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## American Obesity: Rooted in Uncertainty, Institutions and Public Policy

James Woodward

*University of Kentucky*, [jwoodward@uky.edu](mailto:jwoodward@uky.edu)

Digital Object Identifier: <https://doi.org/10.13023/ETD.2016.521>

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James Woodward, Student

Dr. J.S. Butler, Major Professor

Dr. Eugenia Toma, Director of Graduate Studies

AMERICAN OBESITY: ROOTED IN UNCERTAINTY, INSTITUTIONS AND  
PUBLIC POLICY

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DISSERTATION

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A dissertation submitted in partial fulfillment of the requirements for the degree of  
Doctor of Philosophy in the Martin School of Public Policy and Administration  
at the University of Kentucky

By

James Briggs Woodward

Lexington, Kentucky

Director: Dr. J.S. Butler, Professor of Lexington, Kentucky

2016

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## ABSTRACT OF DISSERTATION

### AMERICAN OBESITY: ROOTED IN UNCERTAINTY, INSTITUTIONS, AND PUBLIC POLICY

Despite the efforts of policymakers, medical professionals, and other stakeholders, obesity and related health problems show no signs of receding from their record-high rates. Public policy has largely taken the form of consumer advice, (e.g., USDA's *Dietary Guidelines*). Since consumers bear most of the costs associated with their obesity, the goal of obesity prevention appears to be incentive-compatible, *prima facie*. That is, there is no *a priori* case for much further policy intervention unless existing advice is deficient or consumers' exhibit systematically poor decision-making.

My review of the literature shows that scholars have long conveyed a consistent narrative regarding our scientific understanding of obesity—one which emphasizes the apparent behavioral 'anomalies' of consumers. Unacknowledged by most investigators is a body of scientific literature which, if valid, severely undermines the predictive and explanatory power of most accepted models of obesity. That is, credible institutions may prevent consumers from discovering obesity-alleviating diets because nutrition authorities and policymakers have condoned only one approach to healthy eating for several decades. I advance a theory of obesity rooted in Shackle uncertainty about the operationally relevant characteristics upon which consumers should base their decisions. I relax the standard assumption that consumers exhibit open satiation isocalorically.

To measure consumer preferences in the pre-obesity epidemic era, I perform a content analysis of American cookbooks from the early 18th to the middle of the 20th century. Results show that, if anything, past Americans preferred food that would be considered worse—even further from the USDA ideal.

Using USDA survey data (1994-1996), I construct a finite mixture model to analyze Americans' consumption patterns, preferences, knowledge, and beliefs about diet and health. My estimation shows that Americans were aware of the tenets of healthy eating at that time and consumption patterns were broadly consistent with the strength of these beliefs and preferences. I argue that economic theory would not predict rates of obesity doubling in the interim, given consumers' continued exposure to information and their experiences. I hypothesize that this is evidence for a significant discrepancy

between institutionalized advice and advice which is truly effective— a form of uncertainty. I use the extant scientific literature to show the ways in which healthy decision-making is constrained relative to what it would be under counterfactual policy arrangements. I do not reject the null hypothesis that consumers would have been at least as well off with no policy at all. I use the same dataset to replicate Butler’s (1982) work which models the relationship between social stigma and the decision-making of consumers who receive food stamps.

**KEYWORDS:** Obesity, Nutrition, Public Policy, Nutrition Policy, Behavioral Economics, Public Health, Economics of Healthcare, Institutions, Habits, Uncertainty, Content Analysis, Stigma, USDA

James Woodward

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12/15/16

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AMERICAN OBESITY: ROOTED IN UNCERTAINTY, INSTITUTIONS, AND  
PUBLIC POLICY

By

James Briggs Woodward

J.S. Butler

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Director of Dissertation

Eugenia Toma

---

Director of Graduate Studies

12/16/16

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### Acknowledgments

The following dissertation, while an individual work, benefited from the insights and direction of several people. First, the director of my dissertation, Dr. J.S. Butler, exemplifies the high quality scholarship to which I aspire. In addition, Dr. David Freshwater provided timely and instructive comments and evaluation throughout the dissertation process, allowing me to complete this project in a timely manner. Next, I wish to thank the rest of my Dissertation Committee, and outside reader, respectively: Dr. Glenn Blomquist, Dr. Glen Mays, and Dr. Angela Dearing. Each individual provided insights that guided and challenged my thinking, substantially improving the finished product.

In addition to the technical and instrumental assistance above, I received equally important assistance from family and friends. My partner, Candice Rider, provided ongoing support throughout the dissertation process, as well as technical assistance critical for completing the project in a timely manner. My mother, Ilise Eldridge, instilled in me, from an early age, the wherewithal and skills to obtain the Ph.D.

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## **Chapter 1. Introduction**

The latest numbers from the Centers for Disease Control (CDC) indicate that any policy change that could bring about a significant reduction in obesity rates would pay huge dividends, all else equal (Fox, 206). According to the CDC, “The age-adjusted prevalence of obesity in 2013-2014 was 35 percent among men and 40.4 percent among women,” a new record in both categories. They estimate that the 38 percent of U.S. Adults and 17 percent of teenagers are currently obese. Suffice it to say, the personal incentives to avoid or alleviate obesity are significant and far more than cosmetic. Obesity, per se, may be among the lower-ranked concerns for the obese individual because it is also commonly associated with higher rates of heart disease, diabetes, some cancers, arthritis and Alzheimer's disease. Among the less obvious costs, a study by Gallup and Healthways estimated that obese adults are 29 percent more likely to say they lack purpose in life and nearly 34 percent more likely to suffer financially than non-obese adults. Despite the obvious costs associated with obesity, the latest estimates predict that the epidemic will not improve anytime soon (Fox, 2016).

In terms of costs, a 2015 *Health Affairs* article (“Severe obesity in adults cost state Medicaid programs nearly \$8 billion in 2013”, Wang et al.) estimated that severe obesity alone cost the U.S. \$69 billion, which is still only 60-percent of total obesity costs, just in the year 2013. “Approximately 11 percent of the cost of severe obesity was paid for by Medicaid, 30 percent by Medicare and other federal health programs, 27 percent by private health plans, and 30 percent out of pocket. Overall, severe obesity cost state Medicaid programs almost \$8 billion a year, ranging from \$5 million in Wyoming to \$1.3 billion in California” (p. 1943). The authors predict that these costs will continue to rise as more obesity treatments become covered by Medicaid.

The modern definition of obesity is based on a formula pioneered by Adolphe Quetelet, a 19<sup>th</sup> century Belgian mathematician studying the relationship between height and overall body-size in order to come up with a relative weight index. He concluded that, for the most part, “the weight increases as the square of the height’ (Eknoyan, 2007) and lent his surname to the measurement. The concept was popularized and renamed the Body Mass Index (BMI) in 20<sup>th</sup> century by American cardiologist Ancel Keys. In 1972,

Keys concluded that BMI, the ratio of weight to the square of height, was best available way to measure overall fatness because it showed relatively little correlation with height and was consistent with more direct, independent measures of body fat (e.g., the thickness of the subcutaneous fat layer). The threshold for obesity is crossed when BMI equals or exceeds 30. 'Normal' BMIs lie between 18 and 25 and overweight covers BMIs from 26 to 30.

Since obesity was first recognized as a serious, public health problem (around the turn of this century), most investigators in this area, (be they economists, nutritionists, public health researchers, etc.) have come to more or less agree on the major contributors to the obesity epidemic. There is a sense in the literature that widespread obesity is an inevitable consequence or tradeoff to the United States' rapid increase in income, productivity, and technological progress in the post-World War II era. While all of these developments have made Americans' lives much better in innumerable ways, it appears that American habits are no match for the 'obesogenic' environment that followed (Lake & Townshend, 2006).

More specifically, rising incomes and increased agricultural productivity mean that the cost of food, as a proportion of a household's budget shared, has dropped significantly. In general, this is a good thing because now even the relatively poor can better afford to feed themselves than in the past. The tradeoff, of course, is that cheaper food may encourage consumers to buy more than they otherwise would, leading to 'overconsumption' and, eventually, obesity.

Second, changes in the American labor market and physical environment reduce the incentives for losing weight. Fewer jobs require strenuous physical effort than in the past, meaning there is no strong incentive for consumers to lose weight to increase their productivity or wages. More generally, the physical environment in many areas is such that it also discourages everyday physical exertion by, for example, encouraging driving over walking or other means. Technology may also contribute to Americans' inactivity because it provides entertainment options that require little physical exertion (watching Netflix versus going to the theater or doing something outside). Again, the benefits of

easier work-lives and more convenience seem to be partially offset by worsening health outcomes.

Finally, modern medicine makes obesity (and the other maladies associated with it) a less costly health problem than it once was, further reducing the incentives that would otherwise encourage Americans to lose weight and eat well. An obvious example is that Type 2 diabetes, commonly associated with obesity, has become a much more treatable and tolerable condition than it once was (American Diabetes Association, 2013).

The same goes for heart disease, although it remains the number one killer of Americans, aside from Asian Americans, Pacific-Islanders, Native Americans or Alaska Natives, for whom the number one cause is cancer. According to the CDC, 49% of Americans have at least one of the following three risk factors: high blood pressure, high LDL cholesterol, and smoking. There are also several lifestyle choices that are associated with a higher risk of heart disease: diabetes, overweight and obesity, poor diet, physical inactivity, and excessive alcohol consumption (CDC, 2016). While researchers have yet to pin down the precise relationship between these afflictions and choices, the benefits to eating better are manifold since doing so appears to reduce the risk of developing several chronic diseases and premature death.

The interaction of bad consumer habits and increasing medical productivity over time is interesting because the latter is, to some extent, intended to reduce the costs associated with the former. That is, consumers with access to medical care have the opportunity to make a trade-off between short-term behavior change and paying for treatment. Given this choice, the consumer's decision to change her long-term habits becomes relatively less appealing than it otherwise would be. A more trivial example not directly related to obesity is the increased marketing of heartburn medications, which allows consumers to avoid even the short-term costs of eating whatever they are used to. Of course, medical care and lifestyle change can also be viewed as complements to one another but the marginal costs and benefits of each will determine the efficient mix for a given patient.

The three developments mentioned above (cheaper food, lower costs to obesity in general, and significant medical advances) are often marshalled as evidence to explain

why American dietary habits have, apparently, proven so resistant to change. In this dissertation, I do not reject these as contributing factors but, rather, argue that they are probably not sufficient to explain obesity's high prevalence and resistance to social interventions. While all of these changes make obesity more likely to develop and easier to live with, they do not change the fact that obesity imposes high costs upon American consumers and society, as discussed above. The mere fact that obesity is cheaper than it otherwise would be does not necessarily imply that the costs of habit change are too high to be undertaken, *a priori*.

In this dissertation, I hope to bring a new perspective to the obesity debate by revealing the ways in which credible stakeholders in the nutrition domain (including government, experts, and professionals) may have, despite their best intentions, actually contributed to the 'bad' habits that are now so commonplace in the United States. In fact, they may be encouraging the persistence of obesity among at least some Americans because a set of plausible nutritional hypotheses were prematurely enshrined in policy at a time when heart disease was the big, nutrition-related health concern and obesity was receiving relatively little public attention. Starting in 1978 (when obesity rates were low), federal agencies began to offer advice to Americans about what they should eat in order to live long, healthy lives—advice that has changed little since that time.

In other words, my null hypothesis is that prevalence of obesity would be no higher than it is today had the federal government chosen to enact no formal nutrition policy, in direct contradiction to conventional wisdom. My alternative hypothesis, which I can test only indirectly, is that a significant proportion of the rise in the prevalence of obesity came about because consumer choice has been inefficiently restricted by a nutrition policy that has long granted a monopoly on credibility to those (still unproven) hypotheses. Over time, policy has interacted with other credible social institutions, ultimately shaping habits, preferences, and health outcomes in unpredicted ways. I interpret the fact that obesity rates have not receded as potential evidence for a discrepancy between advice or information that is institutionally credible and advice that is appropriate for the individual consumer in question. Specifically, policy advice and credible institutions have long emphasized the importance of calorie-reduction and

exercise as a means to lose weight, and fat-reduction to avoid heart-disease. Based on my review of the scientific literature, there may, in fact, be a range of other viable strategies for healthy weight-loss that conflict or directly contradict this advice.

If I am correct, then uncertainty may play a much larger role than is commonly thought because Americans assume conventional nutrition advice is credible while diets that differ significantly from it are not. As a result, the menu of dietary options (i.e., the range of choices the consumers deems viable) may be unnecessarily restricted. If that is the case, it reduces the explanatory appeal of obesity models which emphasize a lack of self-control because those models assume consumers know what they ‘need’ to do but are unable to commit to their plan in the long-term. If consumers are not aware of efficient choices that would be strictly-preferred, then the more fundamental problem at issue is a lack of information about the proper course of action—i.e., uncertainty. As I will discuss, the nature of credence goods (Dulleck and Kerschbamer, 2006) and consumer habits may contribute to this uncertainty and a dearth of market-based experimentation and learning. It is, after all, generally considered rational to take behavioral cues from credible institutions. But, this does not imply that institutional wisdom is always correct.

In contrast to the conventional wisdom, I hypothesize that consumers have attempted to act much more rationally to prevent and alleviate obesity than is commonly supposed. I do not reject the premise that some consumers might ‘rationally’ become obese because of the nature of their intertemporal preferences. However, I do argue that a rational consumer who does wish to lose weight may soon find herself disappointed by the results of her behavior change. This does not imply that she will give up on dieting immediately, but, on the other hand, it is hard to fathom why someone would continue to try the same, ineffective advice indefinitely.

Over time, consumers may become discouraged and revert to their old, preferred eating habits. It is not that they cannot follow conventional advice, but that the advice is ineffective providing little incentive to continue eating the healthy diet. To the extent that this advice is ill-suited to these discouraged dieters, the choice to revert to old habits may become more utility-enhancing over time because doing so at least allows the consumer to derive some short-term benefit from her diet. Again, this is distinct from the usual

situation in which a fully informed consumer rationally trades-off the short-term benefits of eating poorly with the long-term costs of doing so.

Since food is generally modelled as an economic good, and calories are the unit of measurement that is used to measure food quantity, economists, among others, have long assumed that consumers are characterized by non-satiation with respect calories, all else equal. Furthermore, Americans' inability to reduce their calorie consumption is generally taken as evidence for the stable preferences that appear to be preventing widespread habit change. While this may be a good first approximation of the problem, closer inspection reveals that satiation may be idiosyncratic and significantly affected by food characteristics other than calories. Importantly, policy advice tends to discourage consumers from eating some of the more satiating American foods (e.g., red meat) and encourages them to eat less hearty foods (e.g., fruits, vegetables, and whole grains) in their place. If the healthier diet is both ineffective and less satiating, I hypothesize that this may explain why preferences have remained stable—consumers have enough practical experience with healthy eating to know it's not for them.

The latest election results (2016) indicate that a majority of voters in four municipalities (Albany, Oakland, and San Francisco, California and Boulder, Colorado) believe direct taxes on sugary beverages are, indeed, justified as a more direct, albeit more regressive, way to discourage unhealthy eating habits. The trend toward more direct market interventions to address obesity is increasingly popular worldwide amongst public health advocates (Aubrey, 2016). While I do not deny that Americans could stand to eat less sugar, and would probably benefit from doing so, the problem with such interventions is that they may still be based on a model of obesity which emphasizes the wrong characteristics in the first place. The purpose of the tax is ultimately to reduce consumption of calories but, as I discuss at length below, the tax may not have been needed if Americans were not consistently encouraged by nutrition policy and experts to fixate upon calorie and fat reduction for the past 36 years or so



## Chapter 2. Literature Review

### Introduction

Before I discuss the social science literature directly related to the United States' obesity epidemic, I will begin by introducing a few basic theoretical concepts from economics and public policy that I believe are relevant to the current inquiry. I expand upon and apply those concepts in subsequent sections of this, and later chapters.

### Information and Uncertainty

Any serviceable economic analysis of a consumer's utility maximization problem considers the agent's information state and how it may change over time. Most economic models begin with consumers who have rational expectations about the future. That is, consumers learn to expect a list or range of payoffs from particular courses of action and use that information to maximize their expected utility through their consumption activities. But consumers are always subject to some level of risk (Quiggin, 1993, p. 4) because they do not know the exact value of potential payoffs, at most only their distributions. Economic theory has tended to focus on *event* uncertainty or uncertainty over exogenous events, a more tractable problem than *market* uncertainty, under which consumers are uncertain about other agents' supply or demand offers (Hirschleifer, 1979). Depending on the expected payoff to their known, possible courses of action, consumers may either rationally adapt to their current state of information, or decide to acquire information in order to update their beliefs about the probability of future states of the world.

Economists have tended to use the terms risk and uncertainty rather interchangeably, though Knight (1921) distinguished between the two: risk applies to situations where probabilities are known while uncertainty is reserved for those in which the probabilities attached to particular courses of action are unknown. Although generalized expected utility theory is now the most common and accepted way to treat uncertainty, other economists have expanded upon Knight's observation that not all kinds of uncertainty are the same. Shackle wrote at length about the shortcomings of this now dominant approach (*Epistemics & Economics*, 1976).

