investigation of potential offsetting behaviour resulting from voluntary health improvements, which could be used by government in estimating benefits of proposed policies and regulations.

There is limited evidence, based on the empirical results of this study, to suggest that offsetting behaviour occurs following the purchase and consumption of a functional food. In the increased consumption model, only eight percent of individuals indicated that they would increase total consumption of cheddar cheese following adoption of the hypothetical cheddar. The results of the model investigating whether adoption of the hypothetical cheddar induces an individual to discontinue a low-salt diet were not statistically significant, which may be due to the small sample size. In any case, the results of this study suggest that offsetting behaviour following functional food consumption may not be a large problem.

The result that individuals would not increase consumption of a food item following the addition of a functional ingredient may also help to inform private strategies related to functional food development. The addition of a functional ingredient to a food item and/or functional development may increase costs for a firm. The results of the present study suggest that the individuals will not increase consumption volumes following adoption of a functional food and thus a profit-maximizing firm would have to look to other strategies such as increasing the price of the functional food in order to cover costs and maximize profits, particularly as previous research has found that consumers are willing to pay a premium for functional ingredients/functional foods (West et al 2002; Maynard and Franklin 2003; Larue et al 2004).

Empirical results from the first experiment suggest that being presented with the health impacts of an illness increase the probability of purchase and consumption of a functional food for that illness. Being exposed to the health impacts also increases the probability of increasing overall consumption of the food to which the functional ingredient has been (i.e. cheddar cheese in the case of an antihypertensive cheddar cheese). This result is important for policy and regulation development on labelling of functional foods, as presenting the health information may increase total consumption.

In Canada, Health Canada and the Canadian Food Inspection Agency carry joint responsibility for labelling of food products under the Food and Drugs Act, where Health Canada is responsible for the development of policies, regulations and standards related to the use of health claims on food (Canadian Food Inspection Agency 2009; Health Canada 2009b). Research demonstrating that an individual may be more likely to consume a functional food and to increase consumption of the overall food group to which the carrier belongs if presented the health effects of the illness to which the functional food addresses may help to inform policies and regulation related to allowed health claims, particularly where results suggest, although the probability is low, that it may lead to increased consumption of the carrier. Additionally, Health Canada is currently reviewing its framework for managing health claims and has developed an action plan in which it indicates a need for consumer research on the impact the health claims have on consumer food choice and offerings in the marketplace (Health Canada 2009a). The present study research could help inform the review of the health claim management framework by providing research on the impact (or lack of impact) of functional foods, including the corresponding health claim, on broader dietary behaviour.

Empirical results from the second experiment suggest that the taste of a functional food is important, in particular when a functional food is less satisfying than its conventional counterpart. This result is important for industry as empirical results from the second experiment strongly suggest that individuals are less likely to purchase and consume functional products that taste worse than their conventional counterparts.

5.4 LIMITATIONS

The data collection for this study was undertaken in late June and early July which is the beginning of the summer vacation for elementary and high school students in Ontario. This may have contributed to the small sample size, which presents the problem of generalizing results as, although the sample frame is broadly representative of the city of Guelph, the province of Ontario and Canada, certain demographic groups were over and under-represented.

The small sample size also presented problems in the estimation as estimated models, particularly those in the second experiment lacked explanatory power. This is particularly relevant for the OFFSET model where the model lacked explanatory power and individual parameter estimates were not statistically significant from zero. This lack of significance and small sample size precluded investigating whether the utility/disutility of the hypothetical cheddar and the degree of substitutability between the hypothetical cheddar and the low-salt diet impacted the OFFSET decision. This is important as the theoretical model predicted that offsetting behaviour would occur in the disutility and substitutes model, however, this could not be investigated empirically. Additionally, many of the estimated parameters of the experimental variables included in the four main models (UNDERTAKE, INCREASE, UNDERTAKE2 and OFFSET) were not statistically significant and thus did not provide support for the theoretical hypotheses

Another imitation is that many of the experimental parameters included in the empirical analysis were proxies. The actual effectiveness of the hypothetical cheddar cheese was not presented to respondents but rather a script on effectiveness containing varying amounts of information. The size of loss was also not varied, but rather exposure to information on the size of loss and so the marginal effect of this variable does not provide insight into the impact of the size of loss, only the impact of exposure to the size of loss.

5.5 RECOMMENDATIONS FOR FUTURE RELATED RESEARCH

There are three primary types of extensions that could be made from the present study: conceptual research, offsetting behaviour research and functional food research. The conceptual model developed in the present study to investigate offsetting behaviour in voluntary health improvements could be extended to incorporate a time dimension which would allow for the model to be applied to health outcomes that incorporate a time delay. Perceptions about the efficacy of the averting behaviour could also be incorporated. The model could also be extended to include more than two averting behaviours as well as to investigate the total amount of averting behaviour undertaken in addition to the level undertaken of the individual averting behaviours.

The conceptual model developed in Chapter 2 could be applied to investigate offsetting behaviour in health improvements other than functional foods. Finally, further research on how functional food consumption affects the propensity to make healthy lifestyle choices, diet or otherwise, is needed. Empirical results from the present study on the impact of the adoption of an averting behaviour on the propensity to make healthy lifestyle choices were inconclusive and so further research is needed on the impact of functional food consumption of the propensity to make healthy diet and lifestyle choices.

5.6 SUMMARY

Empirical results of this study provide some evidence of offsetting behaviour following functional food consumption: increased consumption. Although the results did not support reduced propensity to make healthy dietary choices following functional food consumption, the theoretical framework of offsetting behaviour in health improvements developed in this study provides a conceptual basis for future research in this area. Although not a primary objective of this study, empirical results strongly support the impact of taste (disutility) and exposure to the health impacts of an illness on the decision to undertake an averting behaviour, information that is important to both industry and government.

