IMPROVING THE NUTRITIONAL QUALITY AT WHAT COST?

THE ECONOMICS OF REDUCING SODIUM IN FOODS

By

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CHAPTER I

INTRODUCTION

Salt serves a multifaceted purpose in food products for producers and consumers. Producers use sodium as a preservative to increase shelf life, and consumers have a preference for salty, long-lasting, and convenient food products. In recent years a majority of health professionals agree that reducing sodium consumption in consumers' diets would improve their health. However, this idea is not fully supported by all (Robertson 2003; Charlton 1995; Nicholls 2011) and some even have research supporting the contrary (Whelton 2011; Taylor et al. 2011; Stolarz-Skrzypek et al. 2011; Ekinci et al. 2011). Despite inconsistent evidence in nutrition research and in an attempt to make Americans healthier, recent FDA recommendations direct agribusinesses to limit the amount of sodium in food products and thus in American diets. While much research has been done by food scientists and health professionals about the effects of excessive sodium consumption on health and its link to heart disease and death, Americans have not responded to the hype quickly due to a variety of reasons and hypotheses. Some scientists believe many Americans just may not know or be willing to give up foods that are leading them to poor health, while others conclude that higher sodium consumption is needed for proper physiological functioning (Luft 2009).

The U.S. has seen not only increasing obesity rates, but a massive decline in health status and an increase in diseases related to high sodium intake. In 2010, Oklahoma was ranked 46th by America's Health Rankings making the state one of the most unhealthy and obese in the United

States (America's Health Rankings 2011). In addition, Oklahoma is also ranked the number six state with the highest rates of adult hypertension, which has been linked to excessive sodium consumption as a cause and heart disease as a consequence (Trust for America's Health 2010). As far as the producer population, there are a variety of food processors in Oklahoma ranging from small bakeries to large agribusinesses. Oklahoma consumers and producers may not solely transact with the other in this global economy, but Oklahoma is one of the 47 states who have seen increased rates in hypertension between 2003-2007 and 2005-2009.

Salt is a key ingredient in processed foods, and a policy that would limit sodium content in order to address the increased health concern would significantly impact the food processing industry. Beyond consumers' preferences for salty foods and potential loss of market share, producers would also face the costs of more expensive ingredients and research and development, which would likely be necessary for producers to reduce or replace the sodium content or to completely reformulate the product to balance the food's chemistry. The unknown changes in inputs costs could affect food processors' profit margins and could lead to an increase in food prices and industry costs, which is similar to the recent Hazard Analysis and Critical Control Points (HACCP) regulation in the 1990s. Policymakers believe that a sodium reduction policy would benefit consumers, but what sort of policy will be enacted? Plus, the ability of policy to have its desired impact is unknown; consumers add salt themselves if sodium levels are dropped too drastically for their taste.

While the current FDA recommendations are voluntary, cities and states in the United States as well as other countries have taken initiatives of their own. New York, most notably, instigated activities to reduce the amount of salt in packaged and restaurant foods, and this coordination has evolved into the National Salt Reduction Initiative which has gained support across the country (Institute of Medicine 2010). Additionally, many brands are now offered with low sodium, low fat, or fat free versions of products so customers have the option to purchase healthier versions alongside the original product (Institute of Medicine 2010). However, many food processors may fear that if they follow this recommendation and fully change their products while others do not, they will lose their market share because of unchanged consumer preferences for salty foods. While there is still a demand for salty foods and no law limiting the salt content, there will be firms willing to meet that demand. Consumer preference for a saltier taste has shown to be adaptable to a lower sodium diet, but trying to force an entire nation to adapt would require cooperation by the entire food industry. Even before food processors were targeted, the FDA provided food consumption recommendations to the public; for instance, the My Food Guide Pyramid gave calorie goals to achieve and maintain a healthy diet, but the obesity rate has yet to decline. Government issued health warnings have yet to lead to an immediate change in consumer's preferences and have been unsuccessful in some instances.

Consumers change their tastes and preferences in response to new information at varying rates, but diseases related to sodium consumption are still a leading cause of death. Generally, the market changes by producers responding to the changing consumer demand, but now producers may be forced to change and face a major financial impact in product reformulation to reduce sodium use. If a policy is implemented, this would force the remaining food manufacturers to comply, but how will this affect the food industry?

Key questions include:

1. What is the cost to a firm to reduce the sodium in food products,
2. Can firms survive when transforming their production process to meet the requirements of such a policy,
3. Would some firms be more affected than others, and
4. Are there other health interests that food processors would be more interested in addressing rather than sodium reduction?

Objectives

The main purpose of this research is to determine the economic impact to food processors if a mandatory sodium reduction policy were implemented. The specific objectives of this paper are to:

1. Determine producer preferences for addressing various consumer nutrition issues and how sodium reduction compares to other issues,
2. Determine food manufacturer's willingness to accept to avoid a sodium reduction policy,
3. Determine industry policy preferences on regulating sodium consumption, and
4. Determine if the size of the firm or other demographics influences sodium reduction policy preferences.

CHAPTER II

REVIEW OF LITERATURE

1. Background: Purposes and Sources of Sodium

    a. Why is Sodium Included in Foods?

Sodium serves a variety of purposes in food products including preservation, flavor, texture and leavening and is also an element which is necessary for proper human body functionality. Historically, salt was primarily used as a preservative because it reduces the amount of water activity in foods, but with the emergence of technology like the refrigerator and other food preservation measures, that particular function of salt has become less necessary (Institute of Medicine 2010). There are a few other methods of preservation used today including high- or low-temperature processing and storage, pH, redox potential, and a few other additives. However, salt is still highly used in reducing the growth of pathogens which spoil products or at the least reduces the shelf life. Salt also promotes growth of desired microorganisms in certain foods requiring fermentation like cheeses. Other than just increased saltiness, salt's contribution to flavor also includes reducing bitterness and/or aftertaste, enhancing the sweet taste, and improving the overall palatability of the food (Liem, Miremadi, and Keast 2011). The next contribution to the final product qualities comes from its ability to stabilize frozen egg yolks and the texture added to meats, cheeses, and other snack products that the consumer expects. Finally, salt contributes to leavening in products by controlling the fermentation, strengthening gluten, regulating enzyme activity, and controlling the stickiness in bread dough prior to baking (Black 2011).

Sodium also plays a vital role in human physiology, particularly in the “optimal function of established peripheral and central nervous system (CNS) mechanisms” (McCarron et al. 2009). This essential micronutrient balances body fluid and the amount of water in the blood, and our bodies show its need for sodium by being the only mineral that we crave (Geerling and Loewy 2008). While meeting this need was once difficult and an abundance of salt was considered to be a luxury, the minimal requirement for proper physiological functioning is not a health issue in the United States anymore. The rise in popularity of convenient food products and food away from home, both of which tend to have high sodium levels, has contributed to a high and unhealthy average sodium intake and a difficulty to regularly consume a low sodium diet.

b. Economic Feasibility of Salt

Besides salt’s versatility in meeting several purposes all in one ingredient, salt is also an inexpensive input, making it the most financially sound option as well. Thus if simply reducing salt is insufficient, replacing salt as an ingredient and preservative is likely to increase costs. Reducing salt in products would likely cause higher spoilage rates and an increased presence of pathogens, meaning firms would need change processing and handling procedures to avoid these issues. Thus, it may be difficult for producers to reduce sodium and maintain the physical properties of a product due to lack of other ingredients that can fulfill similar functions in a cost efficient manner or at all.

c. Sources of Sodium

Why should manufacturers be asked to reformulate their products to reduce consumers’ intake of sodium? Salt is not the only leavening agent or sodium based ingredient; sodium can end up in food through multiple ingredient compounds. Consumers most commonly use salt themselves while cooking and at the table; however, this is not where the majority of salt consumption occurs. James, Ralph, and Sanchez-Castillo (1987) and Institute of Medicine (2010) conclude that 10% of intake comes from the natural salt content of food, 15% from discretionary salt use (table salt), and the remaining 75% comes from salt added by manufacturers in food products, which accounts for about half of the salt intake of Western populations. In addition, all of the salt used while cooking does not end up in the consumer's food unlike what some studies have assumed in the past; about three-fourths of cooking salt evaporates. Thus, James, Ralph, and Sanchez-Castillo (1987) imply that in order to achieve a reduction in the average salt intake, manufacturing salt use should be targeted.

There is also a growing disparity between the sodium densities of foods consumed at home and away from home where consumers have less control over the nutrient content. One study found that the sodium density, "defined as the number of milligrams of sodium per 1,000 calories,…was 1,825 mg/1,000 calories [of foods away from home] compared to 1,422 mg/1,000 calories for foods consumed at home" (Institute of Medicine 2010). In addition, many consumers have a misconception of where their sodium intake may occur even between different types of food. Most salt intake actually comes from the consumption of bread and pasta rather than processed meats, contrary to what much of the general public may think.

d. Potential Sodium Substitutes

While salt is a major source of sodium in food products across the country, there are many sodium-containing compounds. Some of these compounds have a lower sodium content than salt and are potential possibilities thanks to the advancement of ingredient technologies (Institute of Medicine 2010). However, for each type of food product, different alternatives must be considered; there is not a universal ingredient that could fully replace sodium. Sodium plays different roles when it's included in different food types, which contributes to the dilemma food manufacturers are facing as they consider what substitutes are available.

As far as specific sodium replacers in foods, there are many that have been identified as possibilities. First, potassium chloride, calcium chloride, and magnesium sulfate "contribute a certain salty taste quality, [but] they may also provide undesirable after tastes such as bitter, metallic and astringent tastes, which has limited their current use in food manufacturing" (Liem, Miremadi, and Keast 2011). Sea salt has also been mentioned by some as a sodium replacer; however, the American Heart Association (2010) heeds that sea salt has just as much sodium as table salt. The Association conducted a survey in which 61% of respondents believed that sea salt had less sodium content than table salt, which is a public misconception. Sea salt does contain traces of minerals such as magnesium, potassium, and calcium due to the lack of processing, but these minerals can easily be obtained by the consumption of other healthy foods. Since the 1920s, table salt has had iodine added during processing to prevent iodine-deficiency disease, and sea salt does not have this addition. While there are pros and cons for sea salt's lack of processing and some find it to be 'natural' and thus favorable, it should only be a "matter of letting your taste buds decide" (American Heart Association 2010).

The use of herbs and spices in foods would be an option for processors to enhance flavor, but they do not have a salty taste. Lee (2010) wanted to find a viable salt substitute from herbs and spices that provided the salty taste as well, and he found three plant aqueous extracts out of thirteen to include in what he called a plant salt substitute (PSS). Once the degree of saltiness was the same between PSS and table salt, he found that sodium content was 43% less than table salt. There are numerous potential substitutes, but as a spokesperson for Kraft Foods said at an FDA hearing, "what works [to replace sodium] in one salad dressing does not necessarily work in another salad dressing" (Black 2011). The Institute of Medicine (2010) provides a table of alternatives to sodium-containing compounds, which is shown in Table 1. This table is not conclusive, and industry and academia continue to search for an obvious sodium replacer that will eventually contribute to the effort to reduce the average sodium intake.

Table 1. Alternatives to Sodium-Containing Compounds (Institute of Medicine 2010)

Sodium Compound(s)	**Sodium Alternative(s)**	**Comments**	**Reference**
Leavening Agents:	Monocalcium phosphate	Gas may be released at a different time than with sodium-based leavening compounds, and processing changes may be needed to accommodate these difference	Kilcast and Angus, 2007; Reducing sodium, a matter of taste, 2007
Sodium bicarbonate	Dicalcium phosphate		
Sodium acid pyrophosphate	Potassium bicarbonate		
Sodium aluminum phosphate	Calcium acid pyrophosphate	Timing of gas release is closer to that of sodium-based leavening compounds	Reducing sodium, a matter of taste, 2007
Sodium hydrogen carbonate	Ammonium bicarbonate	Has been found to increase the potential for acrylamide formation, creating concern about its use	European Commission, 2003
Sodium acid pyrophosphate (SAPP)	Glucono-δ-lactone	Suitable for use in combination with sodium bicarbonate to reduce use of SAPP in cake-like products	Reichenbach and Singer, 2008
Sodium metabisulfite as a dough conditioner	Cysteine	Provides similar dough-softening action, but is more costly than sodium metabisulfite	Cauvain, 2003
Sodium phosphates as water-binding agents	Potassium phosphates	Provides water binding in deli meats and hams similar to that of sodium phosphates	Ruusenen et al., 2002
Sodium phosphates and sodium citrates as emulsifying salts	Potassium citrates, potassium phosphates, calcium phosphates	Can be used as a replacement in some processed cheese products	Guinee and O'Kennedy, 2007

2. Sodium and Health

a. Current Sodium Consumption: Recommended vs. Actual Levels

The average American consumes approximately 3,400 mg of sodium daily when the suggested maximum intake is 2,300 mg (United States Department of Agriculture and Department of Health and Human Services 2010). The Dietary Guidelines for Americans also recommend for people ages 51 and older; children; African Americans; or those who have hypertension, diabetes, or chronic kidney disease to reduce intake to 1,500 mg, which applies to approximately half of the U.S. population (United States Department of Agriculture and Department of Health and Human

Services 2010). The Guidelines were disputed by McCarron et al. (2009) where they argue that our sodium consumption is set within a physiologic range of 117 mmol/d or approximately 2,450 mg which is higher than the Dietary Guidelines of 100 mmol/d or 2300 mg. This amount is still far below the current average intake, so why have consumers not taken control of sodium intake themselves to meet the recommended levels? Early research first showed that only the higher risk groups such as older adults and African Americans should take measures to reduce sodium (Institute of Medicine 2010). However, "evidence [has become] stronger that sodium should be a concern throughout the lifespan" (Institute of Medicine 2010), but others disagree that sodium reduction should be approached with policy mandates. The Committee theorizes that consumers may not have the motivation to reduce sodium because they do not see serious ramifications due to disputing evidence. McCarron et al. (2009) also suggest that since our intake is physiologically determined, then a national policy that failed to recognize this relationship would be setting an unachievable goal.