Shackle takes major issue with the use of probability as a way for measuring knowledge. Much of his criticism questions the validity of assuming that all possible consequences of all actions are known in advance to the agent. Shackle introduces the idea of a “surprise function”, which measures the degree of surprise the agent experiences following an unexpected outcome or payoff. In theory, the agent could rank the degree of surprise she would experience among a number of different payoffs. Outcomes, or sets of outcomes, which are known to occur with certainty, on the other hand, would take on a zero value. This is an intuitive enough concept, e.g., if used to think about innovation, but the inherent difficulty of modelling such situations may explain the concepts’ failure to take hold in the literature (Shackle, 1976).

As mentioned, if an agent finds herself in an uncertain state, she may, and in many cases will, rationally decide to acquire more information about the products she wishes to consume. Economists frequently model consumers as having preferences for ‘goods’ (not “products” per se) which, along with prices, can be transformed into demand schedules, curves, and so on. Although this is convenient and intuitive enough, it is a somewhat circular simplification of reality—goods (including services) are simply things for which some consumers have positive demand while economic “bads” are things for which some, or often most consumers have negative demand or would pay to avoid. Although this approach does not objectively delineate which products should be categorized as goods or bads, in the way a physicist can distinguish between different elements, both terms do retain objective, empirically testable definitions.

Upon closer inspection, and with the inclusion of market prices, the intuition of the basic model is generally enough to overcome its logical shortcomings because rational consumers are highly unlikely to consistently pay positive prices for things they do not consider desirable or “good”. Producers know this and act accordingly in how they design and market their products. Over time, an efficient equilibrium would theoretically develop in which “products” and “goods” are more or less equivalent concepts.

As useful as it is, the convention of modelling products as goods *per se* is not always appropriate. In an uncertain state, the consumer will tend to seek out information on a variety of goods offered in the market. In the process of doing so, she may come

across multiple, non-identical products purporting to offer the same benefits at similar prices. Ergo, the decision-making process for a rational consumer must be finer-grained than one which treats goods and products as equivalent.

### Characteristics and Uncertainty

Lancaster recognized this shortcoming in traditional demand theory (“A New Approach to Consumer Theory”, 1966). He popularized and refined the idea that consumers are more appropriately modelled as having demand for the *characteristics* or properties that are embodied in the goods they actually buy in the market. Since budget constraints are over goods while preferences are over characteristics, the consumer actually faces an additional constraint relative to the traditional model. The *consumption technology* is Lancaster’s term for the objective link between goods and characteristics. As in the traditional model, preferences still vary subjectively depending on how much weight consumers attach to different characteristics. In the market, consumers will ultimately choose the best bundle of characteristics (good) available to them subject to budget constraint.

In the introduction to *Modern Consumer Theory* (1972), Lancaster highlights several implications of his model that differentiate it from traditional approaches. The first is the importance of adequate consumer information about characteristics so that consumers are capable of arriving at their preferred bundle. Second, the small number of characteristic that enter into consumers’ decision-making relative to the number of goods in the marketplace means modeling aggregate demand in terms of a “*representative consumer*” (p. 5) is less plausible than a model based on a diversity of preferences. Finally, the structure of the consumption technology can be used to quantifiably compare or differentiate otherwise incomparable goods in terms of the quantities of characteristics which they do or do not possess.

Lancaster’s more fine-grained analysis of the realities inherent in consumer decision-making shows that the process can be more complex than it appears. In a state of uncertainty, a rational consumer may rather quickly turn her attention to the characteristics of a given class of goods. In Lancaster’s model, the consumer must decide which characteristics or groups of characteristics are *relevant* to the current choice. She

can then compare goods within distinct groups *horizontally* according to the proportion of relevant characteristics they contain. Lancaster further posits the existence of *vertical* separability of the utility function between groups of goods, an adaptation of the separability of utility in goods space to characteristics space, which preserves the “multi-stage optimization property” found in traditional demand analysis.

In traditional demand analysis, the economics of information is important to a complete understanding of consumer preferences. Since acquiring information is costly, it stands to reason that consumers’ stock of information may be associated with *their* observable characteristics, (e.g., education and delay-of-gratification) that predict rational behavior in other domains. In economics of health applications, this is called health capital and used to understand consumers’ varying levels of demand for health (Grossman, 1972). Consumers with more health capital are predicted to have more information or have an easier ability to use health information, all else equal, and better health outcomes. The reverse is true of those with low stocks of human capital, though this may change as their preferences or circumstances dictate.

Since Lancaster’s model preserves many of the properties of traditional demand theories, it is possible to relax the assumption of consumer certainty regarding the most efficient consumption technology. By construction, Lancaster’s consumption technology can be changed or improved in a number of different ways over time (1972, p.44, 48-49). He takes this as further theoretical support for the provision (presumably via some form of policy) of better consumer information in order to increase household efficiency in consumption. The inclusion of consumer uncertainty over the consumption technology allows for the possibility that consumers could be uncertain about the characteristics or group of characteristics most relevant to their decisions. This is particularly true in a world of with more goods than characteristics, which is what motivated Lancaster’s more modern theory.

Aside from increased provision of information, Lancaster does not specifically address this hypothetical problem. Or, more precisely, Lancaster assumes the efficient consumption technology is known and uniform, in which case “efficient choices are the same for all consumers” (p.45). In this scenario, the uncertainty the consumer has over

groups of characteristics can be successfully corrected because the rational consumer is or will rationally become aware of the consumption technology. In a market of many goods possessing many characteristics in variable proportions, awareness of such technologies would be drastically more efficient than, say, learning by trial-and-error.

Does economic theory offer any guidance to consumers for how to choose the correct consumption technology? If, as Lancaster writes, the consumption technology is known to be efficient for all consumers, then economic theory suggests consumers should use it and economists ought to try to understand consumers who do not. The technology itself is assumed to be exogenous, as is the knowledge of the validity and value of this new technology.

If, on the other hand, the consumption technology's true value is technically uncertain, economic theory cannot proceed with nearly as much confidence. In either case, economists must rely on sources of information outside their own discipline to model consumer demand in many different markets, particularly in order to establish technical relationships (Barzun 1966). If those sources are accurate, actual consumer behavior can be compared to a hypothetical consumer who acts 'perfectly' upon such information, potentially revealing areas where consumers are prone to error. Importantly, due to the division of knowledge in society, researchers may not have the skill nor the opportunity to completely vet research outside their respective fields. As a result, models tend to be built upon sources of information that are considered institutionally credible.

### Satiation

In a chapter based on a lesser-known article included in *Modern Consumer Theory* ("Operationally Relevant Characteristics in the Theory of Consumer Behaviour"), Lancaster uses his characteristics-based theory of demand to analyze another fundamental assumption in traditional demand analysis, that of non-satiation. In economic jargon, satiation occurs when a consumer is not made better off by additional units of a good. Economists typically assume that consumer 'true' demand for goods is unlimited, all else equal, but that consumers must optimize their utility function subject to a budget constraint. The demand for money, subject mainly to time and human capital constraints, is a context where non-satiation is a reasonable assumption.

Although satiation is not a particularly popular topic in economics, some authors argue that it helps to explain the incredible growth of modern market-based economies (Witt, 2001). If consumer demand were easily satiated by simple goods, consumers would not experiment with new goods or new varieties of goods and there would be little incentive for firms to innovate and compete for their business—the economy would become stagnant. The market encourages innovation and competition because there is always some unmet demand for firms to compete for.

To be clear, this unmet demand does not occur simply because markets encourage efficiency, leading to higher real incomes, an expanded budget set, and so on. Non-satiation could easily apply in situations where real income is held constant, leading firms to expand or change their variety of products through cost-cutting measures or better consumer research. New, more innovative and nimble firms could still enter the market.

Lancaster shows that, for more complex goods, satiation may depend on the particular characteristics of the good in question. His example is food and he uses the characteristics of calories and flavor to model the relationship between a consumer's degree of satiation and the mix of those two characteristics. The resulting indifference curves are more "C"-shaped than in those exhibiting non-satiation. As in traditional versions, there is a negatively sloped portion where consumers are made better off by additional units of the y-axis good (calories). This is followed by a region of "neutral" satiation, represented by a vertical line segment, where consumers are indifferent to additional units of the y-axis good. Finally, the curve's slope turns positive to represent the fact that the consumer regards additional units of the x-axis good (flavor) negatively.

There are a number of implications to these satiation curves that do not apply to traditional indifference curves with single-peaked preferences. A region of neutral satiation implies there may be a wider range of choices on a given budget constraint over which the consumer would be indifferent, as opposed to strictly preferring one choice out of many. Second, consumers who lie on the positively sloped portion of their satiation curve could be made better off by "taking" a characteristic away, either by buying an alternative good with less of the characteristic (which may or may not be available in the

market) or, perhaps, by modifying the good itself. Analyses of demands for goods which assume non-satiation do not allow for this possibility.

Modelling satiation in this way is intuitive. When applied to food, satiation implies a feeling of “fullness”, a physical limit to how much can be consumed in a period. Therefore, literal non-satiation clearly does not apply in this domain (though it may still be a useful assumption) because consumers do stop eating periodically, as Becker (1992) also noted (“Habits, Addictions, and Traditions”). However, in Lancaster’s example, the consumer’s satiation is not determined by physical feelings or cues but psychological ones—weight-consciousness leads the consumer to regard calories past the neutral zone as negative.

### Institutions, Information and Habits

As a social construct, institutions are “rules of the game” in a given society. Institutions are economically important because they influence the menu of options consumers consider to be efficient in a given context. They are bigger than, and affect the behavior of, organizations, firms and individuals. Religion is an obvious example of an institution that gives individuals rather explicit rules of conduct. Cultural norms serve a similar, if subtler, purpose. Government is an institution in theory but an organization of individuals who make rules in practice. The market in general sets the rules used to trade most goods while firms and consumers typically operate in accordance with those rules, i.e., within the confines of that institutionally defined environment. Science, too, can be modelled as a social institution which tends to enhance society’s understanding of the natural world (Barzun 1966). Like the other examples of institutions, markets can facilitate the efficient expansion of technology, but technological progress itself can still occur independent of the market process.

Information, therefore, is institutionally *credible* if it reflects the prevailing opinion of individuals within a socially relevant institution. The socially relevant institutions in a given domain have considerable sway over which characteristics should be considered relevant in that domain. For example, in medicine, if a hypothetical government regulation to reduce mistakes in the operating room were strongly opposed on basic, technical grounds that it simply would not work by the major professional

organization representing surgeons, it would not be an institutionally credible regulation. The regulation's goal attempts to remedy a characteristic of the good, surgery, that is clearly relevant to both sides of the market, but an institutionally credible, non-market organization could play an important role in preventing bad policy at the hands of misguided regulators. The political reality is that such organizations will inevitably find a way to influence any policies they deem relevant to their domain (Olson, 1971).

Institutions can prevent short-sighted mistakes because they tend to change more slowly, to act more deliberately, than organizations or firms. When they are functioning well, institutions can enhance the efficiency of decision-making by reducing uncertainty and doubt because they are often the best-known and most reliable sources of information. As a result, pervasive social institutions can help to severely cut down on costs of searching for information about traded goods, particularly in contexts where characteristics are numerous. In the long-run, more efficient widespread habits, which at least approximate the wisdom embodied in some institutions, may take hold in a population.

As Becker ("Habits, Addictions, and Traditions", 1992) discusses, social institutions must compete with habits, addictions and traditions in attempting to influence consumer behavior. According to Becker, habitual behavior displays a positive relation between past and current consumption and may be beneficial or harmful. Addictive behavior is defined as a strong habit and traditional behavior as "habits that are sensitive to choices in the more distant past" (p. 330).

In Shackle's language, there should be no place for a surprise function in consumers' demand if social institutions are functioning efficiently because they should convey the necessary information (i.e., the consumption technology) to consumers, or at least point them to it. Over time, the process of utility-maximization should lead consumers to systematically avoid forming bad habits—i.e., patterns of behaviors that differ significantly from the recommended credible consumption technology. Such actions would, themselves, be surprising only because they would be considered irrational in such a context. Institutions can bring society to an equilibrium that is superior to a world without good institutions but still short of a perfectly competitive



equilibrium. Depending on how they evolve, they may indeed nudge society along in a more efficient direction over time.

### Behavioral Economics

For many social scientists today the word “nudge” is associated with more specific strategies or public policies intended to improve consumer decision-making (Sunstein 2008). “Nudges” are policy interventions which are meant to bring about improved consumer behavior by making minor changes to the environment. There are a variety of policy areas in which nudges have become popular, many of them health-related. They are generally assessed positively by obesity researchers as part of a strategy to change consumer habits. Nudges are generally preferred to direct regulations because they are meant to be less onerous to market participants because they are not meant to bring about large increases in actual prices (Marteau et al., 2011).

Studies in behavioral economics reveal the ways in which relatively minor changes to the environment can affect decision-making in important, unobserved ways. Present-biased preferences, visceral factors, and status quo bias are examples to explain sub-par decision-making in the context of food-related decision-making (Liu, et al., 2014). Behavioral economists tend to point out the ways in which actual consumer decision-making differs from the ‘rational’ behavior found in the models economists have tended to use. Theoretically, public policy may enhance decision-making by structuring the environment so that it nudges some consumers toward the more efficient decision without any loss of efficiency in the choices made by the un-nudged consumers—so-called libertarian paternalism (Thaler, Sunstein 2003).

Behavioral economics has gained popularity in recent years but the roots of the field can be traced at least back to Herbert Simon’s paper in which consumers “satisfice” given their situation, rather than optimize subject to some assumed set of constraints (“Behavioral Model of Rational Choice” 1953). Other critics argue that economists as old as Adam Smith (Thaler, 2012) were aware of the decision-making biases that everyday consumers suffer from. While there is surely some value in being reminded of common decision-making biases, their extent and importance remains empirically difficult to measure in everyday life. In policymaking, one could argue that the extent of the

decision-making bias does not matter so long as the nudge proposed to remedy it meets the standard of libertarian paternalism.

While this may be true in theory, others argue that we should not be too confident in the ability of policy to correct behavioral biases. Researchers in public choice (Berggren, 2012, Schnellenbach & Schubert, 2014) have responded by pointing to the inherent difficulties which are likely to arise when these nudges are the outcome of a political process—so-called behavioral political economy. While consumers may suffer from decision-making biases, the actors involved in the political process are subject to their own biases when they attempt to design policies intended to improve the decisions of consumers. Public choice scholarship further suggests that stakeholders in a given area of policy have an incentive to convey confidence in the efficacy of their proposed intervention.

More specific applications of behavioral economics to obesity research are discussed later in this chapter.

#### Habit Formation and Credence Goods

Up to this point, I have focused upon the positive, efficiency-enhancing role that institutions can, and often do, play in reducing the uncertainty that consumers would otherwise face in the marketplace. By providing useful information, they may tend to bring about improved habits among consumers in the long-run, consistent with microeconomic theory. However, there is also a strain of literature in economics which stresses the inefficiencies that may arise in situations where typical assumptions do not hold.

Horner (2002) presents a competitive model in which consumers positively associate the relative price of a good (versus its rivals) with the reputational effort of the selling firm. Importantly, since consumers can always defect to competitors in this setting, firms have an incentive to always devote high effort to protecting and enhancing their reputations in order to prevent loss of revenue. Consumers, meanwhile, are unlikely to switch to a firm that is lowering its prices because they associate doing so with low effort. In Horner's model, consumers are aware of the reputation of competitors and their

respective customer bases, which may prevent firms from raising prices in order to appear more “upmarket” because consumers will see through the attempt and buy the (now) cheaper version. Firms that maintain their high reputation will enjoy loyal customers and their reputations increase with age.

Horner’s model is meant to illustrate the conditions under which such healthy competition is likely to take place and weed out disreputable firms. In contrast, the market for medical services is characterized by an information asymmetry between consumer and expert, and far less information being shared among the customer bases. In this case, experts also have an incentive to be as credible as possible, because they are supplying a credence good (Dulleck, Kerschbamer, 2006)—i.e., one with qualities that consumers cannot easily ascertain before purchasing. Doctors, for example, join organizations like the American Medical Association (AMA), at least in part, to shore up their credibility with patients.

But such efforts do not preclude the existence of “quacks” (“Experts and Quacks”, Sandford 2010), who represent one variety of “fraudulent expert” (“Credence Goods and Fraudulent Experts”, Emons 1997). In Sandford’s model, consumers cannot reliably distinguish between experts and “quacks” without repeated interaction. A firm’s incentive to invest in improving its reputation will depend on how tolerant its customers are of bad outcomes. A customer’s tolerance for bad outcomes depends on the costs of switching firms and her opinion of available alternatives. In his model, already-reputable firms have an incentive to coast on their reputation, but the presence of quacks in the market compels the experts to invest in customer relationships, bringing incentives back into proper alignment. According to Sandford, an equilibrium of all quacks is always possible but an equilibrium of only experts is not because of the information asymmetry that will always persist between experts and customers. Finally, he finds that the equilibrium proportion of experts will decrease as switching costs rise and as the relative costs of expertise over quackery rise.