The present study was somewhat successful in meeting its purpose of determining how consumption of a functional food affects broader healthy dietary choices, however, the key contribution is the theoretical framework developed to investigate offsetting behaviour in health improvements. The theoretical framework and its potential applications represent a valuable contribution to the offsetting behaviour literature.

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APPENDICES

APPENDIX A - Experiment One Effectiveness Treatments

In the experimental design for the first experiment, there are three effectiveness levels: low, medium and high. To develop the three effectiveness treatments, an Internet search was performed of the effectiveness statements of current products (medications, supplements and functional foods) available to lower the risk of developing high blood pressure for those with normal blood pressure and to reduce blood pressure in those who already have hypertension. The products, manufacturers and effectiveness claims are listed in *Table 2.* The three effectiveness treatments were developed based on the effectiveness claims on pre-existing products and are presented in *Table 1.*

Table 1: Effectiveness Treatments

Treatment	*Effectiveness Statement*
Low	The product is effective at reducing the risk of hypertension
Medium	Evidence gained from a clinical trial indicated that product is effective at reducing the risk of hypertension
High	Scientific evidence obtained from several clinical trials involving thousands of participants clearly indicated that product is very effective at reducing the risk of hypertension

Table 2: Effectiveness Statements of Current Products Available to Control Hypertension

Product	*Manufacturer*	*Effectiveness Statements*
Adalat®	Bayer	• How effective is Adalat® in lowering blood pressure? • Adalat® has the advantage of being a well-established drug. **Scientific evidence gained from clinical trials involving thousands of patients clearly indicates that Adalat® is very effective at lowering elevated blood pressure without compromising patient safety.** • http://www.adalat.com/scripts/pages/en/patients-

		home/my-adalat/efficacy/index.php
Valio Evolus ® Double Effect products	Valio (Finland)	• The impact of Valio Evolus® Double Effect products depends on the individual. Clinical studies indicate that the effect of Valio Evolus® on systolic blood pressure is on average -4 mmHg and on diastolic pressure -2 mmHg compared to the control group. • The effect of peptides on blood pressure has been shown in **five clinical studies** conducted by Valio in co-operation with universities and independent health care organisations. In double-blind placebo-controlled studies, test subjects consumed either milk drink containing peptides or a placebo. **All the studies show that the people who consumed milk drink containing peptides benefited from a greater reduction in blood pressure than those in the control group.** • http://www.valio.fi/portal/page/portal/valiocom/Company_information/Products_International_Sales/functional_products18102006164724/valio_evolus_double_effect_products05092008150615/questions_and_answers05092008153759
PeptACE Peptides	Natural Factors	• A group of small peptides (proteins) from the bonito fish, a member of the tuna family are used to create Natural Factors PeptACE. This product lowers blood pressure by inhibiting an enzyme known as ACE (angiotensin converting enzyme). This enzyme causes a reaction that increases both the volume of blood flowing through arteries and the degree of constriction of the blood vessels — like pinching off a garden hose while turning up the flow of water full blast! By inhibiting the action of this enzyme, PeptACE helps relax arterial walls and reduce fluid volume, **effectively lowering blood pressure**. • http://www.naturalfactors.com/search.asp?mode=cat&cat=66
Diovan	Novartis	• Diovan **starts lowering your blood pressure the first day you take it**. Just one pill lowers your blood pressure for a full 24 hours. • http://www.diovan.com/info/about/about_diovan.jsp
EXFORGE	Novartis	• In recent studies, EXFORGE was proven to be more effective in lowering high blood pressure than either

		of its components alone. ▪ In adults 18 years of age or older, EXFORGE **was proven to significantly** lower high blood pressure regardless of age or gender. • http://www.exforge.com/info/about/about-exforge.jsp • EXFORGE has **been shown to achieve significant blood pressure lowering results in as soon as two weeks**. (http://www.exforge.com/info/answers/exforge-qa.jsp)
Tekturna	Novartis	• Tekturna **works well** in helping lower your blood pressure closer to 120/80 mm Hg, a normal blood pressure for most healthy adults. (http://www.tekturna.com/info/about/high_blood_pressure_treatment.jsp)
NORVASC	Pfizer	• NORVASC® (amlodipine besylate) helps control high blood pressure for a full 24 hours…NORVASC has been shown to work for many types of patients. It even works for patients with mild, moderate, or severe levels of high blood pressure. (http://www.norvasc.com/high-blood-pressure-medicine/about-norvasc.asp)

COZAAR	Merck	• Studies have shown that COZAAR is a proven medicine with multiple benefits. Like a multipurpose tool for your health, COZAAR can:
		  • Lower your high BP
		    i. If you have high BP, COZAAR can help relax your blood vessels and lower your BP.
		• http://www.cozaar.com/losartan_potassium/cozaar/consumer/benefits/index.jsp

AVAPRO/AVALIDE	Bristol-Myers Squib	• Both AVAPRO and AVALIDE **provide prompt BP lowering at 2 weeks** • AVALIDE: INCLUSIVE trial **demonstrated powerful BP reduction** in patients with systolic blood pressure (SBP) uncontrolled on monotherapy • AVAPRO: Powerful SBP and diastolic blood pressure (DBP) reductions comparable to one of the most widely prescribed antihypertensive agents, amlodipine, at starting doses • The **efficacy of AVAPRO has been established by**