In addition, sodium content varies between different types of food products and carries out a variety of functions as listed above, and despite all efforts made toward this cause, a change in sodium consumption may not occur if consumers add salt to the foods to make up for the loss of flavor or less salty taste. If pursuing the method of requiring food manufacturers to lower sodium content, policymakers must remember that consumers must be cooperative to achieve this sodium reduction goal; consumers adjusting their table salt use would negate the policy's impact.

b. Low Sodium Product Offerings and Demand

Consumers became less concerned about sodium content, along with fat and cholesterol, and more concerned about sugar and calorie content from 1998 to 2004 (Food Marketing Institute 2004). This corresponds with the fact that the introduction of new products with low or reduced salt claims increased until 1991 where it peaked, but then decreased from 1991 through 1997 (Weimer 1999). A variety of factors could be at work against reduced sodium products, but evidence shows that consumers have yet to see the need to sacrifice their money or the product's salty flavor to reduce their sodium intake. Their vote in the market with their food dollars has yet to side with sodium reduction claims even though those food options are available on the shelves.

Why would health claims of reduced or low sodium content not be demanded by consumers? At the FDA Public Meeting on Approaches to Reducing Sodium Consumption, Dr. Richard Black (2011) from Kraft Foods explains that in some products, consumers do not want or look for a healthy version. They were not intending to eat a healthy food when choosing to buy Ritz crackers, for example. When initially introducing this product, they used the health claim of "Low sodium," which did not make it well on the shelves. They were much more successful when changing the claim to "Hint of Salt," even though it was the exact same product. Consumers want crackers that have a salty flavor. However, blatantly claiming low sodium on products like cottage cheese did well on the shelves without having to employ different marketing schemes. Consumers do not expect for some foods like dairy products to contain sodium content and therefore, are not supposed to reduce sodium. This example gives insight that to maintain the supposed flavor appeal and still reduce overall sodium intake may be as easy as marketing techniques with or without a reduced sodium policy. Further research could explore this option.

c. Food Prices and Sodium Content: The Law of Demand

Studies have found that in general, healthier food choices require more money (Darmon, Ferguson, and Briend 2002; Cade et al. 1999), and we assume that reduced sodium products are included in this category. Consumers have an inelastic demand for food in general, but the priority of health claims vs. the product price varies individually. If the price for a reduced sodium product is significantly higher than the regular product, the consumer will likely prefer the regular product, depending on their willingness-to-pay for the healthy attribute. Looking at the application of consumer theory, it is assumed that consumers derive utility from the presence of salt or at least the diverse functionality of salt in their foods and will maximize utility by choosing foods within the limitations of their budgets. Whether their budget or utility of salty foods has a larger impact, both price and taste still remain as the top priorities in food products by consumers (Institute of Medicine 2010).

d. State of Health: The United States and Oklahoma

The health of the United States has declined over the past few decades, which has led many researchers to examine the links between what is causing this epidemic, ways to reduce poor health decisions, and methods to prevent their disease-related consequences. “Twenty years ago, no state had an obesity rate above 15 percent. Today, more than two out of three states, 38 total, have obesity rates over 25 percent, and just one has a rate lower than 20 percent” (Trust for America's Health 2010). The relevance of the obesity epidemic is shown in the connection between it and hypertension. In the most recent Healthy Americans publication, nine of the ten states with the highest rates of hypertension are shown to also hold the highest obesity rates. The state of Oklahoma happens to be included in those top ten states for both polls, number six and number seven respectively. The hypertension rate in Oklahoma increased from 21.7% to 31.9% from 1996 to 2011, and in that same timeframe, the obesity rate has been one of the fastest growing in the United States. In addition, Oklahoma is the 48th worst state in cardiovascular deaths per year with 336.1 deaths per 100,000 population (America's Health Rankings 2011) Thus, the state of Oklahoma not only has a vested interest with food manufacturers whose headquarters lay within the borders, but Oklahoma consumers could also be effected by any decisions made in the sodium reduction debate.

3. The Link between Sodium Intake and Effect on Blood Pressure: If Salt is Reduced, What is the Expected Outcome?

The first and third ranked causes of death in the United States, respectively, are heart disease and stroke, and high blood pressure is a main contributor to these diseases (Warner 2006). One study was even able to link 47% of heart disease and 54% of strokes to elevated blood pressure (Lawes, Vander Hoorn, and Rodgers 2008), and another found 49% and 62%, respectively (He and MacGregor 2010). The correlation between sodium consumption and high blood pressure to these two chronic diseases comes from random clinical tests of sodium intake interventions, which are generally hard to control intake levels (Sacks et al. 2001; He and MacGregor 2004) and population-based research (Intersalt Cooperative Research Group 1988). However, the correlation has been at least questioned or contradicted with evidence showing that the low sodium interventions led to a further decrease in health rather than an improvement as hypothesized by health professionals.

a. Decreased Sodium Intake Results in Lower Blood Pressure

Dahl and Love (1954) provided some of the first evidence towards a correlation between high sodium intake and hypertension in humans. Then in 1974, he led a study in rats that he claimed provided evidence that salt did in fact cause hypertension (Dahl, Heine, and Thompson). However, Moyer (2011) points out that Dahl fed the rats an extreme human equivalent of 500 grams of sodium a day, which compares to the 3.4 grams of sodium consumed by the average American today. Another study simulates what would happen if processed and restaurant food sodium levels were cut in half and found that hypertension could be reduced by 20% and 150,000 lives could be saved in the United States in just one year (Havas, Roccella, and Lenfant 2004).

Selmer et al. (2000) looked at possible interventions to reduce sodium intake in the Norwegian population and estimated the health and economic consequences involved. The interventions considered include: health promotion, development of new industry food recipes, declaration of salt content in food, and taxes on salty food or subsidies of products with less salt. They used a dynamic simulation model and estimated a net savings over 25 years to be $270 million, and that these interventions could halve the intake of sodium per day. “The use of taxes and subsidies will induce people to eat less salt than they normally would prefer…[but] permanent welfare loss is unknown because people tend to prefer less salty food when they have been on a low salt diet for some time" (Selmer et al. 2000). They conclude that great health benefits from these interventions could be discovered which should lead to reduced blood pressure and risk of stroke. They also imply that the costs of implementing these interventions would be offset by the increased life span of the population and decreased healthcare costs.

Dr. Lawrence Appel at the FDA Public Meeting on the issue cites many different types and quantities of studies that find evidence relating salt intake to blood pressure (Appel 2011). However, he explains that many of these studies have "major methodological limitations, particularly related to assessment of sodium intake" because it is difficult to measure sodium intake (Appel 2011). He cites one study as doing the best job in controlling individual sodium intake every day and thus has the strongest case: the Dietary Approaches to Stop Hypertension (DASH) – Sodium Trial. This study finds that blood pressure can be reduced by 6.7% (or 8.9 mmHg) from the typical American diet once put on the DASH diet, and those who came in claiming to eat a healthier diet also saw a 3% reduction (Sacks et al. 2001).

Multiple studies estimate the lives saved or medical costs that could be prevented; however, none have examined the economic impacts of sodium reduction on producers or the impacts on food prices to use salt replacements and account for greater product spoilage.

b. Low Sodium Diet Leads to Negative Health Effects?

Some studies did not find that a lower sodium diet led to reduced blood pressure or other improvements in overall health – they found contradictory conclusions instead. Stolarz-Skrzypek et al. (2011) found that lower sodium excretion in their urinary excretion tests was correlated with *higher* cardiovascular disease mortality. On a couple of studies with patients who had diabetes, lowering sodium intake was linked with "increased all-cause and cardiovascular mortality" in type 2 diabetes (Ekinci et al. 2011) and "is associated with all-cause mortality in patients with type 1 diabetes" (Thomas et al. 2011). While both of these studies do not claim that reduced sodium intake causes these outcomes in diabetes patients, they do caution the application of universal sodium reduction measures.

In some instances, a reduced sodium diet has been found to have indirect or unintended consequences. For example, one study warns that those who try to eliminate or reduce sodium from their diet, lose the consumption of other vital minerals (Engstrom and Tobelmann 1983). In another study focused on the food safety aspect, Taormina (2010) warns against rushing to create a sodium reduction policy due to unknown behaviors of food borne pathogens and spoilage organisms "which could lead to significant disruptions to international commerce at best…and [at worst a] significant increase in exposure to humans to food borne pathogens."

c. Past Health-Related Issues and Their Outcomes

Unintended consequences that counter the original purpose of policy can occur as was found in several health-related studies. One set out to determine the likely impacts if a new proposal were to change the ability of food stamp participants to purchase unhealthy foods (Alston et al. 2009). They found that prices for healthy foods would increase, prices for unhealthy foods would decrease, and non-participants would be encouraged to consume unhealthy foods. The connection to the sodium reduction debate and this particular study is to show that even with the best intentions, negative side effects could occur.

So far the educational attempts to reduce sodium consumption along with other things like fat, sugar and cholesterol consumption have provided undesirable or no results. For example, the nutrition facts panel gave consumers food product information to address the problem of consumers' misconceptions, but it did not work in reducing sodium consumption and the assumed corresponding health problems. Mojduszka and Everett (2005) stated that the mandatory nutritional labeling policy was a large financial investment for the United States government, but that it has been ineffective in influencing consumer demand thus far, at least in the items they studied: prepared frozen meals and salty snacks. Gorman (2010) points out that the Dietary Guidelines have made suggestions to the American public where the substitutes were proven to be worse than the original unhealthy ingredient. For example, about 20 years ago, the Dietary Guidelines suggested reducing butter consumption and usage while cooking, so many people substituted margarine in its place. Research later found that trans fat in margarine was much worse than the saturated fat in butter, and thus, their recommendation did more harm than good. The same thing happened when lower fat diets and more carbohydrates were recommended by the Dietary Guidelines; researchers now think this recommendation has contributed to misconceptions of the nutrient content and the overconsumption of low fat labeled foods and snacks, especially by those who are obese (Hedley et al. 2004; Wansink and Chandon 2006). Wansink and Chandon (2006) also find that especially in overweight individuals, low fat labeling increases their consumption of all foods, not just the low fat items; a "health halo" causes people to eat more just because they believe it is healthier. Thus, manufacturers have reason to question the FDA before they have to put forth money, resources, and effort in the major undertaking of reducing sodium.

Research does not provide a clear answer as to whether high sodium levels cause high blood pressure among all populations. Reducing salt may help some or even majority of the population, but are there some segments of the population that would experience adverse health effects from such a policy? Several caution the use of a nationwide policy and suggest executing a more thorough study before regulating the level of sodium in any particular food product (Nicholls 2011; Thomas et al. 2011). As the evidence stands now, a decision to approach these health concerns via food processors would be a gamble; "for every study that suggests that salt is unhealthy, another does not" (Moyer 2011).

4. Methods to Sodium Reduction

   a. Voluntary Efforts

Previous attempts to reduce sodium consumption with a focus on consumer action have failed, thus the industry is now expected to reformulate products and help Americans reach sodium level goals. The Institute of Medicine (2010) explains that a lack of voluntary product reformulation among the majority of food processors is due to concerns about product taste and the cost involved. Reformulation is usually done to reduce the cost of producing food. Salt is an inexpensive ingredient, so manufacturers have little financial incentive to take on the task. Also, when consumers identify taste as the biggest factor in their food choices over price or nutrition, manufacturers fear a loss of market share to products that taste better or companies who have not reduced sodium content. A policy would remove most of this fear because all parties would have to reduce salt usage, and some say that the best way for Americans to achieve a healthy diet is to improve the composition of the basic foods eaten by all socio-economic classes (van Raaij, Hendriksen, and Verhagen 2009). However, the industry is still left with the uncertainty of economic consequences and the potentially dramatic change in consumer choices with any policy that would essentially change the ingredients allowed in the production process.