Sandford echoes much of what Wolinsky in “Competition in a Market for Informed Experts’ Services” (1993) claims about the importance of switching costs in determining the organization of such markets. Wolinsky goes further by relaxing the

assumption that experts can diagnose customer's problems with perfect accuracy, which may give rise to a negative search externality. Wolinsky models a situation in which experts are obligated to fix a problem at their originally quoted price. Because firms cannot perfectly diagnose their customers' problems, low-cost experts may suffer the "winner's curse" (p. 395) as customers opportunistically seek out their best option. In order to prevent this possibility, the equilibrium price level increases relative to what it would be in the absence of search and reputation costs.

Where food is concerned, Grolleau and BenAbid (2001) discuss the positive role that "public authorities" (p. 208) can play in providing mechanisms which allow consumers to monitor "credence characteristics" (p.208). In that paper, the authors refer to recent food safety scares in Europe and the increased attention paid to genetically modified organisms (GMOs) as examples of characteristics consumers might deem relevant to their food purchasing decision.

To the extent that these characteristics are, indeed, relevant to consumers, the authors contend that (well-designed) monitoring mechanisms can improve consumer habits more quickly than in their absence—a public good. In economics, the public-ness of a good is frequently used as a potential justification for its provision by the government. Above, I discussed the role that social institutions can play in enhancing consumer decision-making by improving their stock of information. Information is often treated as a public good when it is unlikely to be provided by producers. Ergo, government may be able to improve the efficiency of the market by making relevant information more available to all consumers. Alternative, non-government entities could play a similar role but the authority and reputation of the government could speed up the process of widespread adaptation to new information, all else equal.

The parallels and differences between the above scenarios and the study of obesity are worth noting. Fifteen years after Grolleau and BenAbid's article (2001), Compared to food, consumers seeking medical care have little opportunity to assess the efficacy of the services they purchase beforehand and must rely on their physician's reputation. After the fact, they may still need to heal or otherwise wait before they know the 'true' value of their purchase. As such, not unlike in Horner's model, the consumer is

faced with the task of distinguishing between ‘good’ and ‘bad’ doctors without much direct information at all and with a potential delay in feedback received compared to a competitive context. Sick consumers have little-to-no ‘appetite’ for ‘bad’ doctors, and avoid them to the extent that they can.

On the other hand, with reliable labelling, GMO containing foods are easily distinguishable from their non-GMO counterparts. Moreover, to the extent that improved taste is associated with non-GMO status, consumers can assess their purchases much more quickly and cheaply than in the medical care example. They can easily observe their compatriots’ purchases as well. Consumers who do not care about GMO content are left unharmed by the label itself. In fact, there appears to be little downside to anyone (buyer or seller) from simply adding a (truthful) label as long as compliance costs (i.e., the cost of acquiring an anti-GMO ‘reputation’) are low, in stark contrast to the costs and risks that come with reputation-building in the medical profession.

Consumers who are concerned about GMOs presumably avoid them whenever a non-GMO version is close in price. More ‘sophisticated’ or price-sensitive consumers may make trade-offs based on the benefits of non-GMO status for a particular food or food characteristic—the marginal (health or taste) benefit of non-GMO meat or poultry versus those of non-GMO fruits and vegetables, for example. Consumers who switch to non-GMO foods on the basis of perceived health benefits may (rightly or wrongly) attribute improved health outcomes to their new habits and come to expect further improvements in their long-term health. To the extent that these expectations are more or less met, consumers will continue to buy from “good” firms, bolstering those firms’ reputations over time, as Horner (2002) might predict.

Since obesity is commonly associated with increased calorie content, a characteristic that is both universal and unique to food (a necessity), in the obesity literature it is common to assume that the association between calorie content and actual satiation is a weak one. This is in keeping with the standard economic assumption of non-satiation with respect to goods, all else equal. This reasoning is backed-up by the previously mentioned USDA *Guidelines*. To the extent that consumers consider obesity an economic “bad”, economic theory suggests they should make tradeoffs in order to

avoid it, including eating less. The fact that obesity's prevalence has steadily increased over the past several decades is generally taken as evidence for Americans' inability to change their poor eating habits sufficiently, in spite of the personal benefits that are supposed to follow.

Compared to the GMO example, the expected benefits of dieting to lose weight are much higher but, at least in dollar terms, the marginal cost of a weight-loss diet is low because it technically requires the consumer to buy less. More realistically, consumers may choose to spend the same amount of money on fewer, higher quality calories or may decide to allot a larger portion of their budget to higher quality food because of a re-ordering of preferences.

Given that much of the obesity problem seems to come back to the issue of consumer habits, there is a clear role for institutional economics to play (Hodgson, 2004) in understanding their social evolution. Economists in that field are well-versed in analyzing the significant effects (positive and negative) social institutions can have on the evolution of a given society, even if the source of their influence is nebulous or hidden (Hodgson, 2003). Regardless of their benefits, there is no economic or social 'law' of which I am aware that claims credible institutions are necessarily infallible.

While the market tends to punish irrational behavior, including actors who peddle bad information, irrational rules made in non-competitive (e.g., political) contexts may endure if those institutions remain socially credible and their rules continue to guide consumer behavior. If irrational institutional rules are made over the wrong set of characteristics (among many), revealed preferences in the market will be neither a reliable guide for consumer preference nor a promising source for behavioral insights (Lancaster, 1971).

That is, the credibility of the information provided by a given institution may be based on a reputation-effect that has little to do with the quality of the information itself. Its actual quality will likely depend on the competitiveness and incentives that obtain in the institutional environment that led to its creation and provision. Scientists, for example, operate in a non-market setting but compete in other ways in order to encourage higher quality output. But that setting is affected by the behavior of various other

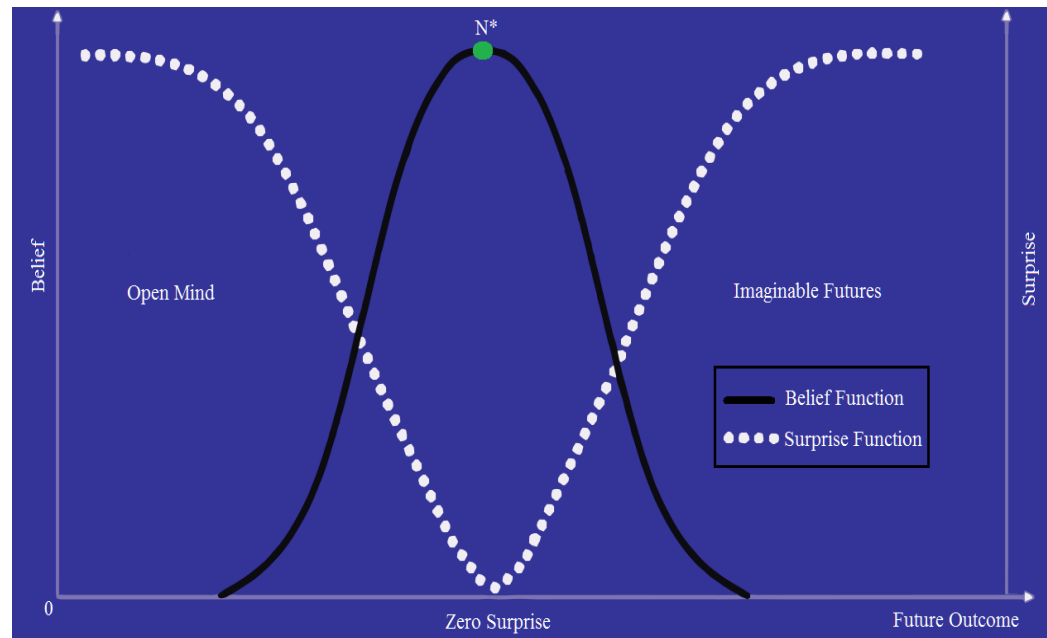
institutions—government, academia, business, etc.—all of which may affect the trajectory of scientific research and discovery over time. Nor are scientists themselves immune to the reputation effects of their peers.

In Lancaster’s analysis, an efficient equilibrium is easily obtained because there is no real uncertainty in the consumption technology, just a failure of consumers to make full use of it. This is how typical nutrition advice is regarded today. In contrast, if there is real, unacknowledged uncertainty, an efficient equilibrium may be prevented altogether, particularly if the choice of institutional rules is made politically rather than competitively (Olson, 1971). If the credibility of those rules “sticks”, Horner’s (2002) analysis suggests that their credibility will tend to rise over time, all else equal.

Moreover, the persistence of inefficient rules increases the probability of a path-dependent process developing (Liebowitz & Margolis, 2000). A path-dependent equilibrium is antithetical to a stochastic, rational equilibrium because when most actors are unaware of efficient courses of action, they cannot form complete, rational expectations and will fail to learn or discover the most efficient, obesity-reducing course of action. Persistently bad rules may set society on an inefficient “path” that no one would have chosen had they known about other paths at the beginning of the “journey”, so to speak. Once on the inefficient path, other paths may not be known if they are not considered credible, particularly the longer one remains on a given path. When choice is not so restricted, a more efficient equilibrium can evolve in the medium to long-run because the ‘market for rules’ would be more competitive.

Shackle’s surprise function is useful for understanding the situation from the consumer’s perspective. As Figure 1 shows, there is an inverse relationship between the consumer’s belief function and her surprise function. Consumers who have high levels of nutrition information or are otherwise motivated to follow credible advice will tend to have stronger beliefs about the ‘correct’ quantity of various nutrients to consume in order to lose weight or maximize their health. They also have an incentive to inform themselves further about the characteristics of a healthy diet.

Figure 1. Surprise and Belief Functions



\*Based on (Dodd, L., (2011)

In Figure 1,  $N^*$  represents the quantity or proportion of a particular nutrient that the government recommends as part of healthy diet. Obese consumers are likely to be most concerned about calories but the government makes recommendations for a litany of nutrients, including the macronutrients: fat, carbohydrate, and protein. As I will discuss, fat has received the most attention from nutrition authorities since the 1970s or so. This may explain why the American diet is relatively close to recommendations when it comes to the proportion of calories from the three macronutrients (though fat consumption remains higher than authorities would prefer).

Rational consumers are unlikely to venture far to the left or right of  $N^*$  along the belief curve because they do not believe such courses of action will lead to their preferred future outcome. Conversely, the further one moves from the corresponding point on the surprise curve below, the more surprised the consumer would be to experience an outcome as good as what he expects to experience from  $N^*$ . Consumers who wish to lose weight probably recognize the long-term value of cultivating healthy habits (as opposed to short-term dieting) and will be particularly unlikely to venture far from  $N^*$ . Given multiple  $N^*$ 's, consumers might find the complexity of the problem difficult at first. Over



time, however, the market appears to provide enough opportunity for experimentation and low-cost learning, reducing complexity over time as new habits take hold.

Another complicating factor in this domain is the fact that weight-loss requires some patience from the consumer. The time investment of undertaking a new, less-preferred diet further encourages consumers to choose credible options (close to  $N^*$ ) so that they do not need to repeat the process. But, according to critics, there is an array of bundles of dietary characteristics which are unnecessarily excluded from nearly all consumers' "consideration sets" (Shocker, 1991), ultimately because they are not considered credible by nutrition experts or authorities. These options are likely to lie so far from  $N^*$  that they will not be attempted, particularly for any length of time, because of the high costs of change and low, or negative, expected return.

It may be the case, however, that a large proportion of obese consumers would be better served if they aimed for a point far to the left or right of  $N^*$  and allowed themselves to be 'surprised' by the outcome that follows from the 'incredible' option. If consumers are discouraged from trying such options even in the short-term, the need for patience in the absence of immediate results rises the further one ventures from  $N^*$  because the 'incredible' option will lose credibility over time, depending on the consumer's experience—the opposite of the situation for a competitor with a long-standing, good reputation (Horner, 2002)—while the credibility of options close to  $N^*$  stays level.

In his article, "Public Decisions as Public Goods" (1971) Tullock points out an obvious flaw in the chain of reasoning often used to justify government provision of so-called public goods (p. 917):

The public decision-making process is a procedure for generating a public good; and the persons involved in it, whether they are the voters, judges, legislators or civil servants, all can be expected to treat it as any other public good. Hence, we can anticipate that they will invest less in the "private costs" of considering that public decision than is optimal.

In theory, relaying valuable information to the populace is a prime example of a public good. In practice, however, proper justification for such actions requires that the information promulgated be accurate and useful to the intended audience.

A proper investigation into the origins of American eating habits and the obesity epidemic requires a long-run analysis of the interactions between government, nutrition-related institutions and American consumers because habits tend to change slowly and interact in subtle ways with these institutions. Relatedly, I think it is important to review the long history of policy in this area in order to understand how government, as an institution, has tended to interpret and address societal nutrition issues. In the next section, I attempt to summarize these interactions over the preceding decades in order to explain the narrative that now informs most discussions of obesity, nutrition policy, and the relevant microeconomic factors at play.

## Origins of the Current Narrative

Long before obesity became widespread, human societies had to overcome big, nutrition-related shortfalls that threatened their very existence. Thanks to Robert Fogel (2004), among others, economists are well-aware of the fairly recent and remarkable, “techno-physio” evolution (U.S. Department of Agriculture, Economic Research Service, Food and Rural Economics Division, 1999, p. ii) of agriculture and the food market. The relatively recent boom in agricultural technology and productivity has led to a better-fed world population than would have otherwise been possible in a world without both technology and trade. The innovations Fogel recounts are also pre-conditions for an obesity epidemic because they allow for “overconsumption” to happen in the first place.

More obscure is the diet-related work of Irving Fisher. As an economist, Fisher is best known for his contributions to econometrics, but for a short time he also attempted to educate everyday consumers about how to live healthy lives, based on the latest science at his disposal. I do not know the extent to which the book influenced economists’ or the public’s thinking on such matters, but, on the whole, the advice is remarkably similar to the dietary advice published today and not particularly at odds with most of the other perspectives recounted below.

In *How to Live: Rules for Healthful Living Based on Modern Science* (Authorized by and Prepared in Collaboration with the Hygiene Reference Board of the Life Extension Institute, Inc., 1917) Fisher and co-author Eugene Lyman Fisk cover many dimensions of health and hygiene over the course of the volume’s 345 pages, made up of 5 chapters and a series of supplemental notes. It is obvious from the beginning of chapter 2 (“Food” p. 28) that Fisher and Fisk subscribe to the caloric view of obesity. The advice is familiar:

“Meals should be light and frequent, rather than hearty and infrequent. A little fruit may be taken on rising and a glass of hot water. A light breakfast is advisable; one or two poached eggs, no sugar, bread and butter in small quantity. For dinner, choice may be made of chicken, game, lean meat, fish not cooked in fat, in moderate portions, and of such vegetables as celery, spinach, [...], bulky vegetables of low food [caloric] value. Tapioca or similar pudding may be used

for desserts, and melon, and other cooked unsweetened fruits...Foods to avoid, in cases of overweight, are sugar, fats, milk as a beverage, salmon, lobster, crabs, sardines, herring mackerel, pork and goose, fat meats, nuts, butter, cream, olive oil, pastry and sweets, water at meals..." (Fisher, 1917, p.215-216)

As this passage indicates, Fisher believes that one of the keys to a healthy, weight-reducing diet was moderation in total calories consumed and a general avoidance of nutrients from which Americans derived utility —namely sugar and fat. This should come as no surprise given that Fisher was a vegetarian ("Irving Fisher" 2008), but his advice also had the scientific backing of his Institute's Hygiene Board, made up of physicians, professors, and various members of state boards of public health, all of whom appear to have been credible in their respective fields at the time. *How to Live...* was meant for a popular audience, not an academic one, and was apparently rather commercially successful—going through 15 editions between October, 1915 and March, 1921.

Fisher stresses the importance of proper mastication (chewing) and "slow eating" (p.51-54) both of which lead to "food instincts" that "are far more keen and correct...than if he bolts his food [eats quickly]" (p. 54). On the topic of overweight and obesity, Fisher stresses the importance of establishing healthy habits early on if overweight runs in the family, encourages obese consumers to avoid sugary high-fat foods, and claims that hunger is "largely dependent upon the contractions of the empty stomach, and not upon a general bodily craving for food" (p. 261), a claim which is now considered untrue. Fisher's primary explanation for the onset of overweight is consumers' failure to count their calories completely and properly (p. 32-33), though they should choose the proper level for themselves, using changes in their weight as a guide in their decision-making (p. 34).

Anthropologist Margaret Mead is another figure worth discussing in order to arrive at a clear understanding of how social scientists and policymakers have typically viewed Americans' habits vis-à-vis healthy diets. Mead served on the Committee on Food Habits, which first met in January, 1941 and was assigned to the Division of Anthropology and Psychology of the NRC. The Committee on Food Habits was meant to

work in tandem with the Committee on Food and Nutrition (later renamed the Food and Nutrition Board), it being assigned to the Division of Biology and Agriculture, all under the auspices of the National Research Council (NRC, 1943).