		7 major placebo-controlled trials in 1,915 patients with baseline diastolic blood pressure (DBP) of 95 to 110 mm Hg. • AVALIDE **was shown to produce powerful BP reduction within 2 weeks**. • AVALIDE: More power for more patients than ever before across all stages of hypertension, Rapid (Week 1) and powerful (Week 7) BP reductions to help patients reach JNC 7 BP goal of <140/90 mm Hg† • http://www.avapro-avalide.com/powerful_bp_efficacy.aspx • http://www.avapro-avalide.com/bp_efficacy/prompt_and_powerful_bp_lowering.aspx • http://www.avapro-avalide.com/bp_efficacy/when_added_efficacy_is_needed.aspx • http://www.avapro-avalide.com/bp_efficacy/all_stages_of_hypertensive_risk.aspx
Ameal bp®	Calpis	• Ameal bp ® is a clinically proven lactotripeptides supplement that – with a healthy diet and exercise program – can help you maintain healthy blood pressure levels, naturally. • http://www.amealbp.com/ • AmealPeptide® is the proprietary name for the two lactotripeptides Valyl-Prolyl-Proline (VPP) and Isoleucyl-Prolyl-Proline (IPP). Clinical studies have shown that it requires the combination of both VPP and IPP to produce optimal benefits for your blood pressure. • ameal bp™ is a dietary supplement that contains the naturally derived, active ingredient AmealPeptide®. **It has been clinically shown to help promote healthier blood pressure levels without the side effects of prescription drugs.*** After three to four weeks of taking ameal bp™, you should start to see changes in your blood pressure. Clinical tests have shown a significant lowering of both systolic and diastolic blood pressure when 5.1 mg of AmealPeptide® is taken on a daily basis. • http://www.amealbp.com/images/stories/pdfs/consumer_brochure.pdf
AmealPeptide	Calpis	• While it's not a medicine, AmealPeptide® **is clinically proven to be effective**. It's also safe for

		people with lactose intolerance and dairy allergies. • http://www.amealpeptide.com/consumers/index.html
Kaiku Vita	Kaiku (Spain)	• Tomando una botellita de Vita de Kaiku al día podrás comprobar sus efectos en un período de entre 5 y 7 semanas. (Drinking a bottle of Vita de Kaiku every day will allow you to see its effects within 5 to 7 weeks) • Para mantener un correcto estado de la tensión arterial se recomienda consumir el producto dentro de un estilo de vida saludable. Tomando la dosis diaria recomendada de Vita de Kaiku (1 botellita), podrás ver tu presión arterial reducida en el plazo de 5 a 7 semanas. (To maintain a normal level of blood pressure it is recommended to consume the product within a healthy lifestyle. Taking the daily recommended doses of Vita de Kaiku (one bottle) will allow you to reduce your blood pressure in 5 to 7 weeks) • http://www.kaikuvita.com/

APPENDIX B – Experiment One Survey

NEEDS LOGO AT THE TOP

Guelph Food Panel

Consumer Acceptance of Food Products that Reduce the Risk of Hypertension

Researchers in the International Food Economy Research Group at the University of Guelph are using the Guelph Food Panel to undertake a study of consumer perceptions of and attitudes towards various food issues. As a member of the Guelph Food Panel, we would like to ask you to complete the survey that follows. The survey will take around 15 minutes to complete.

You are free to participate or not in this survey and, should you choose not to participate, you can withdraw from the survey at any time. As well, you are free to skip any question you would prefer not to answer. By completing and submitting the survey, you provide consent to participate in the study. Further information on your consent to participate can be reviewed by clicking here <LINK TO ETHICS HERE>.

Results of this survey will be used for a Master of Science thesis currently being undertaken at the University of Guelph. For the purposes of the Master's thesis, we need to update our records so you may notice that some of the questions in this survey were asked in last year's surveys.

1. In the past year have you, a member of your family, or a close friend been diagnosed with any of the following conditions? (*Check all that apply*)

	Allergies from foods	**Arthritis**	**Cancer**	**Heart disease**	**Diabetes**	**Gastro-intestinal / digestive problems**	**High cholesterol**	**Kidney disease**	**Lactose intolerance**	**Osteoporosis**
Yourself	□	□	□	□	□	□	□	□	□	□
Member of family	□	□	□	□	□	□	□	□	□	□
Close friend	□	□	□	□	□	□	□	□	□	□

None /don't know	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

In this study we are looking at concerns related to a number of diseases, with a focus on hypertension, commonly called high blood pressure.

2. In the past year, have you been diagnosed with high blood pressure? (*Check one*)

   ☐ Yes (proceed to question 4)
   ☐ No (proceed to question 3)

3. Were you diagnosed with high blood pressure previous to the past year? (*Check one*)

   ☐ Yes (proceed to question 4)
   ☐ No (proceed to question 6)

4. Do you currently have high blood pressure? (*Check one*)

   ☐ Yes
   ☐ No

5. Did/do you use prescription drugs to treat your blood pressure? (*Check one*)

   ☐ Yes
   ☐ No

6. How effective do you consider prescription drugs to be in treating high blood pressure? (*Check one*)

Extremely Effective ←→ Not at all Effective						
7	6	5	4	3	2	1
☐	☐	☐	☐	☐	☐	☐

7. In the past year did you do any of the following to reduce the risk of developing high blood pressure and/or manage your high blood pressure? (*Check all that apply*)

   ☐ Limit consumption of alcohol
   ☐ Engage in regular physical activity

☐ Reduce stress
☐ Quit smoking
☐ Quit the use of products containing nicotine
☐ Reduce exposure to second-hand smoke
☐ Lose weight
☐ Consume the daily recommended intake of fruits and vegetables
☐ Consume the daily recommended intake of whole grains and cereals
☐ Avoid foods containing high levels of salt
☐ Limit the amount of salt added while cooking
☐ Limit the amount of salt added at the table
☐ Buy and eat processed foods with low salt or sodium labels
☐ Limit consumption of foods containing high levels of saturated fat
☐ Avoid foods containing trans fat
☐ Did not do anything

8. Using the following scale, please indicate how effective you consider each of the following in reducing the risk of developing high blood pressure and/or managing high blood pressure? (*Check one per line*)