Some agribusinesses have taken the recommendation to heart and have taken steps to reduce sodium levels in their food products. Two approaches have been utilized voluntarily to reduce sodium by firms. First is that firms are making just enough changes to qualify for sodium content claims, which is provided clearly on the packaging. The other approach used is making gradual “silent reductions” that are generally not advertised to avoid losses in market share, which has occurred in previous attempts to advertise reductions (Institute of Medicine 2010).

There are multiple ways this issue could potentially be regulated, but currently it is unknown how the FDA will approach this initiative. The impending sodium policy may set a limit on salt content in all food products across the board, not necessarily based on the type of food. Even if basing on the type of food, how would appropriate limits be set? If a sodium reduction policy is implemented, this would force the remaining food manufacturers to follow suit, and the question is raised of how this will affect the food industry. What is the cost to a firm to change the nutrient make-up of their products, and will it be covered by what studies claim to be the benefit of reduced sodium foods? Can firms, large and small, survive when conforming to policies that may be implemented to limit sodium content in processed foods?

b. Potential Policy Options

Some regulatory approaches are evaluated in the literature on their potential effectiveness and costs in the context of reducing salt. Forshee (2008) gives five potential approaches the FDA could take which include doing nothing and maintaining the status quo, providing the risk and information to consumers, reclassifying salt as a food additive rather than an ingredient (changing the Generally Recognized as Safe (GRAS) status), a straightforward tax on sodium to consumers, and a cap-and-trade system. Forshee (2008) concludes that the cap-and-trade system would be the most effective approach, and he cites that the system is recommended by the EPA when "the environmental and/or public health concern occurs over a relatively large area; a significant number of sources are responsible for the problem; the cost of controls varies from source to source; and emissions can be consistently and accurately measured." Sodium consumption and use fit all of these categories, and the process would start with sodium credits being given to each firm after an overall reduction is established. Companies could then auction off leftover credits to firms who have more difficulty meeting their targets, and firms are thus given the opportunity to be cost efficient and maintain market share for goods that require more salt to keep the same product quality. While this option seems logical on paper, research has not identified what producers would be more willing to implement, but even so, it is unclear if the FDA will employ the most favorable or least cost method for producers when the policy is being formulated.

Looking at a related topic, Kuchler et al. (2005), who are all ERS economists, analyze different ways to combat the issue of obesity through policy. There are many variables that effect individuals' diet choices other than just prices and income; taste, convenience, family structure and traditions, age, health status, knowledge, and lifestyle are also factors. Thus, a policy changing the price in the form of a tax may not be as effective with all the other factors held constant, so incentives must be created to change diet choices. ERS examined a few potential obesity policies including mandatory nutrition labels in restaurants and taxes on snack foods. Mandatory labeling could result in a number of different scenarios ranging from an overall improvement in the nutritional quality of food in restaurants to promotion of their less healthy options alongside an extended menu of healthy options to avoid alienating consumers who are not nutritionally conscientious. Many restaurants have added at least a small offering of healthier menu options with labeling of some kind. However, as the obesity rates continue to climb, the average consumer is still placing more value on cheaper food calories over the benefits of a healthy lifestyle or at least overlooking the healthier part of the menu.

On the proposal for a tax on snack food, Kuchler et al. (2005) discuss a few problems. First, this excise tax would be considered regressive because the burden of the tax would hurt low-income consumers more since they use a larger proportion of their income on food than the upper and middle class. Second, a tax on certain foods may cause consumers to substitute to other goods that are not taxed, but not necessarily better either. Next, food companies would have to be in a perfectly competitive market for the tax to be fully passed onto the consumer rather than the tax being absorbed partially by the manufacturers. Fourth, expenditures on snack foods account for a very small percent of annual income, so consumers are unlikely to pay attention to changes in the total price. A high tax rate on salty foods could influence better choices on behalf of consumers, but only if the tax is broad so consumers cannot substitute one salty food for another.

Schmidhuber (2004) discusses some possible remedies to the overall obesity epidemic around the world including price interventions at the commodity and final consumer level, along with incentives and disincentives to lose excess body weight, which can relate to the sodium issue at hand. The first food price intervention analyzed is the tax on energy-rich foodstuffs with the desired effect of reducing excess food consumption. This, however, would affect low income individuals more as mentioned earlier, but it would also interfere with high calorie needs individuals. Also, "if these 'junk' foods were to be taxed, the fat and sugar added currently to ice creams and hamburgers would occur elsewhere in the food chain" (Schmidhuber 2004). The next intervention technique of taxing producers for the primary causes of obesity like sugar and fat, for example, assumes that the tax is passed onto consumers, which changes their consumption of goods containing those ingredients. However, depending on the individual products and their price elasticities, some of the tax may not transfer to the consumer and little change occur in consumers' consumption habits. The disadvantages to these interventions are likely to be greater than the advantages when confronting obesity, but in a 'perfect world' situation where the price interventions are targeted, demand is elastic for all goods, and consumers have the ability to substitute for healthier foods, an intervention could work.

The most effective and efficient tax to reverse the trend of obesity as suggested by Schmidhuber (2004) is a tax on excess body weight rather than calorie consumption. This would "essentially reflect the application of the 'polluter pays principle' for obesity" (Schmidhuber 2004), and this method accounts for calorie expenditure as well as calorie consumption. Calorie consumption may be high due to high metabolism or high levels of physical activity, so taxing food calories is putting a burden on individuals in those circumstances who are not the target of such a tax in the first place. A "fat tax" directly taxes the dietary energy imbalance instead. One study finds that the price elasticity of demand for food with high levels of fat, salt, and/or sugar is elastic, thus a fat tax could be unobtrusive and still create a considerable change (Szucs and

Csapo 2010). Therefore, a tax is an opportunity for consumers to reformulate their eating habits and hopefully work towards a more adequate level of health care costs. For example, this could be translated to salt consumption via higher insurance rates for high blood pressure patients, for example, as an incentive to reduce salty food intake. But until more conclusive evidence is found, the translation of this policy option would be difficult to define.

A simpler suggestion mentioned proposes to focus on “new product development with [a] lower sodium…baseline…may be less costly than reformulating existing products with established consumer taste expectations” (Institute of Medicine 2010). For the time being, however, it is uncertain of the route the FDA will choose, or even which method food processors would prefer or be more willing to perform over the others.

5. Consumer Preferences for Salty Foods – Can They Change?

Consumer demand for reduced sodium products has fluctuated throughout the past few decades, and even while in a slump of overall concern for the issue by consumers, the government has taken interest for them. Efforts have been made to provide health information about sodium to consumers; however, many do not use that knowledge to consume a healthier diet. One particular study found that “despite abundant information regarding the adverse health effects of fat and cholesterol, the decline in fat consumption among men and women has been considerably small since 1977” (Rimal, Moon, and Balasubramanian 2007), which thus far is similar to the story of sodium consumption.

Will an initiative to reduce sodium in the food supply reduce the average sodium intake in the United States and be accepted by consumers? As the Institute of Medicine (2010) explains, “even with a focus on changes in the food supply, it must nonetheless be recognized that consumers would still have a role to play in decreasing sodium intake, and efforts to promote changes in consumer behavior would be worthwhile.” But when 70% of Americans do not know the Dietary Guidelines for sodium, either the consumer's lack of interest or lack of knowledge on the topic would be inhibiting change (Greenstein 2011).

Including the DASH Sodium trial with hypertension patients, Karanja et al. (2007) found that over a long period of time of consuming a low sodium diet, participants would be more accepting of low levels of sodium. Participants in the experiment and control diet groups were easily able to distinguish between the different sodium levels and gave the highest acceptability rating to the intermediate rather than the high level of sodium. Participants in these studies likely consumed high sodium levels before entering the study, which they assume to be why they gave low acceptability ratings to the lowest sodium option. Also considering that the DASH diet study found that blood pressure is lowered when sodium is reduced to recommended levels (Sacks et al. 2001), the Dietary Guidelines for Americans 2010 cites the study when recommending the maximum daily intake.

Since consumers are hearing more and more in the media that high sodium intake is bad for one's health and could lead to hypertension and high blood pressure, why is information alone not swaying consumers to purchase low sodium items? Hersleth et al. (2011) explain that it might be because salty foods fall in the category of "habit-natural." These are foods generally labeled as traditional foods that are eaten frequently meaning that small changes in the ingredients would be noticed, and the salt content level would be considered a habit-natural ingredient in foods. This means that manufacturers want to investigate consumers' reaction to changes in sensory properties in a product before launching new versions on the market. In their study on dry-cured ham, a majority actually preferred the product that is naturally salty to have lower salt levels. Saha et al. (2009) perform and evaluate a consumer taste test on four varying levels of salt on marinated poultry breast meat and one control of unmarinated breast meat. They found that the marinated fillets overall had better Just About Right (JAR) ratings than unmarinated fillets regardless of the salt concentration. As the level of salt increased, taste testers were able to distinguish between the concentration levels, and a majority of the consumers considered the lower levels of salt to be JAR and the higher levels to be too salty.

Certain households are more conscious of their consumption of products which contribute to health problems. Rimal, Moon, and Balasubramanian (2007) consider how individual demographics and 'health attitude,' or health consciousness of household meal planners, affect their food selection involving various dietary components to improve health intervention and information programs. They found a positive relationship between consumer's awareness of fat and chronic diseases and their household income. In their particular study of 3,000 households, they found that income affects fat, calcium, and cholesterol considerations of food, but not salt. The size of the household, which indicates the presence of children, has a positive correlation with the concern for salt and calcium while cholesterol, fat, overall health contribution, and sugar were not considerations in food selection. Age also has an effect – older households consider sodium, calcium, and cholesterol intake more than younger households. The health attitude significantly influences the considerations of most nutritional factors while making food selections. Therefore, those with health aptitude, older ages, and a presence of children in the household are more likely to have interest in sodium reduction claims or potential policy.

6. Initiatives by:

    a. Government

        i. United States Government – Timeline of Regulation

The history of sodium regulation in the United States starts in 1958 when salt was given the GRAS or "Generally Recognized as Safe" status. Then in 1978, the Center for Science in the Public Interest (CSPI) petitioned for the FDA to regulate sodium, and the following year, the Select Committee on GRAS Substances (SCOGS) said after a review of salt that sodium should be reduced. 1980 was the first year that the Dietary Guidelines recommended to avoid excessive salt consumption, but the FDA "concluded that it would not act "at this time" to revise the GRAS status of salt, relying instead on public education, voluntary industry efforts, and a new FDA effort to expand disclosure of sodium content on product labels" (Taylor 2009). CSPI even sued FDA to try to force action on sodium reduction in 1982, but the court's verdict was to allow time for FDA's approach of voluntary action to work (Jacobson 2010). When little change was observed throughout the 1980s, CSPI re-petitioned the FDA to regulate sodium in foods. In 2007, the FDA held a public hearing, but it led to no action. New York City pushed the FDA at this hearing to regulate and urge cuts, and in 2008, the city government took matters into their own hands, which is discussed in the next section. In 2010, the Institute of Medicine released a report that eventually called for a gradual reduction in sodium, and in the following year, the FDA held another public meeting on Approaches to Reducing Sodium Consumption where health experts and professionals in the industry where able to testify on the subject. Now, the FDA is reviewing comments that were submitted by the January 27, 2012 deadline before making a decision on a Final Rule.

ii. City of New York

The National Salt Reduction Initiative (NSRI) was established in 2008 to develop a framework for voluntary reductions in sodium content by partnering with city and state health departments and public health organizations. The initiative "is intended to promote gradual, achievable, substantive, and measurable reductions" (Institute of Medicine 2010) with a goal to reduce sodium intake by 20% over the next five years. Their approach includes these steps: "defining and establishing food categories, proposing targets, reviewing industry feedback, announcing 2012 and 2014 targets, assessing progress toward food targets, and measuring changes in population sodium intake over time" (Institute of Medicine 2010). In order to measure changes in sodium, a packaged food database was created that connected sales data to nutrition data tables through the Universal Product Code (UPC), and a restaurant food database was created as well. Packaged food categories were defined based on key food categories and their contribution to daily sodium intake, and targets were also set based on the desired percentile reduction of sodium for each category. To test the overall reduction, the NYC Health Department will conduct a 24-hour urinary sodium evaluation in 2010 and 2014 to see the change in population sodium intake.

iii. United Kingdom

The United Kingdom has focused on three areas: involvement with the food industry, a Food Standards Agency sponsored awareness campaign, and voluntary front-of-package nutrition labeling. The UK has continually decreased sodium intake levels over the past few years, and they have now lowered their population sodium consumption to US sodium consumption levels. If the intake levels continue to fall, UK methods may also become an effective method.

iv. Summary of Other Countries

The Institute of Medicine (2010) also provided methods used by other countries and individual US cities and their effectiveness thus far, which could serve as a starting point for forthcoming salt reduction policy. Some approaches include education, voluntary reduction, research, the media dispensing information to the public and an assessment of urinary sodium excretion. Media outlets have proven effective in Finland where companies have realized lost market share for high salt content products so they are either dropping these products or reformulating them to reduce the sodium content. The NYC National Salt Reduction Initiative uses similar methods.