The NRC is one of many government agencies that began involving itself in matters of national nutrition in the 1940s. The NRC and National Academy of Sciences were the “parent organizations” of the Food and Nutrition Board, which was “born in a period of war emergency.” (Board, p.3) Russell M. Wilder served as the first chairman of the board, which had 21 initial members; nine more were added a year later. These included 13 biochemists, nine physicians, three home economists, two agricultural economists, one food industry executive, one food technologist, and one physiologist (Board p.4). Dr. Wilder’s “charge” to the members captures the committee’s broad directive:

It is no longer a question of a few experts in our colleges and research centers talking about vitamins and minerals. What we must do now is make people understand that nutrition is not an academic matter but a thoroughly practical consideration, concerning every person in the country—producers, processors, marketers, consumers, nutritional experts—everyone! (Board, p.5)

In other words, the Food and Nutrition board’s purpose was to provide information about nutrition science in order to influence individual American’s tastes in a healthier direction. The difficult task before the members of the committee (and its various sub-committees) was to quantify the meaning of the word “healthy” in terms of nutrient content in an individual’s diet.

The reasoning behind the two-committee setup was clarified shortly after the first meeting of The Committee on Food Habits:

...the National Research Council has acted on the assumption that, while the first step toward achieving an adequate national nutritional level is the securing of scientific information on what constitutes proper diets, there remains the second step, requiring an equally scientific approach, of finding the most effective ways

and means of adjusting the habits to needs, of getting people to what they need. This Committee, in undertaking its assignment, agrees wholeheartedly with this point of view and feels that governmental agencies as well have a similar twofold responsibility. (Mead, 1943, p.10)

Not surprisingly, given the time period in question, there is considerable attention paid to how various war-time measures should be best handled to avoid the inculcation of detrimental habits once the war ended (p. 21).

Mead, like most of her fellow committee members, was an anthropologist and they used the tools of cultural anthropology to approach the issue of food habits, which are defined as “the culturally standardized set of behaviors in regard to food manifested by individuals who have been reared within a given cultural tradition” (p.21). She notes that “[W]hile cultural factors are expected to account in very large degree for the food habits of mankind, there is also the possibility that combinations of foods may exert a certain degree of coercion upon physiological responses, so that the constitution of foods themselves must also be taken into account.” (p.21)

Mead goes on to identify other cultural, psychological characteristics of American food habits that are less talked about today but may still be relevant to the discussion of pervasive obesity:

European peasant conception of status which have given an importance to white bread, much sugar, meat every day; the Puritan tradition of a connection between food which is healthful and food which is disliked and the tendency in communities with a Puritan tradition to use food for purposes of reward and punishment and to handle delicious food as the reward for eating healthful, but disliked food; the equally definite Southeastern food pattern in which the emphasis is not upon health and duty but upon personal taste and a personal relationship between the eater and his food. (Mead, 1943, p.23)

She also notes an increasing emphasis on the appearance of food in the marketplace and a growing preference for “refined, purified, highly processed foods.”

Almost contemporaneously, economist George Stigler wrote on the more applied problem of “subsistence diets” in his 1945 article (“The Cost of Subsistence”). Stigler was more interested in the consumer problem of supplying an “adequate” diet at the least cost. In order to define “adequate” Stigler could not rely on his training as an economist but, rather, facts and figures from the NRC, admitting that: “[t]he science of nutrition is much too young to have attained even an approximate measurement of the "health" function for representative individuals, or to determine the extent of individual variation.” The NRC figures did provide him with daily “allowances” “(a term used to indicate their preliminary nature)” (304-305) quantities for nine nutrients, including calories, protein, calcium, iron and various vitamins. From here, based on the prices for the various foods which contain these nutrients, it is at least theoretically possible to compute the least-cost option for a subsistence diet.

However, Stigler notes at least six areas over which “a larger margin of uncertainty” still remain in the solving of this particular problem:

1. Many nutritive values have not been established
2. Most foods are not even approximately homogenous with respect to nutrient content
3. The maturity, and length and conditions of storage are important.
4. The way in which food is prepared also affects nutrient content, even if it is known.
5. Food waste is difficult to measure
6. Many nutrients in foods may not be fully extracted for biological reasons.

Stigler proceeds with his analysis and finds that “the content of a diet can be altered substantially without affecting its cost appreciably” (p. 311). Moreover, he finds that his diet is of lower cost than several other diets then marketed as low-cost. Stigler reasons this is because “dieticians [sic] take account of the palatability of foods, variety of diet, prestige of various foods, and other cultural facets of consumption. Primarily on such grounds can one explain their emphasis on meat and the inclusion of sugar”. In other words, Stigler’s diet is cheaper and less palatable while still meeting the minimum requirements specified by the NRC. He reasons that his diet would serve as a better

recommended minimum diet for two reasons: these non-nutritive recommendations are “highly personal” and “non-scientific” and because it would be difficult to adapt such minimum requirements to the diverse tastes of the American population.

The origins and validity of Stigler’s attitudes toward dietitians, nutritional science and the allowances provided by the NRC are unclear. If they reflected popular opinion at the time, those opinions must have shifted rather rapidly following this initial period of government interest in the science of nutrition. The RDAs were revised every five years following their initial publication in 1943, at least up until 1963, “so that new information might be incorporated as it became available.” (Board, p.13)

Included in an NRC Retrospective piece (*The Food and Nutrition Board: 1940-1965: Twenty-five Years in Retrospect*, 1966) is a 1958 article reprinted from Journal of the American Dietetic Association by Lydia Roberts, who served as chairman of the first committee to publish the Recommend Daily Allowances. According to Roberts, “the members worked hard and long for more than a year and enlisted the efforts of scores of other nutrition specialists” in formulating the allowances.

The tentative allowances were opened up to comment from other members of the Board and, as part of a “democratic approach”, disseminated to “nutrition workers” (p. 34) throughout the country in search of criticism and suggestions. After receiving feedback, the allowances were revised and sent out again and, finally, modifications were made by the Board. The allowances were then presented to members of the American Institute of Nutrition at their annual meeting. Roberts was somewhat surprised to find that there were no “serious disagreements or attacks” to the allowances and attributes the favorable response to the process itself (most stakeholders had already had a say) and the quality of the science at the time.

Roberts has many positive things to say about the allowances 16 years after the first version was published, “For the first time in history, all groups working for nutritional betterment have used a common allowance instead of the varied and conflicting ones which previously obtained.”(p.36) She explains the wide acceptance and use of the allowances in terms of the credibility of the NRC, “whose reputation for scientific caution and dependability is outstanding” and the “democratic procedure” that



birthed them, concluding, “All have realized that the consensus of judgment of nutrition authorities should prevail and have therefore been willing to accept allowances so derived until further evidence should justify changes.”

Jordynn Jack (2009) argues that what Roberts refers to as a “democratic approach” to science is, to some extent, a rhetorical strategy that she, personally, used throughout her career to “forge consensus among experts, shoring up her own authority and that of the NRC.” Jack notes that “using “democratic” approaches mainly to increase one’s own credibility or that of other elites can be problematic, especially if it occludes the interests and perspectives of the publics who might contribute scientific knowledge.” (p.126)

This is not to imply that the Roberts’s findings, or those of any committee under the auspices of the Food and Nutrition Board were necessarily wrong or inaccurate. The nature of relying on experts and large institutions, including science and government, requires some degree of trust in those institutions and the actors within them. Roberts demonstrated a clear ability to win that trust from her peers and used it to spread her vision of the common good via the NRC. Stigler, whatever his misgivings, had little choice but to rely on the initial allowances in formulating his subsistence diet.

Twenty years after Stigler’s diet problem, Arrow wrote on the topic of uncertainty in medical care (“Uncertainty and the Welfare Economics of Medical Care”, 1963). In the second paragraph of that paper Arrow says that, compared to medical care, at low levels of income basic “commodities”, among them nutrition, are likely to be more important in terms of their impact on health. Presumably Arrow is referring to consumers’ ability to afford a diet that meets basic survival needs. As the title suggests, the focus of the paper is “the complex of services that center about the physician, private and group practice, hospitals, and public health” (p. 941). Today, of course, many consumers interact with the medical-care industry due to an *excess* of one nutrient or another.

Arrow goes on to compare and contrast the market for medical care with the more familiar competitive model. One of his key insights, for my purposes, is that “information, in the form of skilled care, is precisely what is being bought from most

physicians and, indeed, most professionals” (p. 946) before concluding that virtually all of the special features of this market stem from uncertainty. Though imperfect in terms of risk-bearing and information transmission, Arrow points out that “in some circumstances other social institutions will step into the optimality gap, and that the medical-care industry, with its variety of special institutions, some ancient some modern exemplifies this tendency [to substitute other institutions for the market’s failure]” (p. 947).

Writing on uncertainty, Arrow gets to the heart of the informational and reputational problem when a consumer seeks dietary advice from a physician or Registered Dietitian (RD):

Because medical knowledge is so complicated, the information possessed by the physician as to the consequences and possibilities of treatment is necessarily very much greater than that of the patient, or at least so it is believed by both parties. Further, both parties are aware of this information inequality, and their relation is colored by this knowledge. (Arrow, 1963, p. 951)

While the Food and Nutrition Board was active in shaping government policy and beliefs about nutrition science between 1940 and 1965, a new body took the helm eight years later: The United States Senate Select Committee on Nutrition and Human Needs or the McGovern Committee for short, after George McGovern, its sole chairperson. Though the Food and Nutrition Board first began studying the importance of dietary fat and its relation to disease in the 1950s, by the late 1970s there was widespread agreement among many scientists, including nutritionists and dietitians, and physicians that Americans were eating too much fat and increasing their risk of chronic disease, particularly atherosclerosis, in the process.

Not unlike the policy response four decades earlier, these committee meetings eventually lead to the creation of a committee to study American eating habits, their consequences, and potential remedies which culminated in the publication of the *Dietary Goals for the United States*, which would soon after become the basis for the USDA’s *Dietary Guidelines* (Select Committee...1977). Among the members of the McGovern Committee, there was at least one dissenting viewpoint present during the formulation of

the *Goals*, Senator Charles H. Percy. According to a committee print of excerpts from the committee's meetings, Percy said "...science cannot at this time insure that an altered diet will provide protection from certain killer diseases such as heart disease and cancer". Surely this is not Percy's professional opinion as a Senator but, rather, based on his own sources. In the same document, Dr. C. Samuel West calls this statement "unwise" and "foolish".

In 1980, the USDA began publishing its *Dietary Guidelines*, later partnering with the Department of Health and Human Services (HHS) in their creation. Much like the RDAs, these *Guidelines* are revised every five years. The latest version was published in 2015 (USDA, ERS, Food and Rural Economics Division., AIB 750.)

### The Economics of Obesity Today

Recent work on economic issues related to obesity and nutrition has lost virtually all of the skepticism that runs through Stigler's early article or Arrow's article on medical care. One exception is *The Food Police*, by economist Jayson Lusk. In it, he discusses the pitfalls in rhetoric and reasoning that characterize much of the popular food policy discussion. It serves as a much-needed counter to books like Marion Nestle's *Food Politics* (2008), required reading for my university's public health course on the topic of food systems, in which obesity figured prominently. Nestle places most of the blame for Americans' poor eating habits (i.e., relative to the *Guidelines*) and diet-related health outcomes squarely on the shoulders of the food industry and its efforts at "lobbying, marketing, [and] engaging the services of nutrition experts" (ix).

In Nestle's version of recent history, obese consumers are essentially the unwitting victims of manipulation by food companies seeking to maximize their profits. She devotes little to no attention to consumer preferences per se nor to consumer theory and concludes her condemnation of the food industry with a series of policies intended to further promote the "eat less, move more" message. In order to improve the "social environment", and thus decision-making, Nestle suggests better labelling, food advertising disclaimers and prohibitions, education campaigns, better school lunches and bans on selling junk foods in schools. She also supports increased healthcare training in nutrition, more research on the "environmental determinants of food choice". Finally, she

recommends subsidies for fruits and vegetables and taxes on soft drinks and other junk foods to both curtail demand and fund the aforementioned education campaigns (p. 367).

Lusk, on the other hand, devotes a chapter (4) to a discussion of why it is frequently assumed, without much basis in theory or fact, by the “food police” that Americans need a government authority to tell them how to eat in the first place. Lusk also directs criticism at findings from behavioral economics, which are increasingly mustered as evidence in support of more direct market interventions—e.g., food taxes. He discusses three myths that are perpetuated in such discussions—that the findings are “really important”, that “paternalism is different from elitism”, and perhaps most relevantly, that “experts can make better decisions than layfolk”. As these headings imply, Lusk is skeptical of the effectiveness of policies inspired by insights from behavioral economics, politicians, and experts alike to reduce obesity’s impact.

In the chapter on fat taxes (and obesity in general), Lusk debunks several other arguments that are used to justify government interventions meant to improve national nutrition. Most pertinent to the present discussion, he points to the apparent ineffectiveness of government education campaigns regarding proper diet, discussed earlier. Turning conventional thinking in this area on its head, he asks “[I]f the billion-dollar weight-loss industry cannot, with all its marketing expertise, persuade people to lose more weight, what makes the government think it can?” (p. 150). After briefly noting that the USDA’s early Food Pyramid “did not stem the rising tide of obesity (and according to low-carb advocates, it actually contributed to it)”, Lusk then quotes another economist, Steve Sexton, “The causal-chain from mandatory information consumption to improved health outcomes is so weak that one wonders whether it is worth making people feel bad about themselves” (p. 151). Quite the departure from Nestle’s assessment of the situation.

Although Lusk’s extended debunking of common myths surrounding food, nutrition, behavior and politics is welcome, he does not dig quite deep enough to understand the role that information and uncertainty might play in the etiology of today’s obesity epidemic (granted, that is not the purpose of his book). More favorably, Lusk assumes far less than others about the validity of our existing knowledge with respect to

obesity—a skepticism he rightly extends to possible policy interventions. However, in so doing, Lusk mostly ignores the possibility that policy, credible institutions, and market-provided commitment devices have already shaped, and continue to shape, consumer preferences and habits in ways that are counter-productive to the weight-loss and overall improved health that many Americans are seeking.

To the extent that citizens find their government credible, its decision to endorse and promote certain beliefs would increase the credibility of those beliefs, all else equal. Though consumers will likely never be perfect in implementing their dietary plans, and producers are not angelic in their marketing practices, such ‘inefficiencies’ do not naturally lead to a confident prediction of an obesity *epidemic*.

Since obesity is, by all accounts, a disease of overconsumption (of one nutrient or another) economics is one discipline that could provide insights into its origins. Many economists now rely upon a model of obesity wherein the consumer lacks the self-control or knowledge required to follow the diet they would ideally prefer. Self-control (Thaler and Shefrin, 1981) and willpower are concepts used in the more traditional economics literature to explain tempting (Ozdenoren and Salant, 2012) behaviors, and economists have increasingly used them to explain diet-related behaviors, including obesity. As is their wont, behavioral economists point to the cognitive biases that may lead consumers to miscalculate the healthfulness of their diet. Consumers may mis-estimate portion sizes or nutrient content of particular foods, for example, as a result of environmental cues. Present-biased preferences, visceral factors, and status quo bias are other concepts used to explain sub-par decision-making in eating contexts (Liu, et al., 2014).

The behavioral health literature has also yielded some interesting results, but it is not always obvious how such analyses are substantively different from traditional economic analyses because the tools for analysis are often the same (Galizzi, 2014). Fan and Jin (2014) found that, despite a stronger intention to lose weight, overweight and obese individuals were less likely to meet recommended nutrient or physical activity levels. The authors attribute the finding to a lack of self-control compared to individuals of normal weight, and conclude by saying, “knowledge-based anti-obesity intervention policies are likely to have limited effects.”

This narrative appears plausible because, like almost everyone else, social scientists have long believed that they know, with certainty, at least a few hard facts about diet, health and obesity. John Cawley's model of obesity and physical activity is among the better-known general treatments of the microeconomics of obesity ("A Framework for Understanding Eating and Physical Activity", 2004). In that article, calories are counted as health "costs" (because of their contribution to obesity) but economic "benefits" (because they increase short-run utility) while exercise is an economic "cost" (because it cuts into leisure time) but a health "benefit" (because it consumes energy). Cawley also includes a term,  $\delta$ , to account for differences in individuals' metabolic rates as a function of their genes,  $G$ . Consumers may not know the precise value of  $\delta$ , but their family history should provide some guidance, especially over time. Cawley is careful to note that his SLOTH model is meant only as an approximation, and should be judged according to its usefulness. The consumer's problem is to balance these competing goals, behaviors and incentives as best she can over the course of her day.

These classifications conform to everyday experience (and may be useful enough for a preliminary model) but, in reality, they clearly do not apply homogeneously across calories, activities, situations or people. It is important to acknowledge, particularly in this domain, that tastes are not, in practice, constant, fixed and identical across time or individuals (Stigler and Becker, 1977) (Cowen, 1988). Individual tastes will, quite literally, dictate the diminishing marginal returns of any particular food. Likewise, the appeal of any form of physical exertion depends on its type, circumstance, as well as the goals and past experiences of the individual. The existence of a large market for diet and exercise-related goods and the apparent success of at least some consumers in avoiding or remedying their own obesity constitutes further evidence against the fixity of preferences, healthy or unhealthy. In fact, absent a significant change in overall consumer preferences, it is hard to imagine a significant, sustained reduction or increase in obesity rates over the period during which such a change might occur, and indeed has occurred since the middle of the last century ("America's Eating Habits: Changes and Consequences", USDA, 1999).