	Extremely Effective ←					→ Not at all effective	
	7	6	5	4	3	2	1
Limiting consumption of alcohol	☐	☐	☐	☐	☐	☐	☐
Engaging in regular physical activity	☐	☐	☐	☐	☐	☐	☐
Reducing stress	☐	☐	☐	☐	☐	☐	☐
Quitting smoking	☐	☐	☐	☐	☐	☐	☐
Quitting the use of products containing nicotine	☐	☐	☐	☐	☐	☐	☐
Reducing exposure to second-hand smoke	☐	☐	☐	☐	☐	☐	☐
Losing weight	☐	☐	☐	☐	☐	☐	☐
Consuming the daily recommended intake of fruits and vegetables	☐	☐	☐	☐	☐	☐	☐
Consuming the daily recommend intake of whole grains and cereals	☐	☐	☐	☐	☐	☐	☐
Avoiding foods containing high levels of salt	☐	☐	☐	☐	☐	☐	☐
Limiting the amount of salt	☐	☐	☐	☐	☐	☐	☐

added while cooking							
Limiting the amount of salt added in at the table	□	□	□	□	□	□	□
Buying and eating processed foods with low salt or sodium labels	□	□	□	□	□	□	□
Limiting consumption of foods containing high levels of saturated fat	□	□	□	□	□	□	□
Avoiding foods containing trans fat	□	□	□	□	□	□	□

9. In the past year, was anyone in your family diagnosed with high blood pressure? (*Check one*)

    □ Yes
    □ No
    □ Don't know

10. In the past year, were any of your close friends diagnosed with high blood pressure? (*Check one*)

    □ Yes
    □ No
    □ Don't know

11. Does your family have a history of high blood pressure? (*Check one*)

    □ Yes
    □ No
    □ Don't know

12. The statements below will enable us to better understand how you feel about high blood pressure. For each statement, please indicate the extent to which you agree or disagree with the statement using the following scale. (*Check one per line*)

	Completely Agree	←		→			Completely Disagree
	7	6	5	4	3	2	1
Having high blood pressure significantly alters your way of life	□	□	□	□	□	□	□
High blood pressure is usually a severe condition	□	□	□	□	□	□	□

High blood pressure is unlikely to have a significant impact on your health	☐	☐	☐	☐	☐	☐	☐
People in my age group are vulnerable to high blood pressure	☐	☐	☐	☐	☐	☐	☐
It is unusual for someone my age to have high blood pressure	☐	☐	☐	☐	☐	☐	☐
Once you have been diagnosed with high blood pressure there is nothing you can do about it	☐	☐	☐	☐	☐	☐	☐
High blood pressure is inevitable as one gets older	☐	☐	☐	☐	☐	☐	☐
There is little you can do to reduce the risk of suffering from high blood pressure	☐	☐	☐	☐	☐	☐	☐
There are effective ways to treat high blood pressure when it has developed	☐	☐	☐	☐	☐	☐	☐

13. The statements below will enable us to better understand how you feel about the risk of developing high blood pressure. Please consider each and indicate where you would place yourself on the following scale. (*Check one per line*)

	Extremely High ⟵					⟶	Extremely Low
	7	6	5	4	3	2	1
Compared to the average person, my risk of developing high blood pressure is…	☐	☐	☐	☐	☐	☐	☐
I believe that the likelihood that I will have high blood pressure in the future is…	☐	☐	☐	☐	☐	☐	☐

14. Using the following scale, please tell us how important each of the following is to you personally. (*Check one per line*)

	Extremely Important ⟵ ⟶ Extremely Unimportant

	7	6	5	4	3	2	1
Being vulnerable to high blood pressure	☐	☐	☐	☐	☐	☐	☐
Being in a high risk group for high blood pressure	☐	☐	☐	☐	☐	☐	☐
Being unlikely to develop high blood pressure	☐	☐	☐	☐	☐	☐	☐

15. Do you ever consume cheddar cheese? (*Check one*)

☐ Yes (proceed to question 17)
☐ No (proceed to question 23)

16. Over the past two years, have you increased, decreased, or maintained how frequently you consume cheddar cheese? (*Check one*)

☐ Increased
☐ Decreased
☐ Maintained

According to the Heart and Stroke Foundation of Canada, there are lots of things that you can do to keep your blood pressure in a healthy range. Some of the choices they recommend include being smoke-free, limiting alcohol intake to 1 or 2 drinks per day, finding healthy ways to manage your stress, participating in regular physical activity and following a diet that is rich in fruits, vegetables and whole grains while low in salt, saturated fat and trans fats.

In this section of the survey we are going to ask you about a food product developed to reduce the risk of hypertension.

<Nothing/ Hypertension, or high blood pressure, is the number one risk factor for death in North America. According to the Public Health Agency of Canada, high blood pressure is one of the most important risk factors for heart disease, is one of the top risk factors for stroke, the number one reason for Canadians to visit a doctor, and the top diagnosis for which medication is prescribed. Uncontrolled blood pressure can lead to artery damage and hardening of the arteries which can cause heart disease and heart attacks, strokes, kidney failure, loss of eye sight, reduced blood supply to the brain, and aneurysms.>

17. Suppose the grocery store where you and your family shop most frequently begins to sell a specialty cheddar cheese developed to reduce the risk of developing high blood pressure or hypertension. The new cheddar cheese is identical in appearance to conventional cheddar cheese (i.e. one that does not work to affect high blood pressure), contains no artificial ingredients and tastes no different than

conventional cheddar cheese. The new cheddar cheese bears the following label < **This product is effective at reducing the risk of developing hypertension/ Evidence gained from a clinical trial indicated that this product is effective at reducing the risk of developing hypertension/ Scientific evidence obtained from several clinical trials involving thousands of participants clearly indicated that this product is very effective at reducing the risk of developing hypertension>.** The new cheddar cheese costs **<$5.59/ $5.99/ $6.49>** for a 300g package while the average price of a 300g package of conventional cheddar cheese is $5.09. Would you purchase and consume the cheddar cheese developed to reduce the risk of hypertension? (*Check one*)

- ☐ Yes (proceed to question 18)
- ☐ No (proceed to question 19)
- ☐ Don't know (proceed to question 20)

18. In order to interpret your response correctly, please briefly give your reasoning behind why you answered "Yes" to the last question? (proceed to question 21)