The Institute of Medicine (2010) considers efforts to reduce sodium intake throughout the world because reducing salt across the board would be the most cost-effective way to reduce the risks associated with cardiovascular disease. In 2006 in Canada, the Chair in Hypertension Prevention and Control was appointed to lobby for policies aimed to reduce salt in foods. A working group was also established and functions using a three-prong approach: education, voluntary reduction, and research. The European Union developed a common framework in 2008 with a goal to meet the World Health Organization (WHO) standard of a 16% reduction throughout the next four years. Finland has been the trailblazer in being one of the first countries to attempt to reduce sodium intake with the use of the media to dispense information as well as an assessment of urinary sodium excretion. France has implemented a similar program and working group, but no significant changes have occurred. Finally, Ireland has successfully reduced salt in all bread at a minimum of 10% over the span of five years.

b. Industry and Retailers

Many prominent food companies have set their own goals and initiatives to reduce sodium. First, Kraft Foods spokesman, Dr. Black, declared that Kraft is planning to reduce sodium by an average of 10% over the next two years (2011). However, this does not mean every food item will have sodium taken out of the final product; he explained that while some products cannot have any sodium taken out without changing the final product, some goods can have a 30% reduction. Next, Walmart has set specific goals that they believe will result in the removal of 47 million pounds of sodium from products sold in their stores each year, and Tres Bailey (2011), Walmart spokesperson, explained that they would reduce sodium by 25% as well as reduce the sugar content and remove trans fat in their Great Value brand products over the next five years. Figure 1 lists targets that other companies around the globe are aiming to achieve voluntarily.

a. Restaurants

McDonald’s USA has pledged to reduce sodium by an average of 15% by 2015. Dr. Goody (2011), the McDonald’s spokesperson in a testimony at the FDA Public Meeting, noted that to be effective in their particular chain of restaurants in reducing sodium intake, an incremental, market driven approach must be conducted in order to meet the food preferences of their customers. Starting in 2003, the company began the process of reducing sodium in the kids’ meal favorite: chicken nuggets. In nine years, they have been able to reduce sodium by 20% in the product. Without such a gradual reduction, consumers will go elsewhere to order their favorite meals or add the salt back at the table.

Industry Sodium Reduction Commitments

Company	Territory	Target
General Mills	U.S.	-20% across 40% of product portfolio (2015)
Grupo Bimbo	U.S./Mexico	-40% across bread portfolio (2015)
Kellogg's	Global	Continue reducing salt in breakfast cereals leading brands
Kraft Foods	North America	-10% across product portfolio (2012)
Mars	Global	Continue reducing salt across entire global food portfolio (e.g. -25% in flavoured varieties of Uncle Ben's rice by 2015)
Nestle	Global	-25% in products with a sodium content greater than 100mg/100kcal (2005-2010)
PepsiCo	Global	-25% in key global brands in key countries (2015)
Unilever	Global	-25% across product portfolio to meet an interim target of 6g of salt per day, with ambition to go with further with 15%-20% gradual reductions to 5g per day (2015 - 2020)

Figure 1. Sodium Reduction Commitments (International Food & Beverage Alliance)

7. Conclusion

Salt has been linked to major health problems, and many professionals are suggesting government involvement to reduce the amount of sodium in foods. This is formulating "policy goals that will make healthy choices the easy choices" (Trust for America's Health 2010). But should healthy foods be the only choices allowed to be available? While it could be argued that health choices should be a matter of willpower and personal choice rather than enforced by the government, a balance could be achieved through consumer education and the free market. If a policy is implemented, food processors would likely have to reformulate their products, shocking the entire industry and market. More problems could arise than just economic costs; some caution that food borne pathogens would be an obstacle to overcome due to sodium's role in controlling these organisms. A host of other unintended consequences could turn into additional costs, and in the case of sodium, the economic impact could include the cost of reformulation, any necessary precautions, and the changes that could occur to their operations as a result. This research hopes to find the economic impact to food manufacturers if this FDA recommendation were to become a policy.

Even specifying a limit that differs based on the food groups like the National Salt Reduction Initiative could prove to be more effective rather than one level that is set for all foods. Beyond the question of how this would affect the food industry, more research should be done on alternative preservative and flavor ingredients to insure the FDA is not taking control of one issue that will spawn an even worse nutritional issue.

CHAPTER III

METHODS AND PROCEDURES

A policy mandating agribusinesses to change production practices in order to meet a market failure issue or a goal in favor of the American public has been implemented only a limited number of times. In one instance, the government used this policy approach to ensure safety in the food supply with the mandated use of the Hazard Analysis Critical Control Point (HACCP) system in the production process (Unnevehr and Jensen 1999). HACCP was implemented in several segments of the food industry throughout the 1990s in the United States, and research to compute an estimated cost for its implementation resembles this research relating to a reduced sodium mandate.

Procedures that HACCP researchers used in the past to determine estimated costs for producers will provide guidance on how to calculate the economic impact in this research. Hooker, Nayga Jr., and Siebert (2002) used a majority of the steps in the Dillman Tailored Design Method for survey distribution, and they also pre-tested their questionnaire on-site with ten firms prior to full distribution. The Dillman Method uses five steps to acquire a high response rate among the sample population which are: a respondent friendly questionnaire, four personalized contacts by first class mail with another special contact, return envelope that includes a real stamp, personalized correspondence, and a token of prepaid financial incentives (Dillman 2007).

1. Survey

In order to find the estimated impact of a reduced sodium policy, food processors in the Food and Agricultural Products Center (FAPC) database were asked to complete an online survey. The online survey builder Qualtrics was utilized in this study for distributing the questionnaire in the Spring of 2012. The survey was segmented into three sections. The first section asked about current sodium uses, sources and costs; the desirability of various sodium reduction policy options; an estimation of expected percentage cost increases; the primary function of sodium in their food products; and their primary sales product. The second section set up a choice experiment between two regulatory environments, which will be discussed in part 2. Finally, the third section asked demographic questions about the companies. The full survey with the Block 1 Regulatory Environment questions is provided in Appendix A; Block 2 regulatory environment questions that vary from the first are located at the end of Appendix A.

Limitations arose when deciding that the focus would be on food manufacturers in Oklahoma and the surrounding region. A database of all food manufacturers' contact information does not exist, so research constraints led to the utilization of contacts with FAPC, who continually work with food companies in our desired region. While this is not a random sample of the population, which we consider to be Oklahoma and area food manufacturers, it is a valid list of current companies and most importantly, it also provides the contact name and email address of the most likely person to be able to answer questions about sodium input.

According to the U.S. Census Bureau (2009), there are 254 food manufacturing companies in Oklahoma. However, this includes mills, animal feed manufacturers, rendering plants, coffee/tea manufacturers, and other various types of plants not included in this study, and due to companies being classified in multiple categories, the true population could not be determined without more detailed information on each company. Compared to the FAPC sample of 119 contacts just in Oklahoma, this still provides that 46.85% or more of Oklahoma food manufacturers were issued a survey.

The total FAPC sample consisted of 162 companies which are based mostly in Oklahoma with 73.46% of the total companies represented, 13.58% is from neighboring states, 12.35% is from elsewhere in the United States, and 0.62% is from outside the United States. The survey was distributed online with a pre-survey letter sent a week in advance to explain the project and upcoming survey link. The response rate for the questionnaire was 20.37%, but the finished, usable responses provide a rate of 17.90%.

2. Regulatory Environment Questions

In order to investigate how a sodium reduction policy compares to other initiatives in the food industry, an experimental design was created following methods by Lusk and Shogren (2008). Using an economic experiment gave "the ability to control treatment variables and isolate the effects of changes in key variables of interest" (Lusk and Shogren 2008). The first step was indentifying the variables of interest and the corresponding levels for each variable. Five variables were chosen: change in profits, policy to reduce sodium, policy to reduce fat content, change in the number of food safety inspections, and the new Food Safety Modernization Act (FSMA) being in place. Considering that the number of potential treatments increases exponentially as another variable or level of that variable is added, those five variables were considered at just two levels: either 0% or a 10% increase. A full factorial design would use all of the possible treatments, which is the number of levels of the variables raised to the number of variables or $2^5 = 32$ treatments. This would mean asking 32 of nearly the same question in the survey. Instead, one particular fractional factorial design – the main-effects only design – was found using SAS, and this allowed the number of questions to be reduced to 16. This type of design ensures that it is orthogonal and balanced, which, respectively, means that the variables are uncorrelated with the other variables and each level of the variables occurs in the same proportion. To reduce the length of the survey further, the 16 questions were split into two blocks;

this reduced each survey respondent to only having to answer eight of the regulatory environment questions. An example of one of the questions is in Figure 2, and Table 2 provides the eight question variations for Blocks 1 and 2. Splitting the questions into two blocks also means that the sample needed to be randomly split into two groups. To achieve this, the random number generator in EXCEL was utilized and limited to numbers 1 and 2. Contacts in group 1 received the same survey as contacts in group 2, and the only questions that differed were the eight experimental design question values.

Q13 In the next 8 questions, we will present you with similar questions that differ by 0% or 10% in the two regulatory environments. We are interested to know which environment you and other food processors in the state would prefer to operate their business. Which regulatory environment would you choose for your company if given a choice? *Please rank the following options to fit the desired levels for you and your company.*

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	+10%
Policy to reduce sodium by:	0%	10%
Policy to reduce fat content by:	0%	0%
Change in the number of inspections by:	10%	10%
FSMA is in place	No	No

	A	B
My company would prefer option:		

Figure 2. Example of Regulatory Environment Question: Number 13 in Block 1

Table 2. Experimental Design: Main Effects Only Fractional Factorial

Block 1	**Questions**															
	1		**2**		**3**		**4**		**5**		**6**		**7**		**8**	
Variables	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
CPROFIT	0	10	0	0	0	0	0	10	10	0	10	10	10	10	10	0
SODIUM	0	10	0	0	10	10	10	0	0	10	0	0	10	10	10	0
FAT	0	0	10	10	0	0	10	10	0	10	10	0	0	10	10	0
INSPECT	10	10	10	10	10	0	10	0	0	10	0	10	0	0	0	0
FSMA	0	0	10	0	10	10	0	10	0	10	10	10	10	0	0	0

Block 2	**Questions**															
	1		**2**		**3**		**4**		**5**		**6**		**7**		**8**	
Variables	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
CPROFIT	0	0	0	10	0	10	0	0	10	10	10	0	10	0	10	10
SODIUM	0	0	0	10	10	0	10	10	0	0	0	10	10	0	10	10
FAT	0	10	10	0	0	10	10	0	0	0	10	10	0	0	10	10
INSPECT	0	0	0	0	0	10	0	10	10	0	10	0	10	10	10	10
FSMA	10	10	0	10	0	0	10	0	10	0	0	0	0	10	10	10

3. Demographic Data

With only 29 usable responses, there was some concern about how this sample would be able to represent Oklahoma. However, these respondents represent 6,970 employees or 44.1% of the total food manufacturing employment out of 15,793 in Oklahoma according to the U.S. Census Bureau (2009). Then outside of Oklahoma, these 29 companies employ 16,500 across the United States. Table 3 shows that there is representation from both large and small firms where 24.1% employ less than 5 people and 24.1% employ over 500 people. The respondents were predominantly in Oklahoma with 93.1%, so the response of 49.1% of sales occurring in-state is mostly in Oklahoma as well. A majority of 31% of respondents spend over $50,000 per year on advertising, marketing and public relations expenditures. As far as annual sales, 20.7% made over $250 million in sales, followed by 17.2% each for less than $250,000 and $1 million - $10 million in sales. Then for annual profits, a majority of 20.1% made less than $100,000, followed by 10.3% across the next four answer choices, and then 13.8% responded that they made over $10 million in profits. Finally, most respondents or 37.9% chose meat and meat alternatives as their primary sales product, and coincidentally 24.1% chose men as their primary customer.