Cawley (2004) goes on to discuss possible rationales for obesity-related interventions. He rightly notes that there is no economic rationale for intervention in the absence of a market failure. One form of market failure is externality, in which one market actor imposes costs upon another who is not party to the original trade. In such situations, government policy can act to coordinate action or rearrange property rights to bring about an efficient allocation of resources.

In their piece “Who pays for Obesity?” (2011) Jay Bhattacharya and Neeraj Sood show that the answer is, for the most part, “the obese”. Thus, the externality argument for intervening via public policy is limited because the obese are already paying the vast majority of the costs associated with their consumption. In theory, such incentives might be sufficient to bring about behavior that is desirable for individual and society alike—a Pareto improvement. The authors do not deny that there is a clear personal incentive to worry about obesity due to its link to other chronic illnesses but absent an externality justification, they reason that another potential justification for government intervention is on the “basis of helping people to address problems of ignorance or self-control that lead to obesity” (p. 141).

Cawley (2004) goes on to explain that another rationale for policy intervention is to provide information, a public good which the government already has a fairly long history of providing and regulating in the form of the *Guidelines*. Cawley notes that this information may be ignored or drowned out by advertising, and that consumers may need still easier-to-use forms of information in order to bring about sustained reductions in the prevalence of obesity.

A third possible rationale for policy intervention is described under the heading “Consumer Protection”. Cawley notes that the Food and Drug Administration (FDA) and Federal Trade Commission (FTC) closely regulate the provision of information on nutrition labels and advertising, respectively. Such labels can provide useful information but they may also mislead consumers—Cawley’s example is that of a “cholesterol-free” label on vegetable oil (an inherently cholesterol-free food), which conveys useful, true information but may also give consumers the false perception that the so-labelled oil confers additional health benefits relative to its unlabeled competitors. Cawley also notes

that there is a beneficial role for government to play in preventing deceptive advertising by the weight-loss industry. In addition to the obvious financial and time costs, deceived consumers also pay the opportunity costs of not pursuing an effective weight-loss method and if “repeatedly fooled by deceptive advertising may become discouraged and abandon attempts at weight loss or exercise” (p. 121).

The final possible economic rationale for policy intervention Cawley discusses applies to situations in which “Individuals are not Rational”, to be judged by “whether the individual is capable of acting in his own interest” (p. 122). Time-inconsistent preferences, i.e., “succumbing to the temptation to accept immediate gratification at the expense of long-run best interest” (p. 122), is suggested as a possible rationale for a tax because it would force consumers’ to account for the long-run costs of their actions to a greater degree than they presently do. Finally, in this section, Cawley discusses some relatively early findings from behavioral economics that relate to nutrition, including the positive association between portion sizes and calorie consumption.

More recently, many other researchers have explored insights from behavioral economics and their potential applications to understanding obesity’s recent rise. In her dissertation, *Economic Aspects and Implications of Obesity* (2009), Elise Hefti incorporates several assumptions, alone and together, about this market that deviate from standard, rational consumer theory. Among these are hyperbolic, and quasi-hyperbolic discount functions, both of which incorporate consumers’ dynamically inconsistent behavior. Arguing in support of a hyperbolic discount function, Hefti proposes that there are four patterns observed in reality that cannot be accounted for by an exponential (i.e., time-consistent) discounting model:

1. **Violation of the stationary property** or the common difference effect, “characterized by lower implicit temporal discounting for long delays than for short delays” (Chapman and Weber 2006 p. 590)
2. **The absolute magnitude effect** (“less discounting of large outcomes than of small outcomes” (p. 590))
3. **Gain-loss asymmetry** (“losses are discounted at a lower rate than gains” (Hefti 2009 p. 117) )



4. **Delay-speedup asymmetry**, an asymmetry between speeding up and delaying consumption in which agents demand far more to delay receiving a reward than they demand to consume it sooner (Loewenstein and Prelec 1992).

Ultimately, Hefti concludes that a quasi-hyperbolic discount function is most appropriate because of its tractability, results from studies which showed measured differences in how obese individuals' brains reacted to food versus their lean counterparts, and because food's action in the brain is similar to that of drugs (p. 120). Referring to Gruber and Koszegi (2001, p.121), she distinguishes between "naïve" hyperbolic discounters and "sophisticated" ones. Naïve agents are unaware that they face a self-control problem and ignore preference reversals whereas sophisticated agents are aware of their self-control problem and plan accordingly.

In one version of her model, Hefti incorporates an addictive good in the form of carbohydrate as a way to account for cycles of overeating in spite of time-consistent maximization of a standard utility function. The possibility of addiction raises the question: can consumption of addictive goods be modelled "rationally", as some economists have argued ("The Family and the State", Becker and Murphy, 1988)? According to the model of Gruber and Koszegi (2001), given time-inconsistent behavior, which ignores naïve agents, both exponential discounters and hyperbolic discounters decrease consumption of an addictive good when faced with a price increase so long as the degree of addiction is sufficiently low. Their model also makes virtually the same behavioral predictions as a model based on rational addiction.

Although the models' predictions are the same, as Gruber and Koszegi point out, the optimal government policy depends on which is a more accurate depiction of reality. If obesity is the result of a rational addiction, there is no market-failure to correct and thus no reason for government intervention. In contrast, if consumers' preferences are not time-consistent, then the revealed preferences observed in the market may be a poor guide for what consumers would actually prefer (p. 1285-1286) and there is a potential argument for policy intervention.

Richards and Hamilton (2012) find experimental evidence for a statistically significant positive correlation between consumers' quasi-hyperbolic discount rates, BMI, and drinking behavior. While there may be an externality argument for policy intervention in the case of rational addiction (with time-consistent preferences), under time-inconsistent preferences the purpose of the intervention is to correct an internality—behavior in the present which has negative spillovers on a future self or selves. Based on their results, Richards and Hamilton suggest that anti-obesity policy should target “more general behaviors associated with impatience and immediate gratification” (p. 193). Policy efforts should not focus on more of the same diet and exercise messages and “would be best directed to informing individuals as to the long-term implications of short-term gratification, rather than taxing foods directly” (p. 181) because the future cost of the taxes will be discounted by the hyperbolic discounter relative to an exponential discounter (p. 193).

Gruber and Koszegi (whose article focuses on smoking) are dismissive of the potential effectiveness of market-tested self-control mechanisms (i.e., commitment devices) even for sophisticated agents because “they are probably undercut by the market mechanism itself” (p.1286) and because there will always be an incentive for future selves to revert to old habits. Weight-loss diets are commitment devices (goods) which are consumed in order to bring about more time-consistent behavior between the present self who wants to enjoy a meal for its short-term utility and the future self who wants to live a long, healthy life (Strotz, 1956, Bryan, 2010). The need for commitment devices comes about when there is conflict between the agent as “farsighted planner” and “myopic doer” (Thaler & Shefrin, 1981 p. 392).

Regardless of which discounting model is more useful (exponential or hyperbolic), even sophisticated consumers might “allow” themselves to become overweight or even obese for a period of time before they reach some threshold (perhaps when the scale finally reads X) at which point they will either implement a known diet, in the case of exponential discounters or sophisticated hyperbolic discounters, or educate themselves about healthy diets and the relationship between various foods or nutrients and health outcomes and strategies for achieving them in the case of naïve hyperbolic

discounters. Some consumers may decide to trade eating poorly and enjoying it in their early years in exchange for a healthy (less enjoyable) diet once they decide they are “too fat”. Empirically, that scenario is indiscernible from one in which a previously obese individual has a “burst” of self-control, receives a life-changing piece of advice, or experiences some diet-related “wake-up call”. Nor are these four scenarios mutually exclusive.

Clearly this point, the “obesity-preference threshold”, will vary between consumers but, less obviously, even relatively informed consumers probably will not know the exact weight that will actually spur a change in behavior. In this sense, overweight and obesity are “experiential bads” because the costs associated with eating a particular way accrue gradually over time and are not fully known until after eating habits are established. In contrast, among chronically obese individuals, leanness may be, for all intents and purposes, an experiential good.

Even consumers who rationally allow themselves to gain weight and plan to lose it later do not necessarily know the true behavioral costs of doing so until that moment comes—i.e., the value of  $X$  is not known in advance. Consumers may find old habits harder to change or new habits harder to implement than previously anticipated. Or, they may settle into an acceptable weight or eating pattern combination before  $X$  is reached. Consumers who have a history of alternating between a healthy and an unhealthy weight have particularly sensitive discount functions, reflecting their discouragement.

Although the case for policy interventions is not cut and dry (Bhattacharya, J. and N. Sood 2011), the microeconomic incentives to attempt to change one’s behavior are self-evident and becoming more so over time if only due to consumers’ increased awareness of the problem in their everyday lives. Moreover, to the extent that a given diet “works” in the short term, in practice, as judged by the consumer, one might expect that consumers’ new, health-promoting behaviors would eventually evolve into truly healthy, long-term habits. It seems somewhat damning to microeconomic theory that this has not happened yet.

According to the latest research, the decision-making problem that faces the obese consumer is basically known and understood to both her and the researchers studying the

problem. The practical difficulty lies in solving it. Kenkel (1991) discusses the folly in assuming that more public health information will necessarily lead to improved behavior, though he focuses on smoking and drinking. Consumers must have a personal incentive to follow information for it to have the intended effect. Incentive incompatibility may help explain why, despite the long history of efforts by the US government and state education systems to convey information about diet and health to consumers, obesity and other diet-related maladies are stable or increasing in prevalence. Kenkel's point that we should not expect miracles from more information is well-taken but, then, how should one view obesity in this context? Would it be even worse with no public information campaigns at all?

In their analysis of the past and future benefits of the federal government's anti-smoking policies, Jin, Kenkel, Liu, and Wang ("Retrospective and prospective benefit-cost analyses of US anti-smoking policies", 2015) estimate that they reduced the prevalence of smoking by 28% resulted in a consumer benefits of \$573 billion (2010 dollars) between 1964 and 2010 based on a 3% discount rate. The authors were unable to compute the costs of those policies but discuss evidence suggesting the net benefits were substantial. They go on to project the consumer benefits of a simulated, future anti-smoking regulation arriving at a figure of \$100 billion between 2010 and 2040 but are less certain that such a regulation represents a net benefit because it imposes costs upon some consumers.

Cutler, Jessup, Kenkel and Starr ("Valuing Regulations Affecting Addictive or Habitual Goods", 2015) also performed a benefit-cost analysis of smoking regulations and also find that the net benefits of anti-smoking regulations are still positive, even amongst smokers who experience withdrawal or ongoing losses from smoking cessation. They compute these losses as only 20-25 percent of health gains. Marginal smokers, on the other hand, will be induced to quit by the regulation and are unlikely to experience significant losses. Interestingly enough, this is far lower than the offset that the FDA has assumed in similar articles. Compared to anti-obesity policies, anti-smoking policies have been much more effective, perhaps because there are important differences between the demand for smoking and unhealthy foods.

As mentioned, various time discounting rules and time-inconsistent preferences are the most accepted tools with which to explain the development of obesity in individuals in spite of the various personal and public efforts to remedy it. And dieting is an obvious real-world example of time-inconsistent behavior (Frederick, et al. 2002, Laibson 1997). Changing any preference is difficult, especially one as habitual, familiar, and personal as those for food (Todd & Morrison 2014).

Healthy habits may have been easier to maintain in the past, when food was simply less available. Prior to the “techno-physio” evolution of the food environment (Fogel 2004), our species had far, far less choice in terms of the quantity or quality of food—they were in some sense “given” by nature and had to be extracted by humans via the costly processes of hunting and gathering for comparatively immediate personal consumption. The far more pressing issue then was starvation and diseases of deficiency. Although evolution of the food environment was surely the result of human-directed, purposive action, it is plausible that, in dealing with new, rapidly spreading agricultural technology, we could end up with a food environment that no one is particularly happy with, one that makes food choices which lead to obesity less immediately costly than in the past (Cutler, et al. 2003).

On the other hand, the degree of choice provided by the modern food environment is a remarkably large and positive innovation because of both the quantity and variety of foods to which consumers now have easy access. Obese and lean individuals shop in the same supermarkets, so it is not as though the two populations live in completely separate physical environments. No one is forced to consume the unhealthy foods sold in the market in excess any more than they are forced to eat kale at every meal. Likewise, it is not as though this market has moved uniformly in the direction of supplying only unhealthy food. The rising tide of obesity itself lends itself to profit-making opportunities and, indeed, various market-provided diets, foods, exercise equipment, etc. are also available to assist consumers in controlling their willpower in pursuit of their health goals (Bryan 2010).

Based on my reading, the economics of obesity literature distinguishes itself somewhat from other disciplines that study the subject by how it treats the following aspects of behavior in obese consumers:

1. **Self-control:** It is common to refer to obesity primarily as a problem of self-control, often modelled as a conflict between present and future selves, (Fan & Jin, 2014, Legg, Puri, & Thomas, 2000, Thaler & Shefrin, 1981).
2. **Rational obesity** Related to the first point, obesity itself is technically not a problem in and of itself unless the consumer deems it so. To some extent, consumers are likely to trade-off their preferences for health with those for palatability and other preferences surrounding food.
3. **Stable preferences** Individuals have stable, and hard-to-change preferences for their particular unhealthy diet, which may be treated as endogenous to the economic and social system (Palacios-Huerta and Santos, 2004).
4. **Non-satiation** Calories of food enter consumers' demand functions as normal, homogenous goods which do not, by themselves, convey sufficient feedback to prevent consumption past the point where obesity is maintained.

In order for Cawley, Hefti, Fisher and others to model obesity as a social phenomenon, they must trust that the dominant literature coming from an unrelated discipline captures the salient dimensions of the problem reasonably well. Cawley's model of economic behavior is necessarily built upon a model of the relationship between diet, physical activity and obesity—such a model or an absence thereof seems a necessary part of the foundation for any economic or behavioral framework in this area.

As such, Cawley's model pre-supposes that obese individuals became that way because they failed to undertake certain behaviors—namely, reduced calorie consumption or increased exercise. He simultaneously assumes that this would be the consumers' preferred allocation of resources given *complete knowledge of the alternatives*. As a result, his, and nearly every other explanation for obesity ultimately reduces to differing

individual preferences (p 120). Unlike “those working in public health” (p 120), Cawley argues, economists are more likely to assume that individuals are acting in their best interest whereas the former are quick to assume the opposite.

### Synopsis and Critique of Obesity Literature

To sum up, most social scientists seem to agree that the causes of obesity are common knowledge (Geanakoplos, 1992), meaning everyone, including the afflicted, basically knows how obesity works. But solutions, in the form of changed habits, have proven difficult for obese individuals to implement because they lack the necessary self-control or, less convincingly, information. On the policy side, 70-plus years of federal efforts in the form of Dietary Allowances, Goals, and *Guidelines* were implemented to prevent precisely this sort of situation. Paradoxically, because so few researchers wishing to address the issue question the underlying wisdom of the *Guidelines* themselves, they spend little time on normative models of consumer behavior and instead try to refine descriptive models (Quiggin, 1993, p. 5), which up to this point can explain only a fraction of obesity’s meteoric rise (Baum & Chou, 2015).

The preceding pages show that, despite much research and writing on the topic, there is still considerable uncertainty about the best choice of policy or policies to combat obesity and its associated health problems, mostly because few policies have proven particularly effective so far. Nevertheless, researchers seem sure that they know which side of the market is most in need of change: the demand side.

For the remainder of this chapter I will review literature and evidence suggesting that the apparent ineffectiveness of past and present nutrition policies may be the end result of long-unacknowledged or unknown uncertainty at more fundamental levels of analysis than is commonly understood by the stakeholders and policymakers in this domain--that is, uncertainty about the fundamental causes of, and cures for, obesity. The USDA continues to publish *Dietary Guidelines*, including advice related to obesity, which are broadly similar to the original *Goals* in 1980 (Sollid 2015). According to government nutrition policy at least, there is no uncertainty regarding the causes and cures for obesity nor the basic requirements of an otherwise healthy diet.

Assuming I knew nothing about obesity trends in the past several decades (but everything else about society), imperfect preferences are a reasonable and defensible explanation for the *onset* of obesity in an individual or even large group in the short to medium-term. There is no *a priori* reason to assume consumers' preferences for food, health and the actual environment will quickly and harmoniously align with the social goal of optimal long-run health, a perspective I share with economists in this area. Those who suffer from food allergies probably understand this point well when eating out. However, the current predicament is that more and more individuals are becoming obese and *remaining that way or worsening*. That is how a country, and the world (Caballero, 2005, Prentice, 2005), develops obesity on such a large scale. At some point, basic microeconomic theory suggests that obesity rates might stabilize, settling into a "natural" rate of obesity.