19. In order to interpret your response correctly, please briefly give your reasoning behind why you answered "No" to the last question? (proceed to question 23)

20. In order to interpret your response correctly, please briefly give your reasoning behind why you answered "Don't know" to the last question? (proceed to question 23)

21. How often do you think you would consume the cheddar cheese developed to reduce the risk of hypertension? (*Check one*)

- ☐ More than five times per week
- ☐ Four to five times per week
- ☐ Two or three times per week
- ☐ Once a week
- ☐ A few times per month
- ☐ Rarely

22. Do you think that your total consumption of cheddar cheese (i.e. conventional cheddar cheese plus cheddar cheese developed to reduce the risk of hypertension) would increase, decrease, or stay the same? (*Check one*)

- ☐ Increase
- ☐ Decrease
- ☐ Stay the same

Finally, we would like to update some information about you that we gathered in one of last year's surveys. This information is only to help us interpret the results across the people we interview and will be kept strictly confidential.

23. To which of these age groups do you belong? (*Check one*)

20-29	30-39	40-49	50-59	60-69
☐	☐	☐	☐	☐

24. In the past year, have you updated your level of education? (*Check one*)

- ☐ Yes (proceed to question 25)
- ☐ No (proceed to question 26)

25. What is the highest level of education you have completed? (*Check one*)

Less than high school	High school	Trades certificate or diploma	College	University
☐	☐	☐	☐	☐

We recognize that your decision to purchase and consume a product that reduces the risk of developing high blood pressure may reflect its price and affordability. In order to understand the results from the survey, we need some indication of your annual household income. We understand that some people are not comfortable providing this information, but as always, you can be assured that all information is confidential and is never associated with you as a named individual, even within the research team.

You may recall that we asked you about your annual household income in one of last year's surveys. We are asking questions about household income again here to get a better understanding of how your household income may have changed from the last time we asked.

26. Would you please tell us what your total household income was in 2008? (*Check one*)

- ☐ Under $19,999
- ☐ $20,000 - $24,999
- ☐ $25,000 - $34,999
- ☐ $35,000 - $44,999
- ☐ $45,000 - $54,999
- ☐ $55,000 - $64,999
- ☐ $65,000 - $74,999
- ☐ $75,000 - $89,999
- ☐ $90,000 - $120,000
- ☐ More than $120,000

27. In 2008, did you earn an hourly wage (as opposed to an annual income)? (*Check one*)

- ☐ Yes (proceed to question 28)
- ☐ No (proceed to question 29)

28. Would you please tell us what your hourly wage was in 2008? (*Check one*)

- ☐ Under $10
- ☐ $10-$14.99
- ☐ $15-$19.99
- ☐ $20-$24.99
- ☐ $25-$29.99
- ☐ Over $30

29. In 2008, did another adult in your household earn an hourly wage (as opposed to an annual income)? (*Check one*)

- ☐ Yes (proceed to question 30)
- ☐ No (proceed to question 31)

30. Would you please tell us the average hourly wage earned by other adults in your household in 2008? (*Check one*)

- ☐ Under $10

- ☐ $10-$14.99
- ☐ $15-$19.99
- ☐ $20-$24.99
- ☐ $25-$29.99
- ☐ Over $30
- ☐ Don't know

31. If you have any additional comments, please feel free to write them below. (*Write verbatim*)

____

____

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Your participation is very important and much appreciated. Thank you **very** much for your time!

APPENDIX C – Experiment Two Survey

NEEDS LOGO AT THE TOP

Guelph Food Panel

Consumer Acceptance of Food Products that Reduce the Risk of Hypertension

Researchers in the International Food Economy Research Group at the University of Guelph are using the Guelph Food Panel to undertake a study of consumer perceptions of and attitudes towards various food issues. As a member of the Guelph Food Panel, we would like to ask you to complete the survey that follows. The survey will take around 15 minutes to complete.

You are free to participate or not in this survey and, should you choose not to participate, you can withdraw from the survey at any time. As well, you are free to skip any question you would prefer not to answer. By completing and submitting the survey, you provide consent to participate in the study. Further information on your consent to participate can be reviewed by clicking here <LINK TO ETHICS HERE>.

Results of this survey will be used for a Master of Science thesis currently being undertaken at the University of Guelph. For the purposes of the Master's thesis, we need to update our records so you may notice that some of the questions in this survey were asked in last year's surveys.

1. In the past year have you, a member of your family, or a close friend been diagnosed with any of the following conditions? (*Check all that apply*)

	Allergies from foods	**Arthritis**	**Can-cer**	**Heart dise-ase**	**Dia-betes**	**Gastro-intestinal / digestive problems**	**High choles-ter-ol**	**Kid-ney disease**	**Lactose intoler-ance**	**Osteo poro-sis**
Yourself	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Member of family	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Close friend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
None/ don't	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

know										

In this study we are looking at concerns related to a number of diseases, with a focus on hypertension, commonly called high blood pressure.

2. In the past year, have you been diagnosed with high blood pressure? (*Check one*)

   ☐ Yes (proceed to question 4)
   ☐ No (proceed to question 3)

3. Were you diagnosed with high blood pressure previous to the past year? (*Check one*)

   ☐ Yes (proceed to question 4)
   ☐ No (proceed to question 6)

4. Do you currently have high blood pressure? (*Check one*)

   ☐ Yes
   ☐ No

5. Did/do you use prescription drugs to treat your blood pressure? (*Check one*)

   ☐ Yes
   ☐ No

6. How effective do you consider prescription drugs to be in treating high blood pressure? (*Check one*)

Extremely Effective ◄──						──► Not at all effective
7	6	5	4	3	2	1
☐	☐	☐	☐	☐	☐	☐

7. In the past year did you do any of the following to reduce the risk of developing high blood pressure and/or manage your high blood pressure? (*Check all that apply*)