Table 3. Summary Statistics from Survey Respondents

Approximate number of people employed		
Less than 5 people		24.1%
6 - 10 people		3.4%
11 - 20 people		10.3%
21 - 50 people		17.2%
51 - 100 people		3.4%
101 - 200 people		10.3%
201 - 500 people		6.9%
Over 500 people		24.1%
Companies based in:	*Sample*	*Respondents*
Oklahoma	73.5%	93.1%
A neighboring state (TX, NM, CO, KS, MO or AR)	13.6%	0.0%
Another state	12.3%	3.4%
Outside of the United States	0.6%	3.4%
Percentage of sales occurring in the following areas		
In-state		49.1%
Regional		19.7%
National		23.9%
International		7.3%
Extent of sales territory from plant		
Less than 100 miles		3.6%
100 - 250 miles		21.4%
250 - 500 miles		14.3%
Over 500 miles		60.7%
Total advertising, marketing and public relations expenditures per year		
Less than $1,000		17.2%
$1,000 - $4,999		20.7%
$5,000 - $24,999		17.2%
$25,000 - $49,999		6.9%
Over $50,000		31.0%

Table 3 continued. Summary Statistics from Survey Respondents

Annual sales	
Less than $250,000	17.2%
$250,000 - $500,000	0.0%
$500,000 - $1 million	10.3%
$1 million - $10 million	17.2%
$10 million - $25 million	6.9%
$25 million - $50 million	6.9%
$50 million - $100 million	6.9%
$100 million - $250 million	6.9%
Over $250 million	20.7%
No Answer	6.9%
Annual profits	
Less than $100,000	20.7%
$100,000 - $250,000	10.3%
$250,000 - $500,000	10.3%
$500,000 - $1 million	10.3%
$1 million - $10 million	10.3%
Over $10 million	13.8%
No Answer	24.1%
Primary sales product	
Mixed dishes	13.8%
Meat & meat alternatives	37.9%
Baked Goods	6.9%
Vegetables	3.4%
Sweets	10.3%
Condiments, oils, fats	10.3%
Convenient foods	3.4%
Milk and dairy products	6.9%
Other	6.9%
Primary customer	
Children	0.0%
Teenagers	0.0%
Young adults	17.2%
Women	13.8%
Men	24.1%
Seniors	10.3%
Other	17.2%
All ages	17.2%

CHAPTER IV

CONCEPTUAL MODEL

1. Regulatory Environment Model

A conditional logit model was chosen alongside the orthogonal fractional factorial experimental design to elicit willingness to accept in profits in order to have equal utility when choosing environments with various health policies. This model deals with unordered data and can explain one choice over another based on the characteristics of the variables. A random utility function will be defined by a deterministic (V_{ij}) and a stochastic (ε_{ij}) component:

(1) $$U_{ij} = V_{ij} + \varepsilon_{ij}$$

where U_{ij} is the i^{th} company's utility of choosing option j, V_{ij} is the systematic portion of the utility function determined by attributes of the alternative options j, and ε_{ij} is a stochastic element. The probability that a company chooses alternative j or one regulatory environment over another is given by:

(2) $$\text{Prob}\{V_{\text{ij}} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik};\ \text{for all } k \neq j\}$$

where j is the choice set for respondent i. If the ε_{ij} are independently and identically distributed across the j alternatives and N individuals with a type I extreme value distribution (e.g., $F(\varepsilon_{ij}) = exp(-exp(-\varepsilon_{ij})))$, the probability of company i choosing alternative j is:

$$\text{(3)} \qquad \text{Prob}\{\text{j is chosen}\} = \frac{e^{V_{ij}}}{\sum_{k=1}^{J} e^{V_{ik}}}$$

and

$$\text{(4)} \qquad V_{ij} = \beta_1 CPROFIT_j + \beta_2 SODIUM_j + \beta_3 FAT_j + \beta_4 INSPECT_j + \beta_5 FSMA_j$$

where CPROFIT = change in profits, SODIUM = a policy to reduce sodium, FAT = a policy to reduce fat content, INSPECT = a change in the number of inspections, and FSMA = FSMA being in place or not are the attribute values for alternative j for company i, and β_n represents the parameter coefficients to be estimated. These variables are also described with all of the variables in this study in Appendix B at the end of this chapter. Each of these attributes will vary by 0% or 10% as determined in SAS and shown in Table 2, except for FSMA which is a binary variable where Yes = 1 and No = 0.

The hypotheses for this model is that utility will increase if profits increase by 10% and will decrease with a policy to reduce sodium by 10%, a policy to reduce fat content by 10%, an increase in the number of inspections by 10%, and FSMA in place. It is assumed that companies prefer an environment that offers maximum overall utility and that they are profit maximizing firms.

To find how much companies would be willing to accept to avoid any of four potential changes in the regulatory environment, the following equation (5) calculates their willingness to accept (WTA) in terms of a percent of their profit:

$$(5) \qquad WTA_{Percent} = \frac{\beta_{2j,}\beta_{3j\dots}\beta_{5j}}{\beta_{CPROFIT}}$$

where $\beta_{2j,}\beta_{3j\dots}\beta_{5j}$ are the four policy attributes in each environment. The WTA term can then be transformed to a dollar amount by:

$$(6) \qquad WTA_{Dollar} = WTA_{Percent} * ANNPROFIT$$

where WTA_{Dollar} represents the WTA for any of the policies and *ANNPROFIT* is the annual profit for company i. The sum of all of the responses will provide an aggregate dollar amount of what these companies would be willing to forfeit in additional profits to avoid any of the policies in the regulatory environment. Responses were also filtered to calculate what Oklahoma respondents are willing to accept, and this calculation can make implications regarding the WTA for all Oklahoma food manufacturers.

While this model gives each company equal weight, the model is executed again including a term that weights their response based on their employment or EMPLOYEES. Accounting for the size of the firm will only make a difference if larger firms are more adverse to any of the policies in the regulatory environments. Hypotheses for the weighted model are similar to the original model, but we expect that larger firms will have larger expenses involved in these policies, and thus, they will be more adverse to their implementation.

2. Policy Preference Model

Since responses are ordered from highly undesirable = 1 to highly desirable = 5 in five different levels, an ordered logit model is necessary for the ordinal variable. We could model such data using the multinomial logit; however, such an approach would ignore information on the order of desirability. Similarly, an OLS model could be utilized; however, an OLS regression treats the variable as cardinal by denoting the quantity but not the order.

In an ordered logit model, a continuous latent variable Y^*_i is unobserved in equation (7) as:

(7) $Y^*_i = X_{ij}\beta_i + \varepsilon_{ij}$.

Although Y^*_i is not directly observable, we do observe the variable Y_i, which consists of ordinal responses: $Y_i = 1, Y_i = 2 \ldots Y_i = j$ where j is equal to the number of response categories or five. Y^*_i also had a random disturbance term, and we assume that ε_{ij} term is independent and identically distributed. To implement the model, we say that:

$$Y = 1 \text{ if } 0 < Y^* \leq \mu_1,$$

$$Y = 2 \text{ if } \mu_1 < Y^* \leq \mu_2,$$

(8) $$Y = 3 \text{ if } \mu_2 < Y^* \leq \mu_3,$$

$$Y = 4 \text{ if } \mu_3 < Y^* \leq \mu_4,$$

$$Y = 5 \text{ if } \mu_4 \leq Y^*.$$

where μ_i, or the threshold parameters, are scaled proportionally and are 1.49 = μ_1, 2.49 = μ_2, 3.49 = μ_3, and 4.49 = μ_4. To estimate that Y will take on a particular value, we have:

$$Prob(Y = 1) = \frac{e^{Xi1\beta i}}{1+ e^{Xi1\beta i}}$$

$$Prob(Y = 2) = \frac{e^{Xi2\beta i}}{1+ e^{Xi2\beta i}} - \frac{e^{Xi1\beta i}}{1+ e^{Xi1\beta i}}$$

(9) $$Prob(Y = 3) = \frac{e^{Xi3\beta i}}{1+ e^{Xi3\beta i}} - \frac{e^{Xi2\beta i}}{1+ e^{Xi2\beta i}}$$

$$Prob(Y = 4) = \frac{e^{Xi4\beta i}}{1+ e^{Xi4\beta i}} - \frac{e^{Xi3\beta i}}{1+ e^{Xi3\beta i}}$$

$$Prob(Y = 5) = 1 - \frac{e^{Xi4\beta i}}{1+ e^{Xi4\beta i}}$$

and the log-likelihood function is:

(9) $$\log L = \sum_{i=1}^{N} \sum_{j=1}^{J} d_j \log(\text{Prob}\{y = j\})$$

Where $d_j = 1$ if $Y = j$ and 0 otherwise. Since the threshold parameters are increasing from undesirable to desirable, or $\mu_i < \mu_{(i+1)}$, the probabilities will be positive.

This model will measure the likeability of nine different policy options individually for sodium reduction with respect to MEAT = primary sales of meat and meat products (Yes = 1 and No = 0), ALREADY = already spend money addressing sodium reduction (Yes or Not directly = 1 and No or Unknown = 0), CHANGE = a combination of MODFAC, ADDON, or NEWFAC (Yes to any of the three variables = 1 and No = 0), and EMPLOYEES = number of employees (calculated with the average of the range level selected or actual number if over 500 employees).

The hypothesis for the Policy Preferences Model is that the size of the firm is a significant predictor of their rating of each individual policy. The size of the firm in this study is measured in terms of the number of employees, and we hypothesize that with larger firms, it is less likely that highly undesirable responses will be observed. In addition, companies who have already begun to address sodium reduction will also be more optimistic about sodium policies. Those who will have to change their facility in any way as depicted in the CHANGE variable will likely respond more on the undesirable side of the scale. Finally, companies who process meat and meat alternatives are believed to respond with higher undesirable rates due to the functionality of sodium in their production process.

3. Total Industry Sodium Cost Function

Contrasting the willingness to accept found in the Regulatory Environment Model, a cost function will be utilized to find what food processors indirectly state to be the expected cost of a sodium reduction policy. This function is as follows:

$$(10) \quad (ANNSALES_i - ANNPROFIT_i) * (INCREASEC_i - COGS_i) = ECOST_i$$

which can also be shown as:

(11) $ANNCOST_i * SODINF_i = ECOST_i$

Where $ANNSALES_i$ is the annual sales for company i, $ANNPROFIT_i$ is the annual profits for company i, $INCREASEC_i$ is expected rise in total costs of production with a sodium reduction policy, $COGS_i$ is the percentage of sodium input costs to their costs of goods sold, $ANNCOST_i$ is equal to $ANNSALES_i – ANNPROFIT_i$ and is also known as annual costs for company i, and $SODINF_i$ is equal to $INCREASEC_i – COGS_i$ or the percentage of the sodium policy influence on production cost. This would calculate the $ECOST_i$, or estimated cost, that each firm believes would be realized if a sodium reduction policy were implemented, and the sum for each respondent would provide the total estimated cost of sodium reduction. To make implications for the state of Oklahoma, the same method of using the sample's percentage of employment from the Regulatory Environment Model will be utilized.

There are limitations in this particular function due to no parameters being given to the respondent other than unknown circumstances of a potential sodium reduction policy, which is represented in the INCREASEC variable. This is unlike the Regulatory Environment Model which set the sodium reduction to 10%. Thus, the assumption for this cost function is that respondents are going to answer with a worst case scenario estimate, which can differ across companies and individual respondents. Other factors could influence a respondent to choose a higher INCREASEC percentage than they actually believe to realize such as hoping to inflate numbers, believing the survey is from the government, or just not actually knowing an answer and overestimating. Given these assumptions, we hypothesize that this model is going to create a high and likely overestimated total sodium reduction cost and will be greater than the willingness to accept estimation.

CHAPTER V

RESULTS

1. Summary of Results

When asked to rank five food attributes on what food manufacturer's believe to be in highest demand by their customers, the average of their rankings puts lower prices as the first priority, followed by reduced fat options, reduced sodium options, organic ingredients and country of origin labeling, which is shown in Table 4. Given this arrangement of priorities that customers are assumed to have and the fact that 50% of the companies expect production costs to increase by 5% or more with a sodium policy, it is no surprise to find that most prefer less government involvement with sodium reduction policies as well. Salt is one of the most inexpensive sources of sodium, and it was also the largest source of sodium use with 65.5% of respondents utilizing salt in their food products. Most respondents answered that their current cost is less than $0.08 per pound of sodium, which corresponds to the percentage of sodium input costs to costs of goods sold being less than 1% for the majority.

Companies were asked if they would have to build a new facility, add on to their current facility, or modify their current facility to be in compliance with a potential sodium policy, and the percentages of those who answered yes increased from 3.6% to 7.1% to 14.3%, respectively. However, only 17.2% have directly spent money on addressing sodium reduction, and 20.7% may have reduced sodium in their products, but not as the primary objective.