Like the natural rate of unemployment, the causes of a "natural" rate of obesity may have frictional and structural components. The shape of a consumer's discount function may lead her to change her habits only after becoming obese, analogous to frictional unemployment, which comes about by choice. "Structural" obesity could be explained by the time it actually takes to change habits or lose weight—behavioral factors, traditionally considered.

Even considering the difficulties that come with dieting and habit change, it is still rather hard to understand exactly why *so many* consumers would continue to make the same chronic mistakes day-in and day-out. Contrary to the traditional narrative, one might think this is precisely the sort of inefficiency a market system with functioning institutions would correct or prevent. Unlike, say, cars or appliances purchased in the United States, which have improved in quality over time, obesity statistics show that American diets have not followed suit.

According to the latest empirical research (Baum & Chou, 2015) behavioral economists are as yet unable to explain the vast majority of the increase in obesity's prevalence—at most 6.5% of the 15% increase in the past decade. It seems even with the incorporation of behavioral factors in economic models, there is a large component of obesity's causes which remains unexplained.



Unfortunately, in order to determine precisely why one consumer is more or less obese than another, a researcher would need complete knowledge of consumer preferences, motivations, metabolism and precise nutrient consumption. Since this empirical requirement is impossible to meet, mainstream theories for obesity's rise technically cannot be falsified so long as American diets do not meet USDA requirements. That is, so long as the average American diet and diet-related health status deviates from the ideal, Americans will always appear to lack *some* self-control. Moreover, well-known measurement and self-reporting issues (Fave, et al., 2009) that accompany observational nutrition research render the task of interpreting empirical results with precision all the more difficult.

Both behavioral and more traditional economists consistently direct the focus of their analyses toward the impediments (be they mental, physical, or environmental) that prevent individuals from following a healthy diet, as defined by the nutrition authority embodied in various federal agencies. In so doing, they are often, in effect and perhaps without realizing it, analyzing two sorts of questions at once: 1) microeconomic questions about changing preferences and habits to meet long-term goals and 2) the more "macro" question of how or the degree to which preferences are shaped by social institutions, including government policies. Researchers of all stripes seem to have assumed that preference change, by and large, remains too difficult for obese consumers to achieve, in spite of the microeconomic incentives, policy efforts, and market-tested commitment devices. Despite the lack of evidence for nutrition policy's effectiveness up to this point, research in this area often, though not always, argues or at least implies that further policy interventions in pursuit of the same behavioral goal may bring about a reduction in the prevalence of obesity. Baum and Cho (2015) suggest behavioral interventions can play, at best, only a minor role.

There are two corollaries to the mainstream point of view that I wish to consider. One is that the obesity epidemic would be as bad or worse under most alternative policy regimes—e.g., if the government had never endorsed any *Guidelines* at all, one could only assume that the situation would be worse. Exceedingly few researchers in this area argue that the solution to the obesity problem is for consumers to follow advice which

differs substantively from USDA advice so I assume that they believe it to be mostly correct or among the best available alternatives. I say “most” alternative regimes rather than “all” because in a counterfactual world that lacks a government-endorsed diet, other institutions and the same sorts of experts and professionals we have today might operate much as they do now. It is entirely possible that things would have turned out much the same as they have (for better or worse) in the absence of any government action at all.

Secondly, if hyperbolic discounting or other self-control based theory is a useful way to explain obesity’s onset and persistence, we still do not know whether the costs associated with obesity’s persistence are, on average, high enough to bring about the significant, long-term changes in consumer habits that policymakers, nutritionists and the public-at-large would like.

Though hyperbolic discounting models are frequently used to explain myopic behavior, part of their appeal lies in their prediction that, at some point, the myopic consumer will choose the more rational option because it pays, in the moment, to do so. Put differently, an obese individual’s incentive to change her heretofore fixed, poor eating habits should increase with time (i.e., the duration of her obesity) as long as she experiences negative (health) consequences associated with obesity and, also, because of the reduction in expected utility due to the reduced quality of life or premature death. But the evidence (rising obesity rates) suggests that sustained preference reversals are more than outnumbered by people who fail to heed sensible eating advice.

Similar to the issues involved in falsifying a widespread self-control problem, there is no way to know if continued efforts to affect consumer behavior in the same basic ways will ever have the intended effect. We do not have the requisite information about the parameters of consumers’ discount functions that would allow for such a prediction. Two questions that may be important to the future of nutrition policy come to mind: Do obese consumers need to experience higher costs in order to change their eating habits? And if so, should this be interpreted as evidence in support of some form of tax on food or specific nutrients? My reading of the literature suggests that, as long as current trends in the field continue, researchers and stakeholders in this domain are increasingly likely to answer “yes” to both questions.

I have identified two significant, interrelated shortcomings in the obesity literature which relate to the obesity epidemic itself and nutrition-related policy efforts past and present. The first is that at least some prominent voices were ignored in the early formation of nutrition policy, when the science was weak and uncertainty arguably was high. The possibility for this to occur in the policy process is raised by Jack in his critique of “democratic” approaches to science and, specifically nutrition science policy (“Lydia J. Roberts's nutrition research and the rhetoric of " democratic" science” 2009). That is, it is possible that some voices will be ignored in a deliberation process dominated by experts directed at reaching some consensus. Minority, dissenting, opinions may be ignored, glossed over and explained away by a majority of experts in ideological agreement, in pursuit of some policy-prescribed goal. In the case of nutrition science, this means a failure by other disciplines, including public policy and economics, to wade into the science of nutrition itself for clues as to why obesity has proven such a vexing public health problem.

Second, by ignoring this real uncertainty (between “rival hypotheses” (Shackle, 1972, p. 19), credible institutions may be reinforcing a suboptimal equilibrium of their own creation without even realizing it.

In the obesity literature, economists have ignored the possibility that consumers’ preference formation is the dysfunctional result of interaction with nutrition institutions and policy. If useful scientific input has been ignored both politically and institutionally, it raises the possibility that consumers’ habits alone are poor guides for how best to understand and combat obesity. The extent to which such uncertainty can explain obesity’s rise, then, depends on two important questions: 1) the substantive differences between relatively credible rival hypotheses regarding the causes and remedies for obesity, and 2) the extent to which consumer habits’ and beliefs are already informed by or “adapted to” credible institutions.

## The Case for Uncertainty in the Scientific Literature

Since the purpose of this dissertation is to counter current and extant theories of widespread obesity, which frequently rely on explanations in terms of individual lack of self-control, I will now explore the scientific roots of this, the dominant narrative regarding the obesity problem in the United States.

Gary Taubes, a science journalist and author, who eventually became interested in the science related to diet, health and obesity, has done as good a job as anyone in critically reviewing the long-lived and often poorly-understood field of nutrition. In his book, *Good Calories, Bad Calories: Fats, Carbs, and the Controversial Science of Diet and Health* (2007), Taubes argues that much of what we believe to be true about the causes of obesity and, importantly, other diet-related illnesses may, in fact, be mistaken. In order to make his case, Taubes reviews the study of obesity in great detail, focusing on the history of scientific and popular thought regarding the causes and cures for obesity. He traces the modern study of obesity to the 19<sup>th</sup> century, when the first weight-reducing diets began to appear. The first of these diets was popularized by William Banting in 1863 in his pamphlet, *Letter on Corpulence, Addressed to the Public*. Medical authorities at the time were quick to criticize Banting and his diet as nothing new, which Banting willingly acknowledged (Taubes, x-xi), as his only wish was to help others like him.

According to Taubes, our failure to keep widespread obesity at bay may have its roots in the public's (or its' trusted authorities') failure to heed Banting, and his intellectual predecessors—Claude Bernard (French physiologist), Jean Anthelme Brillat-Savarin (French lawyer, politician, and gastronome), and Jean-Francois Dancel (French physician and military surgeon), all of whom had written favorably on the topic of Banting-like diets. That is because Banting's diet is the first popular example of a seemingly effective low-carbohydrate diet. A low carbohydrate diet is, proportionally, low in the macronutrient carbohydrate, constituting 20-30% of calories consumed. Under such diets, fat makes up another 50-60% of calories while protein, the third of the three macronutrients, makes up the remainder. Unlike traditional low-fat, low-calorie diets, calories are not the variable of primary concern for weight loss, whether that means reducing consumption or “burning” them through exercise. According to Taubes, our

current understanding of the relationship between diet and obesity is actually one of two schools of thought which have competed with one another since Banting's original pamphlet was published (Banting 1993).

In contrast, since it began publishing the *Guidelines* in the 1980s, the USDA has promoted a low-fat, low-calorie diet, along with exercise, as a healthy approach to losing weight and avoiding chronic disease. Low-carbohydrate diets claim to offer the same set of benefits even though they are starkly different from what has long been considered healthy by most Americans. Such diets were re-popularized in the 1970s by Dr. Robert Atkins and his own eponymous diet has waxed and waned in popularity since. Randomized control trials comparing low-carbohydrate, high-fat, ad-libitum (i.e., without caloric-restriction) diets and low-fat, low-calorie diets for weight loss did not begin to appear until 2003 (Foster, et al., 2003). Today, the so-called low-carb “fad” is enjoying another resurgence in popularity among consumers and scientists alike, as I will demonstrate.

Compared to a low-fat, reduced-calorie diet, a low-carbohydrate diet has a much higher percentage of fat (around 50 percent of calories), much of it saturated fat, a nutrient long-vilified for its role in heart disease though meta-analysis and clinical trials indicate that the risk of developing Coronary Heart Disease (CHD) or Cardiovascular Disease (CVD) is unaffected by saturated fat intake (Siri-Tarino, et al., 2010). Meanwhile, low-carbohydrate diets are much more restrictive when it comes to eating sugar, starch and grains, including whole grains, compared to their low-fat counterparts. Part of the reason for their high saturated fat content comes from their opposing views on which fats are “good” and “bad”. In direct contradiction of longstanding USDA advice, low-carbohydrate diets typically encourage the consumption of saturated, animal fats instead of polyunsaturated vegetable oils that are generally considered healthier. Vegetables and fruits, for the most part, remain healthy, but relatively small, parts of both diets

It is difficult to properly stress just how at odds these two approaches to curing obesity are—i.e., the extent to which they are rivalrous in consumption strictly because of the different consumption patterns they recommend. In the event that one dieting

approach were to be scientifically verified as *the* proper approach, there would be a clear case for some regulation or provision of information about the quality of the foods and the proper role within said diet (Beales, et al, 1981) This might not present a problem in some contexts but, according to Taubes, it has long been the case in nutrition that “[T]he urge to simplify a complex scientific situation so that physicians can apply it and their patients and the public embrace it has taken precedence over the scientific obligation of presenting the evidence with relentless honesty” (*Good Calories, Bad Calories* 451).

In the opening chapter of the book, Taubes quotes Hilde Bruch, a psychoanalyst specializing in eating disorders, as saying “The great progress in dietary control of obesity was the recognition that meat... was not fat producing; but that it was the innocent foodstuffs, such as bread and sweets, which lead to obesity.” That was in 1957, around the time when excessive fat and saturated fat intake were emerging as potential public health problems. According to Taubes and his ilk, there is no obvious, scientific reason why low-carbohydrate diets should have ever gone out of fashion as methods for weight-reduction. At the time, the scientific evidence in support of low-fat diets was not sufficiently clear nor convincing for a scientific consensus to be enshrined in policy. Several fundamental questions surrounding diet and health were far from settled, and arguably remain unanswered.

Few argue that low carbohydrate diets are appropriate for everybody but, for some time at least, they were viewed as the go-to method for weight loss. More recently, however, weight-reducing diets which focus on reducing the raw food-energy consumed and increasing the energy exerted through exercise have competed with low-carbohydrate diets--and mostly won (U.S. News & World Report 2016). Taubes goes to great, and effective, lengths to show that these two views of obesity are not compatible with one another. To illustrate, if, in addition to being low in carbohydrates an individual’s diet is supposed to be low in fat (for example, to avoid some other perceived health risk), following a low-carbohydrate diet becomes incoherent—holding protein intake constant (the US average is 15%), a diet cannot really be “low” in both carbohydrate (~25% of calories) and fat (~30%) without adding some fourth, non-existent macronutrient to make up the remaining 30% of calories.

While *Good Calories, Bad Calories* serves as a brilliant and thorough historical summary of the obesity literature, Taubes was not the last to question the conventional wisdom surrounding diet and health. Nina Teicholz, another science journalist, echoed much of Taubes's research and sentiments in her book *The Big Fat Surprise: Why Butter, Meat and Cheese Belong in a Healthy Diet* (2014). William Davis, a practicing physician, published the best-selling book *Wheat Belly: Lose the Wheat, Lose the Weight, and Find Your Path Back to Health* (2011) after successfully treating his patients with a wheat-free diet. *Grain Brain: The Surprising Truth about Wheat, Carbs, and Sugar--Your Brain's Silent Killers* (2013) by David Perlmutter and Kristin Loberg is another popular example of recent books on the subject. These books are part of an extant and growing popular literature that questions the scientific basis, and some fundamental beliefs, of conventional nutrition advice. These authors tend to conclude two things:

1. That fat, saturated fat, and cholesterol are not the problems they are made out to be with respect to cardiovascular health and may, in fact, make up a large part of a healthy diet.
2. Grains, especially refined grains (particularly white flour and sugar), may be more problematic and linked to more health problems, including obesity, than is commonly believed (Cordain, 1999).

Since 2003, after several decades of public policy advocating the use of low-calorie, low-fat diets, many clinical studies have been conducted to test efficacy and healthfulness of low-carbohydrate, "paleo", or high-protein diets. The results indicate that individuals placed on a low-carbohydrate diet often lose at least as much weight, on average, as subjects placed on low-calorie, low-fat diets. Furthermore, their cholesterol readings, and other measures of cardiovascular health tend to improve or at least not worsen (Boden et al., 2005, Brehm et al., 2003, Brehm et al., 2005, Brinkworth, et al., 2009, Foster et al., 2010, Gardner et al., 2007, Guldbrand, H. et al., 2014, Lindeberg et al., 2007, Samaha et al., 2003, Shai et al., 2008, Shea et al., 2011, Siri-Tarino, Sun, Hu, & Krauss, 2010, Stern et al., 2004, Volek et al., 2004, Yancy et al., 2004). Based on my reading of the evidence, low-carbohydrate diets are at least worth considering for individuals looking to lose weight and otherwise improve their health. On the other hand,

I cannot credibly refute the experiences of those who have successfully lost weight on a low-calorie or low-fat diet.

Other researchers have stressed the negative health consequences associated with even moderate grain consumption (Davis, 2011, Perlmutter and Loberg, 2013). Still others suggest that more specific nutrients, such as fructose, may be to blame for some individuals' metabolic dysregulation (Arora & McFarlane, 2005, Basciano, Federico, & Adeli, 2005, Elliot, 2002). Fructose represents about half the caloric content of the sugar found in most foods.

What all of the above suggests is that obesity, as a biological, metabolic, or medical, problem, is far more complex than is commonly understood today. Confusingly enough, an article entitled "Is a calorie a calorie?" appeared in the *American Journal of Clinical Nutrition* in 2004 (Buchholz and Schoeller), which answers the titular question in the affirmative while simultaneously admitting that "units of dietary energy are metabolizable energy and not gross energy" (what is eaten is not the same as what is "burned" by the body) and that the macronutrient composition affects energy expenditure. This is a particularly relevant finding if the scope of macronutrient composition has been unnecessarily restricted.

That same year, in another journal, Feinman and Fine ("A Calorie is a Calorie" Violates the Second Law of Thermodynamics", 2004) reached the opposite conclusion when it comes to weight-loss and obesity. In 2008, Feinman, et al. published an article ("Analysis of dietary interventions: A Simple Payoff Matrix for Display of Comparative Dietary Trials) containing a "payoff matrix" comparing the efficacy of different diets used to lose weight. Carbohydrate-restricted diets emerged as the winner. Critics of the mainstream view emphasize the point that the metabolism of the obese is important in attempting to understand the emergence of the obesity epidemic, as metabolic processes may have a significant impact on both preferences and satiety (Gerstein et al., 2004, Fiszman et al., 2014, Rolls, et al., 1988).

Because this scientific controversy has been largely ignored, in present-day parlance a "healthy" diet invariably refers to one that is relatively low in calories (<2,000), low in fat (<30% of total calories), low in sugar (variable), low in salt (<2400 mg), focused on



lean meats and high in fruits and vegetables. My finding is that this is the case with many popular diets—they are either roughly similar to existing recommendations or amenable to them with a few minor changes (U.S. News & World Report 2016). This is consistent with economic theory given that the tenets of healthy eating are well-understood and believed—more credible goods tend to have larger markets. As such, vegetarian diets, for example, are not far afield of these basic tenets even if they are not technically equivalent to the USDA endorsed diet.

That is, a vegetarian diet is not inherently rivalrous with a USDA style diet and could easily be considered a first or second best option for some consumers. A low-carbohydrate diet is highly rivalrous because it embodies an entirely different set of beliefs, some of which do overlap with mainstream advice. Consumers also have some room for latitude in their choices and may choose to combine approaches that do not conflict practically or theoretically.