   ☐ Limit consumption of alcohol
   ☐ Engage in regular physical activity
   ☐ Reduce stress
   ☐ Quit smoking
   ☐ Quit the use of products containing nicotine
   ☐ Reduce exposure to second-hand smoke

- ☐ Lose weight
- ☐ Consume the daily recommended intake of fruits and vegetables
- ☐ Consume the daily recommend intake of whole grains and cereals
- ☐ Avoid foods containing high levels of salt
- ☐ Limit the amount of salt added while cooking
- ☐ Limit the amount of salt added at the table
- ☐ Buy and eat processed foods with low salt or sodium labels
- ☐ Limit consumption of foods containing high levels of saturated fat
- ☐ Avoid foods containing trans fat
- ☐ Did not do anything

8. Using the following scale, please indicate how effective you consider each of the following in reducing the risk of developing high blood pressure and/or managing high blood pressure? (*Check one per line*)

	Extremely Effective ←					→ Not at all effective	
	7	6	5	4	3	2	1
Limiting consumption of alcohol	☐	☐	☐	☐	☐	☐	☐
Engaging in regular physical activity	☐	☐	☐	☐	☐	☐	☐
Reducing stress	☐	☐	☐	☐	☐	☐	☐
Quitting smoking	☐	☐	☐	☐	☐	☐	☐
Quitting the use of products containing nicotine	☐	☐	☐	☐	☐	☐	☐
Reducing exposure to second-hand smoke	☐	☐	☐	☐	☐	☐	☐
Losing weight	☐	☐	☐	☐	☐	☐	☐
Consuming the daily recommended intake of fruits and vegetables	☐	☐	☐	☐	☐	☐	☐
Consuming the daily recommend intake of whole grains and cereals	☐	☐	☐	☐	☐	☐	☐
Avoiding foods containing high levels of salt	☐	☐	☐	☐	☐	☐	☐
Limiting the amount of salt added while cooking	☐	☐	☐	☐	☐	☐	☐
Limiting the amount of salt added in at the table	☐	☐	☐	☐	☐	☐	☐
Buying and eating	☐	☐	☐	☐	☐	☐	☐

processed foods with low salt or sodium labels							
Limiting consumption of foods containing high levels of saturated fat	☐	☐	☐	☐	☐	☐	☐
Avoiding foods containing trans fat	☐	☐	☐	☐	☐	☐	☐

9. In the past year, was anyone in your family diagnosed with high blood pressure? (*Check one*)

   ☐ Yes
   ☐ No
   ☐ Don't know

10. In the past year, were any of your close friends diagnosed with high blood pressure? (*Check one*)

   ☐ Yes
   ☐ No
   ☐ Don't know

11. Does your family have a history of high blood pressure? (*Check one*)

   ☐ Yes
   ☐ No
   ☐ Don't know

12. The statements below will enable us to better understand how you feel about high blood pressure. For each statement, please indicate the extent to which you agree or disagree with the statement using the following scale. (*Check one per line*)

	Completely Agree	←		→			Completely Disagree
	7	6	5	4	3	2	1
Having high blood pressure significantly alters your way of life	☐	☐	☐	☐	☐	☐	☐
High blood pressure is usually a severe condition	☐	☐	☐	☐	☐	☐	☐
High blood pressure is unlikely to have a significant impact on your health	☐	☐	☐	☐	☐	☐	☐

People in my age group are vulnerable to high blood pressure	☐	☐	☐	☐	☐	☐	☐
It is unusual for someone my age to have high blood pressure	☐	☐	☐	☐	☐	☐	☐
Once you have been diagnosed with high blood pressure there is nothing you can do about it	☐	☐	☐	☐	☐	☐	☐
High blood pressure is inevitable as one gets older	☐	☐	☐	☐	☐	☐	☐
There is little you can do to reduce the risk of suffering from high blood pressure	☐	☐	☐	☐	☐	☐	☐
There are effective ways to treat high blood pressure when it has developed	☐	☐	☐	☐	☐	☐	☐

13. The statements below will enable us to better understand how you feel about the risk of developing high blood pressure. Please consider each and indicate where you would place yourself on the following scale. (*Check one per line*)

	Extremely High ⟷						Extremely Low
	7	6	5	4	3	2	1
Compared to the average person, my risk of developing high blood pressure is…	☐	☐	☐	☐	☐	☐	☐
I believe that the likelihood that I will have high blood pressure in the future is…	☐	☐	☐	☐	☐	☐	☐

14. Using the following scale, please tell us how important each of the following is to you personally. (*Check one per line*)

	Extremely Important ⟷						Extremely Unimportant
	7	6	5	4	3	2	1
Being vulnerable to high blood pressure	☐	☐	☐	☐	☐	☐	☐
Being in a high risk group	☐	☐	☐	☐	☐	☐	☐

for high blood pressure							
Being unlikely to develop high blood pressure	☐	☐	☐	☐	☐	☐	☐

According to the Heart and Stroke Foundation of Canada, there are lots of things that you can do to keep your blood pressure in a healthy range. Some of the choices they recommend to keep a healthy blood pressure level include being smoke-free, limiting alcohol intake to 1 or 2 drinks per day, finding healthy ways to manage your stress, participating in regular physical activity and following a diet that is rich in fruits, vegetables and whole grains while low in salt, saturated fat and trans fats.

In this section we are going to ask you about a food product developed to reduce the risk of developing hypertension.