Table 4. Summary of Results from Survey Respondents

To be in compliance with a potential sodium policy, will your company have to:				
	Build new facility	*Add on to facility*	*Modify facility*	*Change facility*
Yes	3.6%	7.1%	14.3%	21.4%
No	96.4%	92.9%	85.7%	82.1%

Company already spent money on addressing a sodium reduction initiative	
Yes	17.2%
No	58.6%
Not directly	20.7%
Unknown	3.4%

Total amount spent and/or will spend in product reformulation to reduce sodium levels	
Less than $5,000	37.0%
$5,000 - $10,000	18.5%
$10,000 - $50,000	29.6%
$50,000 - $100,000	3.7%
Over $100,000	11.1%

Average rank of food attributes in highest demand by customers	
Lower prices	1.61
Reduced fat options	2.45
Reduced sodium options	3.39
Organic ingredients	3.48
Country of origin labeling	4.06

Current sources of sodium inputs	
Salt	65.5%
MSG	20.7%
Baking soda	17.2%
Sea salt	20.7%
Kosher salt	6.9%
Natural	44.8%
Food additives	31.0%
Other	6.9%
None	3.4%

Current cost for sources of sodium inputs	
Less than $0.08/lb	41.4%
$0.09 - $0.15/lb	31.0%
$0.16 - $0.35/lb	6.9%
$0.36 - $0.60/lb	3.4%
$0.61 - $1.00/lb	6.9%
$1.01 - $1.50/lb	0.0%
$1.51 - $2.00/lb	0.0%
$2.01 - $2.50/lb	0.0%
$2.51/lb or more	0.0%
No Answer	10.3%

Table 4 continued. Summary of Results from Survey Respondents

Percentage of sodium input costs to COGS		*Expected increase in cost of production*	
Less than 1%	52%	Less than 1%	31.0%
1 - 2%	31%	1 - 2%	6.9%
3 - 4%	7%	3 - 4%	13.8%
5 - 7%	0%	5 - 7%	24.1%
8 - 9%	0%	8 - 9%	0.0%
10% or more	0%	10% or more	24.1%
No Answer	10%	No Answer	0.0%

Primary function of sodium sources	
Safety	3.4%
Preservative	13.8%
Leavening	3.4%
Taste	72.4%
Texture	0.0%
None	6.9%

Substitute(s) planned to use in the event a sodium reduction policy were implemented	
Reduced sodium content only	27.3%
Potassium chloride	12.1%
Calcium chloride, magnesium chloride, and magnesium sulfate	3.0%
Sea salt	30.3%
MSG	6.1%
Yeast extracts	15.2%
Lactates	3.0%
Herbs and spices	21.2%
Mixtures of NaCl substitutes and enhancers	12.1%
Unknown	42.4%
Other	6.1%

**None of the companies choose lithium chloride, nucleotides, amino acids, dairy concentrates, or compounds that reduce bitterness as a substitute.*

Average desirability of potential sodium reduction policies where 5 = highly desirable, 4 = desirable, 3 = neither desirable nor undesirable, 2 = undesirable, 1 = highly undesirable	
FDA continues the recommendation to agribusinesses	3.34
Implement educational activities on sodium health related effects	3.21
FDA modifying the GRAS status of salt's inclusion in processed foods	1.85
USDA revises nutrition labeling standards	1.86
Restaurant nutrition labeling exemptions removed	2.46
Agricultural subsidies to producers for lower-sodium foods	2.24
Tax incentives for production of lower-sodium foods	2.21
Salt tax on foods with high sodium content	1.45
Cap and trade system for sodium	1.43

Employees that would need to be hired to meet potential reduction policy

Number of employees		*Part or full time of those hired*	
None	64.3%	Part time	33.3%
1 - 5 employees	35.7%	Full time	66.7%

Discontinued products due to a sodium reduction policy

		Average number of products discontinued	
No: None	53.6%		
Yes: 1 - 4 products	28.6%	All	1.6
Yes: 4 - 8 products	17.9%	"Yes" average	3.5

The primary function of sodium in the food manufacturers' products was taste overwhelmingly with 72.4%, followed by preservation with 13.8%. Due to the multiple purposes sodium fulfills and its versatility throughout food products, the assumption of having difficulty in finding a sodium substitute was confirmed when respondents were asked about potential sodium substitutes, and 42.4% choose the "unknown" response. "Reduced sodium content only," rather than replacing sodium with a substitute, was only chosen by 27.3% of respondents as well. Respondents could select more than one option, and "sea salt" and "herbs and spices" seem to be the most popular replacements of sodium with 30.3% and 21.2% of respondents including those choices as one of their likely substitutes.

Respondents were asked to rate nine different potential policies that could address sodium reduction on a scale of 1 – 5 where 1 = highly undesirable and 5 = highly desirable. Two policies had an average rating that listed them as neither desirable nor undesirable; one provided that the FDA would continue their recommendation to agribusinesses to reduce sodium levels voluntarily and the other implemented educational activities on sodium related health effects. Five policies had an overall undesirable rating, including modification of the GRAS status for salt, revision of nutrition labeling standards, removal of nutrition labeling exemptions for restaurants, agricultural subsidies for manufacturers who produce lower-sodium foods, and tax incentives for lower-sodium food production. Most opposed though were a salt tax on high sodium foods and a cap and trade system for sodium inputs which had an average rating of highly undesirable.

2. Regulatory Environment Model

Using a conditional logit model in SAS, the following parameter estimates in Table 5 were found, and the model fit summary is provided in Table 6. From this we can use equation (5) to find $\frac{0.0488}{0.0603} = .8093\%$, meaning companies would be willing to accept 0.8093% of unforeseen profits to avoid a sodium reduction policy. In addition, a 10% reduced fat policy would result in a

$\frac{0.0445}{0.0603} = .7380\%$ willingness to accept, but INSPECT and FSMA were not significant in this model. The amount that the sample is willing to accept is calculated by multiplying the $WTA_{percent}$ estimate by ANNPROFIT for each respondent and taking the sum. To fill in some of the missing responses for ANNPROFIT, the average of the ANNPROFIT answer was taken for companies who provided the same answer in ANNSALES. This provided 27 usable responses, and in sum, totals $659,579.50 for the sample, which is depicted in Table 8. When dropping the two responses that are based outside of Oklahoma, this becomes $534,138.00, and remembering that the sample accounts for 44.1% of the Oklahoma food manufacturing employment, we can make implications about the population. With the assumption that our respondents are representative of Oklahoma, the state's food manufacturers will be willing to accept a sodium reduction policy if their profits increased by over $1.2 million. Following this procedure, food manufacturers in Oklahoma are willing to forfeit $1,103,617.28 to avoid a mandatory reduction in fat by 10%. INSPECT and FSMA are also shown in Table 8, but again, the parameters were not found to be significant in the model.

Table 5. Parameter Estimates in the Regulatory Environment Model

Parameter Estimates

Parameter	DF	Standard Estimate	Error	Approx t Value	Pr > |t|
CPROFIT	1	0.0603	0.0213	2.83	0.0047
SODIUM	1	-0.0488	0.0219	-2.23	0.0258
FAT	1	-0.0445	0.0205	-2.17	0.0304
INSPECT	1	-0.0415	0.0223	-1.86	0.0627
FSMA	1	-0.2150	0.2036	-1.06	0.2910

Table 6. Model Fit Summary for the Regulatory Environment Model

Model Fit Summary

Dependent Variable	CHOICES
Number of Observations	222
Number of Cases	444
Log Likelihood	-145.26022
Log Likelihood Null (LogL(0))	-153.87867
Maximum Absolute Gradient	5.00564E-8
Number of Iterations	4
Optimization Method	Newton-Raphson
AIC	300.52043
Schwarz Criterion	317.53382

Discrete Response Profile

Index	OPTION	Frequency	Percent
0	1	125	56.31
1	2	97	43.69

Goodness-of-Fit Measures

Measure	Value	Formula
Likelihood Ratio (R)	17.237	2 * (LogL - LogL0)
Upper Bound of R (U)	307.76	- 2 * LogL0
Aldrich-Nelson	0.072	R / (R+N)
Cragg-Uhler 1	0.0747	1 - exp(-R/N)
Cragg-Uhler 2	0.0996	(1-exp(-R/N)) / (1-exp(-U/N))
Estrella	0.0768	1 - (1-R/U)^(U/N)
Adjusted Estrella	0.0324	1 - ((LogL-K)/LogL0)^(-2/N*LogL0)
McFadden's LRI	0.056	R / U
Veall-Zimmermann	0.124	(R * (U+N)) / (U * (R+N))

When giving more weight to firms who have higher employment rates, the results were quite different; the parameter estimates are shown in Table 7. First, we can reject the null hypothesis where all beta values are equal to zero. Then, we can use equation (5) to find $\frac{0.05414}{0.01659} = 3.2634\%$, meaning companies would be willing to give up 3.26% of additional profits to avoid a sodium reduction policy. In addition, the willingness to accept for a 10% reduced fat policy is 4.33%, and the last two variables were also significant. To avoid 10% more inspections the willingness to accept is 1.05%, and 12.68% is the reduction companies would be willing to accept if FSMA would not be a part of the regulatory environment.

Table 7. Parameter Estimates in Weighted Regulatory Environments Model

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	10478.8617	5	<.0001
Score	10553.5774	5	<.0001
Wald	10141.3968	5	<.0001

Analysis of Maximum Likelihood Estimates

Parameter	DF	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio	Label
CPROFIT	1	0.01659	0.0009780	287.7400	<.0001	1.017	CPROFIT
SODIUM	1	-0.05414	0.0009813	3043.632	<.0001	0.947	SODIUM
FAT	1	-0.07186	0.00101	5077.0546	<.0001	0.931	FAT
INSPECT	1	-0.01746	0.0009680	325.4773	<.0001	0.983	INSPECT
FSMA	1	-0.21037	0.00971	469.0547	<.0001	0.810	FSMA

Multiplying these percentages by their annual profits, we find that in sum, the respondents would give up over $2.1 million and the population of Oklahoma food manufacturers would forfeit nearly $4.9 million in profits to avoid a sodium reduction policy as stated in Table 8. Then, a policy to reduce fat content and FSMA becoming law were actually more highly opposed than a sodium reduction policy in this weighted model, meaning large firms are more highly opposed to these options compared to small firms. Nearly $2.9 million is the amount the sample would be willing to forfeit in profits for an environment where a fat reduction policy was not involved, which amounts to nearly $6.5 million for Oklahoma. Then the FSMA attribute provoked a willingness to accept of over $8 million in order to avoid the uncertainty of further food safety regulation, which implies from our assumptions that Oklahoma food manufacturers would be willing to forfeit nearly $19 million in profits. A change in the number of inspections is not as highly opposed as sodium reduction; however, the sample was only willing to accept just under $700,000 in profits and almost $1.6 million in Oklahoma to accept or comply with a 10% increase in inspections.

Table 8. Willingness to Accept for Oklahoma Food Manufacturers

Oklahoma Food Manufacturing Companies

		WTA in Dollars	
	WTA	OK sample	OK population
*SODIUM	0.8093%	$ 534,129	$ 1,210,259
*FAT	0.7380%	$ 487,065	$ 1,103,617
INSPECT	0.6882%	$ 454,229	$ 1,029,216
FSMA	0.3566%	$ 235,323	$ 533,208
Total		**$ 1,710,746**	**$ 3,876,301**

Oklahoma Food Manufacturing Companies (Weighted)

		WTA in Dollars	
	WTA	OK Sample	OK population
*SODIUM	3.2634%	$ 2,153,852	$ 4,880,313
*FAT	4.3315%	$ 2,858,807	$ 6,477,637
*INSPECT	1.0524%	$ 694,611	$ 1,573,887
*FSMA	12.6805%	$ 8,369,150	$ 18,963,269
Total		**$ 14,076,420**	**$ 31,895,107**

*Indicates statistical significance

3. Policy Preference Model

After running the ordered logit model with different variables including MEAT, ALREADY, CHANGE, and EMPLOYEES, the null hypothesis for all of the nine policies failed to be rejected, meaning that none of the models were significant at the 5% level. This is largely due to more observations being required for ordered logit models. Despite the insignificance of this model, Appendix C explains how this model would work and be interpreted if it were significant, specifically for the agricultural subsidy policy as an example. In researching this topic further and to find what firm characteristics impact their policy preferences, more observations could be gathered to potentially provide a better fit for the ordered logit analysis. It is hypothesized that with more observations MEAT, or companies who produce meat and meat alternatives, would be a significant predictor in how companies rate each policy, or at least the policy concerning agricultural subsidies. The current parameters for the model on agricultural subsidies, which is shown in the Appendix, shows that the p-value for MEAT is significant at the 5% level, but again, the model itself was not significant.

4. Total Industry Sodium Cost Function

Only 27 responses were usable for this question given that a few respondents did not answer questions concerning their annual sales or profits; however, these 27 respondents still represent 43.9% of food manufacturing employment in Oklahoma. When applying equation (10) and (11), the total estimated cost of a sodium reduction policy was $83.8 million within the respondents, and $61.8 million after removing the out of state respondents. Assuming that this estimated cost represents 43.9% of the population, we can imply that Oklahoma food manufacturers project a cost of about $140.7 million if any particular sodium reduction policy were implemented as shown in Table 9.

Table 9. Estimated Costs for the Sample and State of Oklahoma

	Average Company	Total Sample	Oklahoma Sample
ANNSALES	$ 79,273,148.15	$ 2,140,375,000.00	$ 1,815,375,000.00
ANNPROFIT	$ 3,018,518.52	$ 81,500,000.00	$ 66,000,000.00
ANNCOST	$ 76,254,629.63	$ 2,058,875,000.00	$ 1,749,375,000.00
COGS	1.056%	-	1.060%
INCREASEC	4.204%	-	4.120%
SODINF	3.148%	-	3.060%
ECOST	$ 2,400,608.71	**$ 83,881,125.00**	**$ 61,776,125.00**

Implications for Oklahoma
Total Estimated Cost $ 140,732,829.73

CHAPTER VI

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

Discussions about sodium reduction are generally focused on consumers and the welfare of all in the food industry with its compilation of small, medium, and large firms is often overlooked. This study finds that millions of dollars are on the line for food manufacturers if sodium reduction was mandated. Salt is a very cheap input that serves many roles, so producers would miss having the privilege to use it freely. A universal substitute that is healthier does not exist, and any combinations of the potential ingredients that might be chosen to replace sodium will increase the input costs. Many companies do not have a simple answer to reducing sodium without changing the product. Some companies may even have to discontinue products. This could be a major issue for companies who produce a small number of products, since their business could be hurt drastically by any limiting policy. Referring to Black (2011) from Kraft Foods as an example, the sodium content in some of their products can be reduced by 30% while others cannot afford to have any sodium removed. If a company only produces two or three products which also happens to typically be high in sodium, they do not have the luxury of reducing more in other products to average 10% across the company product line.