The exception to the rule that differences between diets or foods marketed as healthy will be relatively minor is found in low-carbohydrate diets. Although researchers interested in low carbohydrate dieting are part of a growing minority in the nutrition field, few of their insights have penetrated the fields of economics or public policy. One exception is economist Zoë Harcombe, PhD whose book (“The Obesity Epidemic...”, 2010) calls attention to the poor science that underlies nutrition policy and everyday advice, as well as the potential promise of low-carbohydrate dieting. Using her economics training, she tests a model of obesity using data from clinical studies and is able to show that subjects’ success or failure to lose weight can be better explained, statistically, by differences in carbohydrate consumption, as opposed to the differences in calorie consumption, as was generally argued by the original authors.

This is not to argue that one diet or another should or should not be recommended to any particular person. As I have shown, recent clinical evidence suggests that many approaches can bring about weight loss. There are a multitude of diets on the market and in the media from which to choose. However, on the matter of policy, according to Taubes (2007) and other like-minded critics, the government acted prematurely in endorsing one interpretation of the evidence, and that interpretation has been with us ever

since, embodied in the *Dietary Guidelines for Americans*. These represent not only the government's opinion on what constitutes a healthy diet but, today, that of thousands of professionally licensed individuals, including Registered Dietitians (RD) and physicians who then relay that information to their clients (Center for Nutrition Advocacy, 2015).

As the prevalence of obesity has increased, media attention to the issue has as well. It, too, reflects the commonly-held belief that obese Americans are some combination of ignorant of proper nutrition or lacking in self-control—that their underlying, fixed habits are inherently unhealthy and apparently incredibly durable. The healthiness of any given diet is framed in terms of its resemblance to a low-fat or low-calorie diet, particularly if the individual in question is known to be obese or to suffer from diet-related illness (U.S. News & World Report, 2016).

### Policy, Institutions, and Habits

The second shortcoming in the literature, facilitated by the aforementioned knowledge gap, relates to the interactions among nutrition policy, information, institutions, consumer preferences, and habits. The literature in this area, written at a time when obesity rates are at an all-time high, naturally seeks to explain obesity as a failure of self-control, in some broad sense, to the extent that it assumes that obesity-reduction is on-net utility-enhancing. The personal incentives appear to be in place, information is plentiful but the four previously mentioned modelling conventions (p.20) lead researchers to focus on the impediments to losing weight or remaining lean. In so doing, they do not consider the extent to which consumer preferences and habits have changed and interacted with important social institutions and public policy over time.

Taubes (2007) argues that current, popular explanations for obesity's prevalence essentially blame obese individuals for being "gluttonous" and "slothful". Experts and professionals seek to correct their behavior by recommending what were once called "semi-starvation" diets along with increased exercise, methods bound to fail. Meanwhile, healthy, viable alternatives are warned against based on years of weak evidence and popular misconceptions. The observational studies that dominate the nutrition literature are little help in discerning which of these rival hypotheses is correct.

The federal government has been actively interested and involved in shaping American eating habits by promoting, directing and funding nutrition research for over 70 years. The goals of these policies and their makers were, and continue to be, well-meaning, and earnest. One has to assume that these efforts have affected consumer preferences and resulting habits in innumerable ways which may be relevant to the study of widespread obesity. According to the USDA, in 1999, Americans were “slowly adopting more healthful diets--the share of calories from fat is declining, people are eating more fruit than 10 years ago, and the U.S. Department of Agriculture’s Healthy Eating Index has shown some improvement in recent years,” (USDA ERS, 1999). What has failed to emerge, however, is a decline in the obesity epidemic.

According to Taubes (2007), the McGovern Committee’s decision, to reduce the “complexity” of dietary decision-making back in 1980 has amounted to a decades-long, nationwide experiment, testing one of at least two available hypotheses of diet and health, including obesity. If other, plausible hypotheses were available or have emerged since the publication of the *Guidelines*, this suggests a breakdown in the interaction between science and government.

I know of no theory of the ideal use of science in policy which has the government deciding to “test” a medical theory on the entire population. Rather, in the treatments I am aware of, sound science is assumed as an input—it is hard enough to design efficient policies even then. If, instead, untested science was used as an input, then bad policy, in the form of bad information, is not necessarily a surprising result. The long-run effects of bad information could be negligible or significant, depending on the situation.

Based on my review of the literature, I cannot reject the hypothesis that the McGovern Committee’s seemingly benign policy intervention set in motion an institutional environment which reinforces suboptimal eating habits. That is, widespread obesity may have come about because of a dysfunctional, path-dependent policy process that prevents efficient consumer decision-making from the outset, eventually leading to the United States’ present predicament. If that is the case, the origins of American eating habits deserve some attention.

## Nutrition Institutions and the Microeconomics of Habits

It is central to my argument that researchers and consumers alike use credible social institutions in their everyday decision-making in order to form expectations about their future health. The extent to which economists, for example, can know whether or not a particular food, nutrient or behavior is relevant to the study of obesity is, itself, determined by outside experts on the subject. In this case, obesity's severity is typically modelled in terms of one variable: calories. Thus, the task of any economic or policy analysis has been to use the tools of social science to describe or explain why calories have become so easy to "overconsume" despite the costs of doing so. Though certainly not the first, Margaret Meade referred to obesity as a problem of "overnutrition" (1964, p. 24). It has been conceptualized and enshrined in policy as such ever since. If, however, there are gaps in our knowledge regarding the causes of obesity then calories per se may be the wrong consumption characteristic to focus upon in analyzing obesity. The case for public policy interventions intended to prevent nutritional maladies is severely limited, if not nullified, if the nutrition authority in charge is sufficiently uncertain about the basic causes of, and solutions to, the problem.

While the *Guidelines* are supposed to respond to new evidence, the extent to which new evidence is useful or relevant is determined by a small group of individuals who are now professionally invested in a particular set of beliefs (Hite, et al., 2010, Hite & Schoefield, 2015) and protected by licensing laws (Center for Nutrition Advocacy, 2015). Those beliefs, in turn, reinforce widespread, decades-old beliefs about nutrition in society. They may have also inadvertently led to institutional and political structures that are neither thorough enough nor responsive enough to objectively present the most useful and accurate findings about the relationships between diet and health to consumers.

If so, this weakens a narrative in which "positive" institutions (science, medicine, government) are unable to overcome consumers' more 'primitive' urges, preyed upon by institutions and actors possessing more ambivalent motivations—the market, agriculture policy, food-related firms, marketing, and advertising. Instead, obese consumers' excessive trust in those more positively regarded institutions may be the very source of their problem.

The mainstream perspective does not fully consider the fact that our preferences are hidden or unknown, even to ourselves, thanks to the subtle influence of institutions (Hodgson, 2003). Of course, food companies may not necessarily have our best long-term interests in mind when marketing their products, either. Nevertheless, they do have an incentive to make their products appear as healthy as is profitable, which can include changes in production decisions, including ingredients.

It is sometimes argued, particularly by nutritionists, that food companies send possibly misleading signals via their labels in order to entice consumers (Nestle 2007). These positive health signals are generally sent on the front of the package without mention of any other changes to the ingredients, which are listed on the back of the product. For example, a product labelled low-fat may, simultaneously, have more sugar than its higher-fat competitor. In terms of useful information, it is not clear that the consumer is better or worse off with the “low-fat” label on the front—simply turning the food package around or repeated experience with the product ought to reveal whether the health signal is reliable or useful. As long as consumers are aware of what is going on, overall efficiency is hardly affected, particularly as consumers learn and are able to generate expectations in accordance with their own preferences. The salient point, however, is that the health signal on the front and the “Nutrition Facts” label on the back of the package both derive their credibility or lack thereof from basically the same set of institutions and organizations.

These institutions shape the way consumers think and, in turn, the marketing behavior of food companies in subtle ways. For example, although low-carbohydrate versions of popular foods are increasingly available, I have yet to see one that markets itself as high in fat even though the two characteristics are complementary under a true low-carbohydrate diet. Nor have I observed labels on bacon or other pre-existing fatty foods extolling the same virtue. In theory, such labels would appeal to a small segment of consumers who value those characteristics. The downside to this approach is that the label would likely reduce demand for the final product among a much larger segment of consumers—those who believe that additional fat will increase their risk of health

problems. Those seeking higher fat might be expected to choose bacon and other such foods on their own, without a label.

Instead, marketers of low carbohydrate foods use their labels, which are also regulated by the FDA, to draw attention their products' lack of carbohydrates, including sugar, wheat, gluten, etc. Presumably, this is a way to attract either group (low-fat or low-carb) because carbohydrates make up the majority of almost all consumers' calorie intake (as the *Guidelines* suggest) and so are likely the easiest to give up at the margin.

Meanwhile, foods which are low in both carbohydrates *and* fat are free to use both the low carbohydrate and low fat labels, which will predictably lead to sub-optimal decision-making if high-fat diets do not actually increase the consumer's risk of heart disease and the consumer has a taste for fat. Like mainstream nutritionists, low-carbohydrate diet proponents are quick to point out that one should be careful relying too heavily on packaged foods that advertise their lack of characteristics because they may still be relatively high in carbohydrate or sugar.

What the above examples suggest is that the role of food companies in causing obesity is not purely negative, at least partly due to government regulation. Sophisticated or motivated consumers could, and probably do, educate themselves on how to use labels effectively and on which pitfalls to avoid in order to cultivate healthier habits. As mentioned above, the USDA had evidence suggesting that Americans were adopting modestly healthier habits at least as far back as 1999.

If the credibility of many commonly-held beliefs about nutrition is as dubious as I have argued, then an alternative hypothesis for a significant portion of America's obesity epidemic is possible. Americans have only one, inferior consumption technology available to them in pursuit of weight-loss. They might have been better served by a market of competing commitment devices, and professionals that would allow for more personalization and individualized learning. Since only one approach to weight loss is widely considered credible, the market for such credence goods (Dulleck & Kerschbamer, 2006) has been narrowed relative to what it would have been without any official endorsement of a particular set of beliefs about nutrition and health.

In short, government policy both set the stage for, and encouraged the creation of, the credible nutrition institutions which, for better or worse, have shaped nearly everyone's understanding of obesity at all levels of analysis. Obese consumers' habits, rather than being biased, may reflect their best adaptation to credible, but bad, information. Those same institutions remain in a position to address the obesity epidemic. To the extent that the true causes of obesity are unknown—e.g., to the extent that calories are the wrong characteristic upon which to base obesity models, economists and most others working in service of credible nutrition institutions will incorrectly model individual behavior and habits. This includes self-control's supposed central role in the obesity epidemic

### Concluding Remarks

In this section I emphasized the extent of heretofore mostly unacknowledged real uncertainty in the nutrition literature. While it is convenient to separate uncertainty into various categories, reality is far more complicated. John Stuart Mill (*On Liberty*, 1859) recognized the difficulty of categorizing conflicting opinions

"Popular opinions, on subjects not palpable to sense, are often true, but seldom or never the whole truth. They are a part of the truth; sometimes a greater, sometimes a smaller part, but exaggerated, distorted, and disjoined from the truths by which they ought to be accompanied and limited." (*On Liberty*, 1859 (ch.3, paragraph 34))

If few opinions can be assumed to be 100% true, then there is considerable value in allowing dissent and debate within society so that better truths can be substituted for worse ones. Likewise, excessively confident beliefs in untrue opinions would delay such substitutions. To the extent that federal pronouncements are considered credible, they inspire confidence in the beliefs they espouse, including consumer confidence in everyday decision-making. Therefore, the possibility for improved decision-making must be weighed against the possibility that such pronouncements will inefficiently restrict the range of options available in the market—i.e., the range of competing hypotheses that are treated as credible beliefs. As Tullock (1971) points out, it is rather unlikely that

policymakers will devote the requisite effort to this task because they lack the incentives needed (and perhaps the ability) to do so.

This is not to imply that the government endorsed information that was considered incredible at the time—if anything, the information embodied in the *Guidelines* was becoming more accepted and more mainstream among the general public and medical professionals alike. In the intervening years, experts, professionals, and various levels of government, through their funding decisions and regulations, have further reduced any competitive pressure this viewpoint might otherwise face.

But, according to critics of the *Guidelines*, there were still experts within the nutrition community who questioned the beliefs embodied therein. That is, the competitive pressure within the scientific community had not been allowed to play out completely prior to the publication of the *Dietary Goals*. Those same critics argue that there is still reason to believe (because the science remains unsettled) that the *Guidelines* continue to emphasize the wrong nutritional characteristics altogether, for at least some portion of the obese population. Moreover, stakeholders' emphasis on calories, may be discouraging Americans from consuming diets that are both lower in calories and more satiating than their present diets—diets that would be strictly preferred to their current options.

In the next section, I present a theory of policy, institutions and individual behavior that could help to explain the discrepancy between the American public's desire to lose weight and their actual eating habits. Though the insights from the obesity literature discussed above are surely relevant to the discussion, those hurdles to eating well seem like small potatoes compared to the billions of dollars per year that obesity has cost the American economy in recent times, particularly if those costs mostly accrue to the obese.



## Chapter 3. Theory

### Introduction

The theory of individual behavior which forms the basis for my model of widespread obesity is more rational than is commonly assumed in the obesity literature. That is, I hypothesize that most consumers' current buying behavior already mostly reflects their motivated attempts to adjust their preferences in ways that are consistent with institutionally credible advice from nutrition and health authorities.

Consumers' preferences are therefore consistent with accepted economic theories of preference formation and purposive, self-interested behavior. Based on this basic model, my aim is to provide a possible explanation for why the long-term health outcomes associated with these adjustments have been disappointing, at best. Obesity's recent, meteoric rise remains difficult for economists and other analysts to precisely explain, even when models include a variety of behavioral modifications to agents' behavior (Baum & Chou, 2015). To some, more direct market interventions may appear to be the only solution left which is likely to lead to improved consumer habits—government information and labelling, professionals, and the market have all failed to bring about a desirable outcome after several decades of efforts.

My hypothesis for this discrepancy between observed behavior (improved, if imperfect, consumer habits) and observed results (widespread obesity) is unique in that it includes a significant role for non-Bayesian uncertainty, as discussed by Shackle throughout his career (Cantillo, 2010). According to Shackle, the probabilistic view of uncertainty which had already come to dominate most economists' thinking in his time, embodied in more recent authors like Herschleiffer (*The Analytics of Uncertainty and Information*, 1992), is not always the best guide for understanding how decisions are actually made. His most pertinent point to the current discussion is that Bayesian reasoning [italics in original] “stands for a language for expressing judgements as to the weight that the individual in choosing his conduct ought to give to each of a variety of rival hypotheses concerning the outcome of some one course of conduct...It assumes, implicitly, that the hypotheses that have been enumerated, specified and presented for the assignment of weights are *the only relevant ones*”. Social scientists, including

economists, have long assumed that one hypothesis should be considered relevant to weight-conscious, obese consumers. It is the one which has been endorsed by government nutrition policy, credible institutions and respected professionals for over 35 years.

In other domains, consumers' trust in respected social institutions, including the government and market, could theoretically enhance their certainty as to the proper course of action, and they subsequently would realize an outcome that approaches their expected results. Although there are informational and behavioral hurdles to any dietary change, they are not obviously onerous to the degree that the current obesity epidemic would suggest. I argue above that there is ample scientific evidence which undermines the trust placed in the major nutrition institutions considered relevant by consumers, government officials, and most researchers. As a result, potentially relevant options may be quickly or altogether excluded from the vast majority of obese consumers' menu of options when they otherwise would not be. On the research side, the long-term influence of political interests and institutions has been misinterpreted, and counterfactual scenarios left unconsidered.

The highest-quality evidence that many accepted dietary restrictions are unnecessary comes from recent clinical results on the efficacy and safety of low-carbohydrate diets. The evidence is compelling because it contradicts years of credible advice regarding the proper mix and quantity of macronutrients for weight-loss and good health. The evidence is not definitive, but the stark difference between low-carbohydrate diets and credible low-fat, low-calorie alternatives suggests there may be a wide range of viable relevant options in the region between these two approaches which have been outside of consumers' consideration set (Shocker, 1991) for some time now. Other lines of research raise the possibility that other restrictions on micronutrients (e.g., sodium) are unnecessary for most consumers. Others suggest the role of other commonly consumed micronutrients and specific foods (fructose, flour, wheat, sugar, etc.) in obesity is understressed, and that exercise is, at-best, a weak substitute for dietary changes aimed at weight-loss.

To the extent that viable behavior changes are simply not known to obese consumers, Americans' apparent widespread self-control problems may be more appropriately treated as a longstanding knowledge problem, facilitated by public policy, and ultimately manifested in consumer habits. Self-control theories begin by assuming the consumer has an appropriate plan in mind to realize a future goal but finds it difficult to implement when the time comes. For example, a spendthrift who cannot stay within a reasonable budget may need a more binding commitment device like a savings account or Certificate of Deposit (Strotz, 1956). Likewise, consumers have for some time had many commitment devices, i.e. diets, (U.S. News & World Report, 2016) available to them.