<**Michael/Michelle**> is 50 years old and weighs about the ideal weight based on age and height. <**Michael/Michelle**> recently became concerned about <**his/her**> blood pressure after a family member was diagnosed with high blood pressure. Although <**Michael/Michelle**> has not been diagnosed with high blood pressure, <**he/she**> spoke with <**his/her**> doctor about what <**he/she**> could do to reduce <**his/her**> risk. <**Michael/Michelle**> decided to minimise <**his/her**> salt intake by avoiding foods containing high levels of salt and limiting the amount of salt added in cooking or at the table. Recently, <**Michael/Michelle**> was at the grocery store where <**he/she**> most often shops and saw a cheddar cheese developed to reduce the risk of developing high blood pressure. The new cheddar cheese is identical in appearance to conventional cheddar cheese (i.e. one that does not work to affect high blood pressure) and contains no artificial ingredients. <**Michael/Michelle**> likes cheddar cheese and is interested in consuming the new cheddar cheese instead of minimising **<his/her>** salt intake to reduce **<his/her>** risk of developing high blood pressure. The new cheddar cheese costs **<$5.59/$5.99/$6.49>** for a 300g package which is **<less than the weekly cost of/the**

same weekly cost as/more than weekly the cost of> changes **<Michael/Michelle>** made to **<his/her>** diet to minimise **<his/her>** salt intake. **<Michael/Michelle>** sampled the product and found it **<less satisfying than/as satisfying as/more satisfying than>** the conventional cheese **<he/she>** regularly consumes, <**Michael/Michelle**> spoke to<**his/her**> doctor who told <**him/her**> that the new cheddar cheese when consumed **<instead of/ in addition to>** minimising salt intake is **<as effective as/more effective than>** simply limiting <**his/her**> salt intake.

15. Should <Michael/Michelle> purchase and regularly consume the cheddar cheese developed to reduce the risk of developing hypertension? (*Check one*)

    - ☐ Yes (proceed to question 16)
    - ☐ No (proceed to question 17)
    - ☐ Don't know (proceed to question 18)

16. In order to interpret your responses correctly, please briefly give your reasoning behind why you answered "Yes" to the last question? (proceed to question 19)

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17. In order to interpret your responses correctly, please briefly give your reasoning behind why you answered "No" to the last question? (proceed to question 27)

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18. In order to interpret your responses correctly, please briefly give your reasoning behind why you answered "Don't know" to the last question? (proceed to question 27)

19. Will **<Michael/Michelle>** continue to minimise **<his/her>** salt intake?

- ☐ Yes (proceed to question 20)
- ☐ No (proceed to question 21)

20. In order to interpret your responses correctly, please briefly give your reasoning behind why you answered "Yes" to the last question? (proceed to question 22)

21. In order to interpret your responses correctly, please briefly give your reasoning behind why you answered "No" to the last question? (proceed to question 22)

Finally, we would like to update some information about you that we gathered in one of last year's surveys. This information is only to help us interpret the results across the people we interview and will be kept strictly confidential.

22. To which of these age groups do you belong? (*Check one*)

20-29	30-39	40-49	50-59	60-69
☐	☐	☐	☐	☐

23. In the past year, have you updated your level of education? (*Check one*)

- ☐ Yes (proceed to question 24)

☐ No (proceed to question 25)

24. What is the highest level of education you have completed? (*Check one*)

Less than high school	High school	Trades certificate or diploma	College	University
☐	☐	☐	☐	☐

We recognize that your decision to purchase and consume a product that reduces the risk of developing high blood pressure may reflect its price and affordability. In order to understand the results from the survey, we need some indication of your annual household income. We understand that some people are not comfortable providing this information, but as always, you can be assured that all information is confidential and is never associated with you as a named individual, even within the research team.

You may recall that we asked you about your annual household income in one of last year's surveys. We are asking questions about household income again here to get a better understanding of how your household income may have changed from the last time we asked.

25. Would you please tell us what your total household income was in 2008? (*Check one*)

☐ Under $19,999
☐ $20,000 - $24,999
☐ $25,000 - $34,999
☐ $35,000 - $44,999
☐ $45,000 - $54,999
☐ $55,000 - $64,999
☐ $65,000 - $74,999
☐ $75,000 - $89,999
☐ $90,000 - $120,000
☐ More than $120,000

26. In 2008, did you earn an hourly wage (as opposed to an annual income)? (*Check one*)

☐ Yes (proceed to question 27)
☐ No (proceed to question 28)

27. Would you please tell us what your hourly wage was in 2008? (*Check one*)

☐ Under $10

- ☐ $10-$14.99
- ☐ $15-$19.99
- ☐ $20-$24.99
- ☐ $25-$29.99
- ☐ Over $30

28. In 2008, did another adult in your household earn an hourly wage (as opposed to an annual income)? (*Check one*)

- ☐ Yes (proceed to question 29)
- ☐ No (proceed to question 30)

29. Would you please tell us the average hourly wage earned by other adults in your household in 2008? (*Check one*)

- ☐ Under $10
- ☐ $10-$14.99
- ☐ $15-$19.99
- ☐ $20-$24.99
- ☐ $25-$29.99
- ☐ Over $30
- ☐ Don't know

30. If you have any additional comments, please feel free to write them below. (*Write verbatim*)

____

____

____

Your participation is very important and much appreciated. Thank you **very** much for your time!

APPENDIX D- Experiment One Income and Wage Models

Table 1. Probit regression coefficients and marginal effects for the intention to purchase and consume the hypothetical cheddar (robust standard errors in parentheses)