For the time being, policymakers should recognize the time and money that would be spent to meet sodium standards that may potentially be unnecessary. However, large companies seem to be more willing to accept a sodium policy compared to a fat reduction policy or FSMA, but small companies are more opposed to sodium reduction. FSMA was much more opposed by large companies, which can be explained by who the policy impacts the most: large companies. Firms that make less than $500,000 in sales a year or are labeled as a "Very Small Business" are exempt from FSMA, which makes the inclusion of FSMA in the regulatory environments in this study much less influential for small companies. This exemption could be utilized for a sodium reduction policy as well since small companies oppose sodium reduction the most out of all the options. Large companies still oppose sodium reduction, but not more than other policies listed in the environment.

Safety of the food products has been cited by opponents of sodium reduction as one of the leading precautions against any such policies; however, safety was only chosen by 3.4% and preservation by 13.8% as the primary function of sodium in foods. This particular argument as the most critical piece to the sodium reduction debate might be less powerful than before, or at least to a point and for some food items.

In addition, to what point is sodium inclusion in food an indulgence, luxury, or no longer an issue? For instance, will candy manufacturers be limited to the same sodium policy? Will consumers be limited to products with shorter shelf lives or will there still be a choice for them to buy higher sodium, but longer lasting convenient foods? Do consumers care if salt is reduced in dessert or other unhealthy products? Our results show that food manufacturers give the highest desirability to the policy option of continuing the voluntary recommendation or providing health awareness programs directed at sodium consumption – policies which do not force drastic change in the industry. This would gradually change the market for some at least and could eventually encourage manufacturers to voluntarily reduce sodium. The next best option would be positive reinforcement measures or policies that give tax incentives or subsidies for reducing sodium content, rather than policies that tax or impose complicated systems. In the likely development of a policy, all should be considered and allow room for the consumer's involvement in their health decisions, good or bad.

Further research could improve the number of observations to more accurately reflect the industry and to hopefully find significant factors for their policy preferences. The sample could be broadened to the United States; however, challenges exist in the distribution and collection of data. The importance in this is to ensure all types and sizes of companies are considered. Also, how these types of policies would be implemented and how they would benefit both consumers and producers needs to be studied. Then, rather than relying on employment information alone to measure representation, more data on annual sales could be collected for the population, and the categories in the survey increased to capture a better estimate for very large companies. With a larger sample, results could be evaluated with respect to their primary sales product as well, which is hypothesized to be an influential factor in determining the most impacted sectors in the industry.

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APPPENDIX A

SURVEY

1. Block 1

Q1 Thank you for participating in this study. The following contains information about this study and your rights as a research participant.

Project Title: The Economic Impact of a Reduced Sodium Policy on Food Processors

Investigators: Dr. Rodney Holcomb – OSU Agricultural Economist, FAPC Food Industry Economist; Dr. Jody Campiche – OSU Agricultural Economist, Food & Agriculture Policy Analyst; and Amanda Simpson – OSU Agricultural Economics Graduate Research Assistant

Purpose: This is a web-based survey research study designed to determine the economic impact to Oklahoma food processors if a mandatory sodium reduction policy were implemented.

Procedures: Proceeding with the web-based survey will imply your consent to participate in this study. There are about 30 questions asking about the costs you might incur if the FDA set a limit on sodium allowed in food products, as well as your companies preferences in handling the sodium reduction initiative and various consumer health and nutrition related issues. There will also be a few questions about your company. The survey will take approximately 20-30 minutes for you to complete.

Risks of Participation: The risks associated with this survey are minimal. The risks are not greater than those ordinarily encountered in daily life. Moreover, you may skip any survey items that you perceive as threatening or discomforting; you may also stop at any time.

Benefits: This research will assist researchers and policymakers in understanding the costs to the industry when addressing consumer sodium reduction in this manner.

Confidentiality: Data will be maintained by the PI, not the OFC board, and used solely for assessing the attitudes and perceptions of cooperative members. Only aggregate information (group means, frequency tables) will be released to the OFC board and in any subsequent publications. Data will be kept as coded responses on the secure computer of the PI for a period of five years.

Contacts: If you have any questions or concerns about this project, please contact Dr. Rodney Holcomb (405) 744-6272, rodney.holcomb@okstate.edu. If you have questions about your rights as a volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, (405) 744-3377, or irb@okstate.edu.

Participant Rights: Your participation in this research is voluntary. You can discontinue the survey at any time without reprisal or penalty.

Consent: I have read and fully understand the consent form. I understand that my participation is voluntary. By clicking below, I am indicating that I freely and voluntarily agree to participate in this study, and I also acknowledge that I am at least 18 years of age.

It is recommended that you print a copy of this consent page for your records before you begin.

Q2 Please rate the following possible policy options from highly desirable to highly undesirable ways that your company would prefer for the sodium issue to be handled. For a more detailed description, the highlighted phrases have more information and can be accessed by holding your mouse over the phrases.

	Highly Undesirable	Undesirable	Neither Desirable nor Undesirable	Desirable	Highly Desirable
FDA continues the recommendation to agribusinesses to reduce sodium levels voluntarily					
Government agencies and public health organizations implement educational activities on sodium related health effects					
FDA modifying the GRAS status[1] of salt's inclusion in processed foods					
USDA revises nutrition labeling standards and disclosure/disqualifying criteria for sodium in foods					
The exemption from nutrition labeling for food products in restaurant/food service operations be lifted					
Agricultural subsidies to producers for lower-sodium foods					
Tax incentives for production of lower-sodium foods					
Salt tax on foods with high sodium content					
Cap and trade[2] system for sodium					

[1] The GRAS status stands for "Generally Recognized as Safe" which is given to common food ingredients to exempt them from the definition of a food additive. There have been calls to the FDA to revoke this status for salt which would give authority to the FDA to enforce some regulatory action on salt's inclusion in foods.

[2] A cap and trade system implemented for sodium would set a limit on sodium allowed for each producer and producers who need more sodium would purchase the excess sodium allowance from other producers.

Q3 What is the source of your current sodium inputs? *Please check all that apply*.

____ Sodium chloride (NaCl)
____ Monosodium glutamate (MSG)
____ Sodium bicarbonate (baking soda)
____ Sea salt
____ Kosher salt
____ Sodium that comes natural in foods
____ Food additives (such as sodium nitrite, sodium acetate, etc.)
____ Other ____________________

Q4 What is the current cost for the source of your sodium inputs?

____ Less than 8 cents/lb
____ 9 - 15 cents/lb
____ 36 - 60 cents/lb
____ 1.01 - 1.50 dollars/lb
____ 16 - 35 cents/lb
____ 61 cents - 1 dollar/lb
____ 1.51 - 2.00 dollars/lb
____ 2.01 - 2.50 dollars/lb
____ 2.51 dollars/lb or more

Q5 What is the percentage of your sodium input costs to your cost of goods sold?

____ Less than 1%
____ 1 - 2%
____ 3 - 4%
____ 5 - 7%
____ 8 - 9%
____ 10% or more

Q6 While current FDA recommendations are voluntary, an actual policy limiting the sodium content of foods would significantly impact the food processing industry, as salt is a key ingredient in many foods. The policy method, however, has not been decided upon by the FDA, so further questions asking about a sodium reduction policy should be answered with expected averages.

If a policy were implemented that would effectively reduce the sodium allowed in your food products, by how much do you expect total costs of production to rise with a sodium reduction policy in place?

____ Less than 1%
____ 1 - 2%
____ 3 - 4%
____ 5 - 7%
____ 8 - 9%
____ 10% or more

Q7 What is the primary function of your sodium sources?

____ Safety
____ Preservative
____ Leavening
____ Taste
____ Texture
____ Other (please list) ____________________

Q8 Which of the following do you believe is in highest demand by your customers? *Please rank the following options 1 through 5 by dragging and placing them with your mouse.*

____ Reduced sodium options
____ Reduced fat options
____ Organic ingredients
____ Lower prices
____ Country of origin labeling

Q9 Demographically, who do you believe is the primary consumer of your food products?

____ Children
____ Teenagers
____ Young adults
____ Women
____ Men
____ Seniors
____ Other ____________________

Q10 What is your company's primary sales product?

____ Mixed dishes
____ Meat & meat alternatives
____ Grains
____ Vegetables
____ Sweets
____ Condiments, oils, fats
____ Salty snacks
____ Milk
____ Beverages
____ Beans, Nuts, and seeds
____ Fruit
____ Other (please list) ____________________

Q11 What substitute(s) does your company plan to use in the event that a sodium reduction policy were implemented? *Please check all that apply*.

____ Reduced sodium content only
____ Potassium chloride (KCl)
____ Lithium chloride (LiCl)
____ Calcium chloride (CaCl2), magnesium chloride (MgCl2), and magnesium sulfate (MgSO4)
____ Sea salt
____ Monosodium glutamate (MSG)
____ Yeast extracts and hydrolyzed vegetable protein
____ Nucleotides including inosine-5'-monophosphate (IMP) and guanosine-5'-monophosphate
____ Amino acids, especially arginine and related compounds
____ Dairy concentrates
____ Lactates (potassium lactate, calcium lactate, and sodium lactate)
____ Herbs and spices
____ Compounds that reduce bitterness including adenosine-5'-monophosphate, DHB (2,4-dihydroxybenzoic acid), lactose, sodium gluconate, and mixtures for use in combination with potassium chloride
____ Mixtures of NaCl substitutes and enhancers
____ Unknown
____ Other (please list) ____________________

Q12 Has your company already spent money on addressing a sodium reduction initiative?

____ Yes
____ No
____ Not directly
____ I don't know

Q13 In the next 8 questions, we will present you with similar questions that differ by 0% or 10% in the two regulatory environments. We are interested to know which environment you and other food processors in the state would prefer to operate their business. Which regulatory environment would you choose for your company if given a choice? *Please rank the following options to fit the desired levels for you and your company*.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	+10%
Policy to reduce sodium by:	0%	10%
Policy to reduce fat content by:	0%	0%
Change in the number of inspections by:	10%	10%
FSMA is in place	No	No

	A	B
My company would prefer option:		

Q14 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	0%
Policy to reduce sodium by:	0%	0%
Policy to reduce fat content by:	10%	10%
Change in the number of inspections by:	10%	10%
FSMA is in place	Yes	No

	A	B
My company would prefer option:		

Q15 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	0%
Policy to reduce sodium by:	10%	10%
Policy to reduce fat content by:	0%	0%
Change in the number of inspections by:	10%	0%
FSMA is in place	Yes	Yes

	A	B
My company would prefer option:		

Q16 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	+10%
Policy to reduce sodium by:	10%	0%
Policy to reduce fat content by:	10%	10%
Change in the number of inspections by:	10%	0%
FSMA is in place	No	Yes

	A	B
My company would prefer option:		

Q17 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	0%
Policy to reduce sodium by:	0%	10%
Policy to reduce fat content by:	0%	10%
Change in the number of inspections by:	0%	10%
FSMA is in place	No	Yes

	A	B
My company would prefer option:		

Q18 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	+10%
Policy to reduce sodium by:	0%	0%
Policy to reduce fat content by:	10%	0%
Change in the number of inspections by:	0%	10%
FSMA is in place	Yes	Yes

	A	B
My company would prefer option:		

Q19 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	+10%
Policy to reduce sodium by:	10%	10%
Policy to reduce fat content by:	0%	10%
Change in the number of inspections by:	0%	0%
FSMA is in place	Yes	No

	A	B
My company would prefer option:		

Q20 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	0%
Policy to reduce sodium by:	10%	0%
Policy to reduce fat content by:	10%	0%
Change in the number of inspections by:	0%	0%
FSMA is in place	No	No

	A	B
My company would prefer option:		

Q21 Will it be necessary for your company to have to build a new facility to be in compliance with a potential sodium policy?
____ Yes
____ No

Q22 Will it be necessary for your company to add on to your current facility to be in compliance with a potential sodium policy?
____ Yes
____ No

Q23 Will it be necessary for your company to modify your current facility to be in compliance with a potential sodium policy?
____ Yes
____ No

Q24 What is the total amount you have spent and/or will spend in product reformulation in order to reduce sodium levels?
____ Less than $5,000
____ $5,000 - $10,000
____ $10,000 - $50,000
____ $50,000 - $100,000
____ Over $100,000

Q25 What is the approximate number of people employed by your business?
____ Less than 5 people
____ 5 - 10 people
____ 10 - 20 people
____ 20 - 50 people
____ 50 - 100 people
____ 100 - 200 people
____ 200 - 500 people
____ Over 500 people

Q26 How many more employees will you need to hire in order to meet potential reduction policy recommendations or requirements?
____ None
____ 1
____ 2
____ 3
____ 4
____ Over 5
If None Is Selected, Then Skip to Q28

Q27 What category will the additional employee(s) fit into?
____ Part time
____ Full time

Q28 Will you discontinue any products due to a sodium reduction policy?
____ Yes
____ No
If No Is Selected, Then Skip to Q31

Q29 How many products will be discontinued?
____ Less than 4 products
____ 4 - 8 products
____ 8 - 12 products
____ Over 12 products

Q30 Is your company based in:
____ Oklahoma
____ A neighboring state to Oklahoma (Texas, New Mexico, Colorado, Kansas, Missouri, or Arkansas)
____ Another state
____ Outside of the United States

Q31 How far does your sales territory extend from your plant?
____ Less than 100 miles
____ 100 - 250 miles
____ 250 - 500 miles
____ 100 - 500 miles
____ Over 500 miles

Q32 What percentage of your sales occurs in the following areas?
____ In-state
____ Regional
____ National
____ International

Q33 What percent of your total expenses goes toward advertising, marketing and public relations expenditures per year?
____ Less than $1,000
____ $1,000 - $4,999
____ $5,000 - $24,999
____ $25,000 - $49,999
____ Over $50,000

Q34 Your company's annual sales are about how large?
____ Less than $250,000
____ $250,000 - $500,000
____ $500,000 - $1 million
____ $1 million - $10 million
____ $10 million - $25 million
____ $25 million - $50 million
____ $50 million - $100 million
____ $100 million - $250 million
____ Over $250 million

Q35 What is the total annual profit of your business?
____ Less than $100,000
____ $100,000 - $250,000
____ $250,000 - $500,000
____ $500,000 - $1 million
____ $1 million - $10 million
____ Over $10 million

2. Block 2 Eight Regulatory Environment Questions

Q13 In the next 8 questions, we will present you with what seems like the same question, but each of the two regulatory environments will vary by either 0% or 10%. We are interested to know which environment you and other food processors in the state would prefer to operate their business. Which regulatory environment would you choose for your company if given a choice? *Please rank the following options to fit the desired levels for you and your company*.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	0%
Policy to reduce sodium by:	0%	0%
Policy to reduce fat content by:	0%	10%
Change in the number of inspections by:	0%	0%
FSMA is in place	Yes	Yes

	A	B
My company would prefer option:		

Q14 Which regulatory environment would you choose for your company if given a choice? Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	+10%
Policy to reduce sodium by:	0%	10%
Policy to reduce fat content by:	10%	0%
Change in the number of inspections by:	0%	0%
FSMA is in place	No	Yes

	A	B
My company would prefer option:		

Q15 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	+10%
Policy to reduce sodium by:	10%	0%
Policy to reduce fat content by:	0%	10%
Change in the number of inspections by:	0%	10%
FSMA is in place	No	No

	A	B
My company would prefer option:		

Q16 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	0%	0%
Policy to reduce sodium by:	10%	10%
Policy to reduce fat content by:	10%	0%
Change in the number of inspections by:	0%	10%
FSMA is in place	Yes	No

	A	B
My company would prefer option:		

Q17 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	+10%
Policy to reduce sodium by:	0%	0%
Policy to reduce fat content by:	0%	0%
Change in the number of inspections by:	10%	0%
FSMA is in place	Yes	No

	A	B
My company would prefer option:		

Q18 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	0%
Policy to reduce sodium by:	0%	10%
Policy to reduce fat content by:	10%	10%
Change in the number of inspections by:	10%	0%
FSMA is in place	No	No

	A	B
My company would prefer option:		

Q19 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	0%
Policy to reduce sodium by:	10%	0%
Policy to reduce fat content by:	0%	0%
Change in the number of inspections by:	10%	10%
FSMA is in place	No	Yes

	A	B
My company would prefer option:		

Q20 Which regulatory environment would you choose for your company if given a choice?
Please rank the following options to fit the desired levels for you and your company.

	Regulatory Environment A	Regulatory Environment B
Change in profits:	+10%	+10%
Policy to reduce sodium by:	10%	10%
Policy to reduce fat content by:	10%	10%
Change in the number of inspections by:	10%	10%
FSMA is in place	Yes	Yes

	A	B
My company would prefer option:		

APPPENDIX B

VARIABLE NAMES AND DESCRIPTIONS

Variable	Description
REC	FDA continues recommendation
EDU	Implement educational activities
GRAS	GRAS status
NLSTNDS	Revise nutrition labeling standards
REST	Exemptions for restaurants be lifted
AGSUB	Ag subsidies for low sodium
TAXINC	Tax incentives
NACLTX	Salt tax
CAPTD	Cap and trade
NACL	Sodium chloride (NaCl)
MSG	Monosodium glutamate (MSG)
NABI	Sodium bicarbonate (baking soda)
SEA	Sea salt
KOSHER	Kosher salt
NAT	Sodium that comes natural in foods
ADDITIVES	Food additives (such as sodium nitrite, sodium acetate, etc.)
OTHER	Other
CCOST	Current cost for source of your sodium inputs
COGS	Percentage of your sodium input costs to COGS
INCREASEC	Costs of production to rise with sodium policy - %'s
FCN	Primary function of sodium sources
RSOD	Reduced sodium options
RFAT	Reduced fat options
ORGANIC	Organic ingredients
PRICE	Lower prices
COOL	Country of origin labeling
PCUST	Primary customer
PSALES	Company's primary sales product

Variable	Description
SODIUMONLY	Reduced sodium content only
KCL	Potassium chloride (KCl)
LICL	Lithium chloride (LiCl)
SEASUB	Sea salt
CACL2ETC	Calcium chloride, magnesium chloride, and magnesium sulfate
MSGSUB	Monosodium glutamate (MSG)
YEAST	Yeast extracts and hydrolyzed vegetable protein
NUCL	Nucleotides including inosine-5'-monophosphate (IMP) and guanosine-5'-monophosphate
AMINO	Amino acids, especially arginine and related compounds
DAIRY	Dairy concentrates
LACTATES	Lactates (potassium lactate, calcium lactate, and sodium lactate)
HERBS	Herbs and spices
BITTER	Compounds that reduce bitterness including adenosine-5'-monophosphate, DHB (2,4-dihydroxybenzoic acid), lactose, sodium gluconate, and mixtures with potassium chloride
MIX	Mixtures of NaCl substitutes and enhancers
UNKNOWN	Unknown
ALREADY	Already spent money on addressing sodium reduction
CPROFIT	Change in profits (Regulatory Environment)
SODIUM	A policy to reduce sodium (Regulatory Environment)
FAT	A policy to reduce fat content (Regulatory Environment)
INSPECT	A change in the number of inspections (Regulatory Environment)
FSMA	Food Safety Modernization Act in place (Regulatory Environment)
NEWFAC	Build a new facility
ADDON	Add onto current facility
MODFAC	Modify current facility
REFORMEXP	Spent and/or will spend to reduce NaCl
EMPLOYEES	Employees
HIRING	Number of Employees hired
PARTORFULL	Employee(s) category
DISCON	Will products be discontinued
NUMDISCON	Number of products discontinued
BASE	State or region of company headquarters
SALESTER	Sales territory - range in miles
INSTATE	In-state
REGIONAL	Regional
NATL	National
INTERNATL	International
ADVER	Advertising, marketing and public relations expenditures
ANNSALES	Annual sales
ANNPROFIT	Annual profit

APPPENDIX C

POLICY PREFERENCE MODEL EXAMPLE

The ordered logit model did not return significant results with the limited number of observations in this study. However, an example of the output is provided below where all four variables are included in the model. Upon improving the response rate or range of population, the number of observations could increase enough to make this model significant. Assuming that this model for the agricultural subsidy policy option was significant and the null hypothesis was rejected, MEAT is the only parameter in Table 10 with a p-value that is significant at the 5% level. Therefore, the desirability for agricultural subsidies given to producers for lower-sodium foods would decrease by 1.7572 if a company processed meat or meat alternatives. As for the intercepts, intercept 4 would be interpreted as the likelihood of the respondent choosing desirable or highly desirable over the other three options. Then intercept 3 would be the likelihood of the respondent choosing neither desirable nor undesirable or higher (desirable or highly desirable) plus intercept 4, and so on for intercept 2.

Table 10. Policy Preference Model: Agricultural Subsidies Parameter Estimates

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	9.1369	4	0.0578
Score	7.5149	4	0.1111
Wald	7.8541	4	0.0971

Analysis of Maximum Likelihood Estimates

		Standard	Wald		
Parameter	DD	Estimate	Error	Chi-Square	Pr > ChiSq
Intercept 4	1	-1.1094	0.6066	3.3445	0.0674
Intercept 3	1	0.1974	0.5541	0.1270	0.7216
Intercept 2	1	0.9208	0.5835	2.4903	0.1146
EMPLOYEES	1	-0.00063	0.000441	2.0620	0.1510
ALREADY	1	1.5914	0.8802	3.2691	0.0706
CHANGE	1	-0.7030	1.0286	0.4671	0.4943
MEAT	1	-1.7552	0.8484	4.2798	0.0386

Oklahoma State University Institutional Review Board

Date:	Monday, December 05, 2011
IRB Application No	AG1152
Proposal Title:	The Economic Impact of a Reduced Sodium Policy on Food Processors
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 12/4/2012

Principal
Investigator(s):

Jody Campiche	Rodney Holcomb	Amanda Simpson
528 Ag Hall	114 FAPC	415 Ag Hall
Stillwater, OK 74078	Stillwater, OK 74078	Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTeman in 219 Cordell North (phone: 405-744-5700, beth.mcteman@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

VITA

Amanda Nicole Simpson

Candidate for the Degree of

Master of Science

Thesis: IMPROVING THE NUTRITIONAL QUALITY AT WHAT COST? THE ECONOMICS OF REDUCING SODIUM IN FOODS

Major Field: Agricultural Economics

Biographical:

Education:

Completed the requirements for the Master of Science in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in May, 2012.

Completed the requirements for the Bachelor of Science in Agricultural Business at University of Arkansas, Fayetteville, Arkansas in 2010.

Experience:

Research Assistant, Department of Agricultural Economics, January 2011 – May 2012.

Teaching Assistant, Introduction to Agricultural Economics, Department of Agricultural Economics, August 2011 – December 2011.

Professional Memberships:

Agricultural and Applied Economics Association, January 2011 – present.
Graduate Student Section, January 2011 – present.

Agricultural Economics Graduate Student Association, August 2010 – present.
Treasurer, May 2011 – present.

Graduate and Professional Student Government Association, May 2011 – May 2012.
Social Chair, May 2011 – May 2012.

Name: Amanda Simpson Date of Degree: May, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: IMPROVING THE NUTRITIONAL QUALITY AT WHAT COST? THE ECONOMICS OF REDUCING SODIUM IN FOODS

Pages in Study: 76 Candidate for the Degree of Master of Science

Major Field: Agricultural Economics

Scope and Method of Study:

Salt serves a multifaceted purpose in food products for producers and consumers. Producers use sodium as a preservative to increase shelf life, and many consumers often have a preference for salty, long-lasting, and convenient food products. In recent years, a majority of health professionals agree that reducing sodium consumption in one's diet would improve their health. However, this idea is not fully supported by all, and some research rejects the theory or does not find conclusive evidence. In an attempt to make Americans healthier, recent FDA recommendations are aimed at the food industry by asking agribusinesses to limit the amount of sodium in food products and thus in American diets. Now, the FDA is considering changing the voluntary recommendation to a mandatory policy. For a variety of reasons, this could lead to a high economic cost for the entire food industry. The main purpose of this research is to determine the impact to food processors if a sodium reduction policy is implemented.

To estimate the impact of a reduced sodium policy, a survey was distributed to food manufacturers in Oklahoma and the surrounding area, and a sodium cost function calculated to find the estimated cost. Additional questions provided opportunity to use an ordered logit model for agribusinesses to rate various sodium policy options based on the desirability. A choice experiment was created between two regulatory environments in an experimental design where changes in health related issues vary by either 0% or 10%, which will allow a willingness to accept term for each policy to be estimated.

Findings and Conclusions:

The results provided that when each firm has equal weight, Oklahoma food manufacturers would be willing to forfeit $1.2 million to avoid a sodium reduction policy. However, when each company is weighted through their total employment, that amount increases to nearly $4.9 million. This is the more conservative estimate; in the total cost function, the results imply that Oklahoma food manufacturers alone predict that they would have a total estimated cost of over $140 million with a sodium reduction policy. While the ordered logit model did not return significant results, the most likeable solution to addressing the reduced sodium debate for food manufacturers is to either maintain the current recommendation or implement educational activities which describe sodium's adverse health effects.

ADVISER'S APPROVAL: Dr. Jody Campiche