	Entire sample		Income earners only		Wage earners	
Variable	**Regression Coefficient**	**Marginal Effect**	**Regression Coefficient**	**Marginal Effect**	**Regression Coefficient**	**Marginal Effect**
Experimental Parameters						
PRICE	-0.0626 (0.2812)	-0.0241 (0.1084)	0.1695 (0.4319)	0.0622 (0.1590)	-0.0616 (0.4483)	-0.0244 (0.1777)
EFFLOW	0.1312 (0.2744)	0.0503 (0.1044)	0.4021 (0.3912)	0.1440 (0.1359)	-0.1971 (0.4675)	-0.0783 (0.1856)
EFFHIG	-0.0025 (0.2670)	-0.0010 (0.1029)	-0.1130 (0.4087)	-0.0419 (0.1530)	0.0137 (0.4226)	0.0054 (0.1674)
HLOSS	**0.4399*** **(0.2545)**	**0.1635*** **(0.0894)**	0.2609 (0.4138)	0.0928 (0.1409)	0.6150 (0.4230)	0.2359 (0.1524)
INCMT65	0.1079 (0.2394)	0.0414 (0.0913)	-0.3398 (0.4057)	-0.1212 (0.1397)	a	a
WAGEMT20	**1.8060***** **(0.6114)**	**0.5565***** **(0.0896)**	**a**	**a**	**2.4511***** **(0.8425)**	**0.5928***** **(0.0710)**
Control Variables						
HBP_SELF	-0.2835 (0.2697)	-0.1104 (0.1056)	-0.4885 (0.4110)	-0.1837 (0.1564)	-0.4135 (0.4484)	-0.1637 (0.1757)
HBP_OTHER	0.1373 (0.2645)	0.0533 (0.1035)	**0.6173*** **(0.3628)**	**0.2333*** **(0.1384)**	-0.3464 (0.5076)	-0.1343 (0.1905)
HBP_FAMHIS	-0.0599 (0.2253)	-0.0231 (0.0870)	-0.3925 (0.3164)	-0.1443 (0.1165)	-0.1130 (0.3864)	-0.0448 (0.1531)
REDUCE_SALT	**0.5563*** **(0.3158)**	**0.2167*** **(0.1220)**	**1.0805**** **(0.4490)**	**0.4002**** **(0.1578)**	0.7462 (0.7077)	0.2903 (0.2599)

SPECIFIC_ACTIONS	0.2985 (0.3492)	0.1164 (0.1369)	0.0630 (0.4743)	0.0233 (0.1763)	0.3677 (0.6862)	0.1457 (0.2699)
QUIT_NICOTINE	-0.2559 (0.5423)	-0.1008 (0.2159)	1.1228 (0.7666)	0.2901 (0.1148)	-0.7390 (0.7324)	-0.2819 (0.2494)
PEFF_LIMITSALT	**0.3036*** **(0.1569)**	**0.1170*** **(0.0603)**	**0.4745**** **(0.2251)**	**0.1743**** **(0.0827)**	0.0855 (0.2538)	0.0339 (0.1006)
PEFF_ACTIONS	0.0950 (0.1821)	0.0366 (0.0703)	0.2002 (0.2666)	0.0735 (0.0983)	0.4737 (0.3150)	0.1879 (0.1248)
PEFF_SMOKEALCO	-0.0660 (0.1016)	-0.0254 (0.0392)	-0.2765 (0.1876)	-0.1015 (0.0689)	-0.0699 (0.1352)	-0.0277 (0.0536)
RISK	**0.2846***** **(0.0769)**	**0.1097***** **(0.0295)**	0.1881 (0.1197)	0.0691 (0.0438)	**0.4885***** **(0.1265)**	**0.1936***** **(0.0499)**
VULNER	**0.1652**** **(0.0830)**	**0.0637**** **(0.0319)**	**0.2040*** **(0.1101)**	**0.0749*** **(0.0406)**	**0.3025*** **(0.1635)**	**0.1199*** **(0.0646)**
MALE	-0.1026 (0.2327)	-0.0397 (0.0903)	-0.2876 (0.3490)	-0.1064 (0.1289)	-0.0342 (0.4072)	-0.0136 (0.1616)
A2029	0.4883 (0.4548)	0.1737 (0.1446)	0.1051 (0.7129)	0.0378 (0.2510)	**1.1184*** **(0.6561)**	**0.3743*** **(0.1630)**
A3039	**-0.6021*** **(0.3335)**	**-0.2359*** **(0.1285)**	**-1.0200**** **(0.4874)**	**-0.3874**** **(0.1759)**	-0.2231 (0.5521)	-0.0887 (0.2192)
A5059	0.1896 (0.3217)	0.0721 (0.1206)	-0.3712 (0.4837)	-0.1400 (0.1860)	0.5996 (0.5053)	0.2297 (0.1831)
A6069	0.2986 (0.3799)	0.1114 (0.1360)	0.2424 (0.5380)	0.0865 (0.1857)	-0.0152 (0.5771)	-0.0060 (0.2290)
LESSHS	0.4819 (0.6027)	0.1689 (0.1851)	0.6496 (0.8752)	0.1994 (0.2122)	b	b
TRADES	**-1.0555**** **(0.4603)**	**-0.3959**** **(0.1449)**	**-1.4202**** **(0.7186)**	**-0.5147**** **(0.1979)**	**-1.6348**** **(0.7045)**	**-0.5084**** **(0.1187)**
COLLEGE	-0.1437 (0.3350)	-0.0558 (0.1309)	-0.4599 (0.6181)	-0.1747 (0.2389)	-0.2891 (0.5296)	-0.1147 (0.2097)

UNIV	-0.1683 (0.2982)	-0.0650 (0.1151)	-0.6094 (0.5357)	-0.2182 (0.1837)	-0.2681 (0.4283)	-0.1064 (0.1697)
Constant	**-5.5563**** **(2.3199)**		-4.6628 (3.3614)		**-8.5085**** **(3.8324)**	
	Observations: 191 Wald chi^2 (26 df): 60.62*** Log pseudolikelihood: -98.1621 Pseudo R^2: 0.2400 Observed probability: 0.5916 Predicted probability (evaluated at the mean): 0.6032		Observations: 98 Wald chi^2 (25 df):37.99** Log pseudolikelihood: -49.0858 Pseudo R^2:0.2444 Observed probability: 0.6224 Predicted probability (evaluated at the mean): 0.6580		Observations: 92 Wald chi^2 (24 df):42.01** Log pseudolikelihood: -39.6058 Pseudo R^2: 0.3736 Observed probability:0.5543 Predicted probability (evaluated at the mean): 0.5449	

a denotes that variable was not included in the estimated model
b denotes variable was dropped during estimation due to collinearity
* Denotes significance at the ten percent level
** Denotes significance at the five percent level
*** Denotes significance at the one percent level