If, however, consumers have been mostly dissuaded from otherwise viable diets by credible institutions, the explanatory power of self-control centered models is severely weakened. This is because one of the fundamental assumptions that accompanies theories of quasi rational behavior is violated from the outset i.e., a complete knowledge of alternative courses of action and their consequences. If relevant knowledge is widely considered incredible or is absent from the market, the odds of an inefficient equilibrium developing increase. My theory traces the source of this knowledge deficiency to institutional dysfunction in the nutrition policy domain. My model attempts to explain widespread obesity based on a theory of demand wherein this dysfunction is unknown to credible stakeholders, leading rational consumers to act under a false sense of certainty.

### Theory

I assume that a representative obese consumer does, at some non-extreme point, reach a threshold at which she will make some attempt at behavior change in order to increase long-term expected utility. Further, I assume that the consumer forms her expectations and adjusts her behavior in a way roughly consistent with the dietary component of the "SLOTH" model advanced by Cawley (2004). For simplicity, I ignore the tradeoff between consumers' demand for exercise, leisure and time—I assume her preferences for behavior change between diet and exercise are separable and that diet is strictly preferred to exercise, at least in early stages of the "dieting game".

Instead I focus on the tradeoffs between satisfying known, existing dietary preferences and adjusting behavior, and ultimately habits, in pursuit of long-term weight-

loss. Preference formation is a not a popular topic in economics but given that the ultimate goal (and to some extent the result) of nutrition policy is to change society's preferences—i.e., its dietary habits, I believe a discussion of the relationship between preferences and rational, diet-related behavior is more than appropriate.

I make no positive theory as to how the consumer arrives at her 'obesity threshold' because both exponential discounting and hyperbolic discounting strike me as plausible stories and it is empirically difficult to distinguish between them. I am less interested in explaining obesity's onset because it is easily explained by existing theories, rational or not. I am far more interested in explaining why a consumer might cross this threshold but not cross back, long-term, in spite of the microeconomic incentives and opportunities to do so. Though I am most concerned with obesity, I do not assume that the threshold point necessarily coincides with a BMI greater than 30—it may arrive when the consumer is merely overweight (BMI of 25-29.9) or at higher levels—but I assume its probability of arriving is positively correlated with BMI and time, given fixed habits. BMI is positively associated with fixed habits if those habits were positively associated with BMI in the past.

For simplicity, I assume that the consumer has not, prior to the threshold, engaged in sustained dieting behavior and that she is mostly uncertain about the value of  $\delta$ , her genes' effect on her metabolism. She is therefore aware that some uncertainty accompanies her choice over the proper level and proportions of calories and exercise. To be clear, this is the traditional version of uncertainty where the *range* of possible values for calories and exercise which will lead to weight loss is known, in this case based on USDA guidance. The consumer has little problem determining which characteristics are relevant to his decision to lose weight. In the face of this probabilistic uncertainty, the consumer attempts to 'satisfice' (Simon, 1987) as best she can, given her existing preferences, expectations and results.

More economically, in my model consumers rely on credible institutions like the USDA for guidance as to the characteristics of food and behavior (primarily, calories, fat and exercise) that they should consider salient in their plans to lose weight and live long lives (Lancaster, 1971). That is, consumers will tend to develop beliefs about these

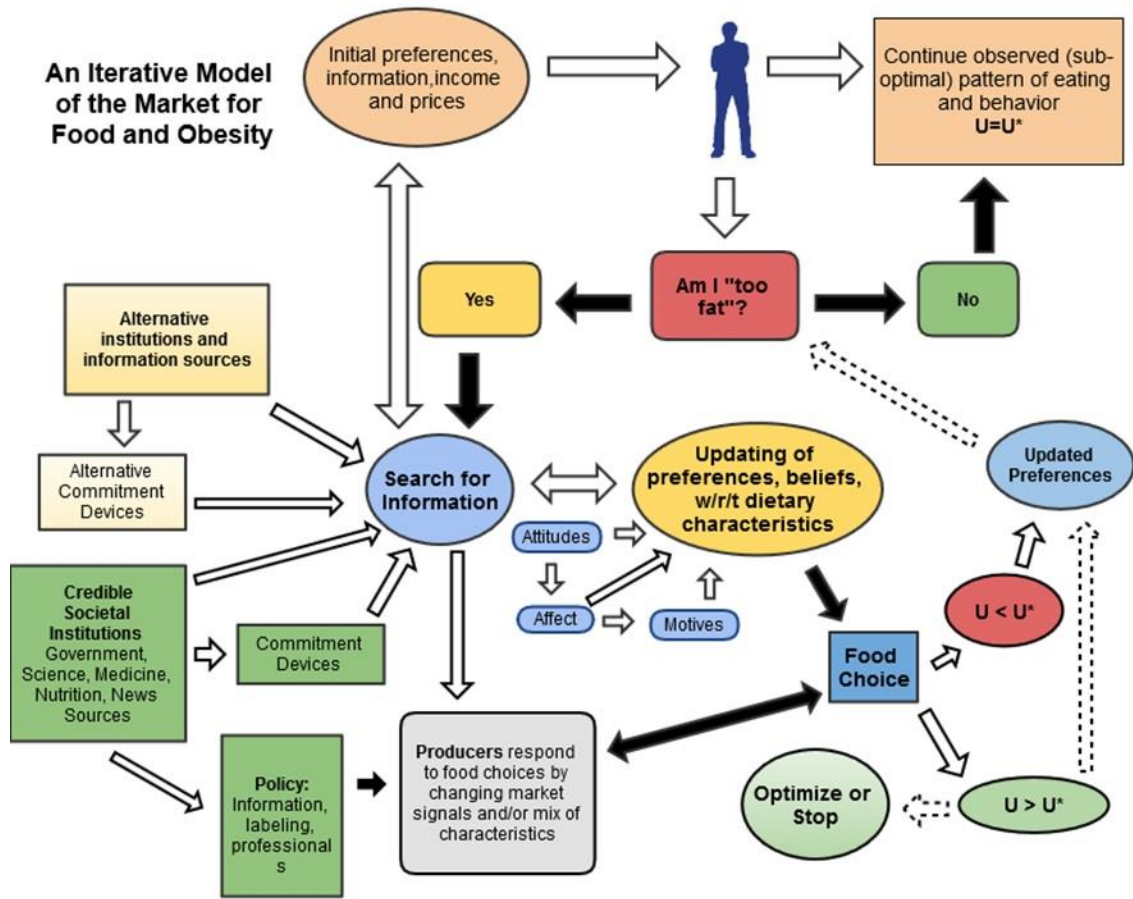
*particular* characteristics' role in their own health. These beliefs may not immediately manifest themselves in individual behavior because of differing perceptions of risk or differing preferences for healthy weight, among other reasons, in line with most theories of subjective, rational decision-making.

Given what consumers know about themselves, including their own weight, past habits, and preferences, as they approach their own threshold points they are more likely to devote increased mental attention to their calorie intake and exercise habits. They may begin to make plans and form new expectations about their dieting and health. Depending on their temperament, they may be confident in their probability of success. In any event, if and when the individual arrives at her threshold, she will embark on an iterative, experimental, and procedurally rational process of behavior change.

Figure 2, below, depicts the dynamic manner in which a consumer plans to 'reform' her preferences in a way more consistent with her long-term health goals. Importantly, and rather obviously, in order for good habits to become fixed, the consumer has to experience some positive improvements, i.e., feedback, in perceived health status within a reasonable time frame. By construction, I assume that the vast majority of consumers will make a change to their diet consistent with a belief in the efficacy of a low-calorie, low-fat diet for at least the first iteration of this process. That is, consumers will make at least marginal reductions in their daily calorie intake, fat intake or sodium intake. Even without precise knowledge on one's own past intake, this is a relatively safe and seemingly painless strategy for anyone wishing to lose weight, given the typical American diet exceeds recommended official recommendations for all three.

As Figure 1 shows, the representative obese consumer's decision to iterate or continue with a new dietary change depends on whether she experiences improvements in her health. Quick results following minor changes predict continued behavioral convergence to USDA norms. A lack of results need not imply the consumer gives up

Figure 2. Food Market Schematic



because there are plausible explanations and sources of optimism. The consumer might believe she mis-measured her calories, did not exercise enough, or needs to try some new strategy to aid in her compliance.

It is here, where short-term results differ from short-to-medium-term expectations, that “self-control” becomes most important in predicting the consumer’s future choices. Higher levels of patience and self-control predict further or more creative iterations while less self-control predicts a faster reversion to old habits in the absence of results. Regardless of the consumer’s patience, she is relatively unlikely to attempt dietary changes that she believes to be risky to her long-term health.

In his paper, Cawley (2004) refers to the costs that are experienced by a consumer who falls for deceptive dieting claims. In such cases, the most damaging aspect of these claims may be the discouraging effect it has on the consumer’s future attempts to diet. Figure 1 helps to show just how costly this adjustment process can be, and discouragement would increase with repeated iterations. At some point, the consumer may reach another threshold: the discouraged dieter threshold, where it becomes unclear whether further dietary changes are worth pursuing relative to a reversion to old habits.

To the extent that Shacklean uncertainty regarding the relevant nutritional characteristics is applicable to significant portions of the obese population, Cawley’s discussion anticipates my theory’s major prediction: that a significant proportion of the obese population has already ‘rationally’ given up on changing their diets because their new diets failed them and they remain ignorant of viable alternatives. That is, USDA advice could be considered deceptive for at least some consumers if it could predictably lead them to ignore viable, obesity-reducing consumption habits that they might otherwise prefer. It is worth reiterating that a USDA-style diet requires typical consumers to give up several food characteristics which they enjoy for a bundle of less-preferred characteristics, all in exchange for their ultimate goal of better expected long-term health.

Low-carbohydrate dieting also requires the reduction in a characteristic which consumers enjoy (carbohydrates, particularly sugar and flour) but it also allows them to safely increase their consumption of at least some forms of fat and, further, to ignore foods’ calorie-content. Moreover, exercise is mostly ignored for weight loss purposes,

though certainly not discouraged. In microeconomic terms, the marginal rates of substitution between the low-carbohydrate and low-fat diets as compared to a typical American diet are vastly different. While no approach is guaranteed to be “easy” to adjust to, based on typical American eating patterns, there is reason to believe that some consumers might prefer such an approach, all else equal. It also represents one point near the end of a long spectrum of options that contradict credible advice.

Earlier, I modelled the uncertainty of this situation using Shackle’s “surprise function”. The surprise function measures the amount of surprise the consumer would feel if she were to experience a particular, unexpected outcome. Bayesian versions of uncertainty will not suffice because she may be ignorant of the possibility of the surprising outcome altogether. For all intents and purposes, the surprising outcome’s probability of occurring is zero—the consumer is certain it will not occur, until it does.

The relevance of surprise to the present topic is demonstrated with a simple thought experiment: Suppose, after years without seeing each other, you run into a longtime friend who was obese the previous time you met. Over the course of your friendship, he was not always fat but he was not always a healthy eater, either. Now, you see him and he is in the best shape you have ever seen him. Eventually, you ask him what he did to get into such good shape, what lifestyle changes he made. What answers would most people anticipate? Which answers would surprise them? More to the point, which answers would surprise a doctor or nutritionist?

In order for the widespread uncertainty I have discussed to result in the drastic uptick in obesity rates observed in the United States, some method of comparing these two diets (and, for that matter, the range of alternatives between them) is needed in order to investigate their behavioral implications with clarity. The application of Bayesian decision theory is further complicated by the fact that the two approaches are derived from rival hypotheses which promise the same outcome to consumers by stressing the relevance of several, overlapping nutritional characteristics. Because of these differing emphases and assumptions, another standard assumption in consumer theory must be relaxed: that of non-satiation.



Satiation is an important concept in this domain because the disparity between consumer habits and credible advice suggests that many consumers are unwilling to make the tradeoff between the utility they associate with their current diets and the health outcomes they expect from a “healthier” diet. Economists typically assume that consumers exhibit non-satiation in consumption—more of a good is always better, all else equal. In this domain, however, the obese consumer is relentlessly counseled to treat the marginal value of the ~2,001st calorie as negative.

The microeconomics of day-to-day demand for meals is somewhat unusual in that the consumer’s overall utility is highly dependent, if not contingent, on finding goods (meals) that routinely satiate her demand. No organism functions optimally on a poor diet and, as such, can hardly be assumed to optimize optimally in such a state. Our relatively recent ancestors would be envious of how easy it is to routinely cure our hunger in the modern world, even were they to ignore the vast improvement in the quality and variety of foods available within it. According to many commentators, it is obvious that our species is not adapted to such easy access to food, and that this is a major contributor to consumers’ chronic overeating, to the point of widespread obesity (Prentice & Jebb, 2003).

Perhaps this is why satiation is commonly associated with the calorie content of a given food or diet. But satiation clearly depends on other dietary characteristics and is not solely dependent on individual metabolism—individual preferences still matter. Everyday experience suggests that some consumers do ‘naturally’ find a USDA-style diet satiating. Whether because of their metabolism or preferences, eating well is not difficult for them. But following a USDA diet would, evidently, require the typical consumer to make macronutrient cross-substitutions and to reduce the overall quantity of food demanded, either of which would lead to a less-satiating, lower utility diet in the short-term, i.e., prior to any observable changes in health status. Based on the advice she has received, the consumer expects an intertemporal utility tradeoff to take place in the medium-term—after expected weight loss has commenced she expects her metabolism and preferences to adjust to the diet and she may expect to optimize the diet to her preferences. Long-term compliance depends positively on whether results match

expectations. The probability of healthier habits actually taking hold depends on whether the consumer can successfully satisfice and form new habits.

There is no telling whether the mix of macronutrients recommended by a low-carbohydrate diet would be preferred, taste-wise, to that of its low-fat counterpart because the nutrient cross-substitutions it requires are so drastic relative to both the typical American diet and the *Guidelines*. Consumers who have not already tried such diets do not really have the required knowledge needed to evaluate them because a novel diet is an experiential good (Kolb, 1984, Holbrook and Hirschman, 1982). Asking the typical American to decide if she prefers a low-carb diet to her current one is likely akin to asking if she prefers food from a country she's only passingly familiar with to her current diet. Given its high fat content, I expect rational consumers (who rely on credible institutions) to be highly skeptical of the low-carbohydrate diets or any others that are starkly different from the norm.

Regardless, advocates of low-carbohydrate diets are likely to argue that if consumers do follow advice to limit carbohydrates, they need not worry about overall calories consumed because excessive calorie intake, per se, does not cause obesity. Further, because low-carbohydrate diets are supposedly inherently more satiating, calorie intake tends to drop 'naturally' (without conscious effort) though the drop itself is not the cause of the weight loss. The lack of a calorie restriction seems to be a feature of such diets relative to low-fat competitors, which inevitably include a calorie limit (Taubes, 2010) because such diets lack this satiating effect.

My aim is not to evaluate the accuracy of these claims but, rather, to provide a framework for analyzing consumer behavior that allows for either theory of obesity to be true. To that end, I go out of my way not to assume any particular mechanism of action for either theory of obesity. Mainstream researchers tend to argue that low-carb diets work, to the extent that they do, because calorie intake decreases by necessity simultaneously when the proportion of calories derived from carbohydrates is reduced. Low-carb advocates, on the other hand, contend that any attempted dietary change is likely to be lower in carbohydrates (particularly sugar or flour) than whatever was previously eaten. By this logic, their approach should be the most effective overall, all

else equal. This is one of several avenues of disagreement between various camps. Neither side's set of arguments definitively refutes the recent evidence suggesting both approaches are associated with a decent probability of success, when followed.

For the purposes of my argument, it is sufficient to take the position that for any given consumer there is a roughly equal probability of a significant predicted average treatment-effect for either dieting approach, consistent with recent observational studies. That is, there is no *a priori* reason to assume that either approach will prove more effective, behaviorally, in the long run, whether because of the consumers' metabolism, preferences or other factors. Since I do not assume either approach is technically superior, I cannot dismiss the possibility that either approach would work if access to food were strictly controlled. However, I allow for the possibility that one approach will be strictly preferred on the basis of some combination of the characteristics it allows and the consumer's actual weight-loss experience with alternatives.

In *Modern Consumer Theory* (1972), Lancaster analyzes the issue of demand satiation, as it relates to diet and food. In line with Lancaster, I hypothesize that the degree of satiation a particular diet confers at various intake levels (the shape of its satiation curve) depend on that diet's characteristics and those of the consumer. In Lancaster's analysis the characteristic that determines the shape of the indifference curve is "flavour". He hypothesizes that there may be regions on the satiation curve where the consumer is indifferent between consuming more or less of a given characteristic, in this case calories are used to measure the quantity of flavor. At low levels, calories exhibit non-satiation, followed by a neutral zone, and finally by a segment in which additional calories have a negative effect on utility because the consumer is assumed to be weight-conscious.

It is notable that Lancaster uses this sort of satiation as an illustrative example when this apparent lack of consciousness forms the cornerstone for most theories of obesity. Today, researchers are more likely to remark on the apparent weak correlation between calorie content and consumers' decisions to cease eating. Since all consumers do, eventually, stop eating for a while, these two examples suggest that there are two types of satiety— psychological and metabolic—which operate somewhat independently.

That is, one consumer's metabolism may require her to impose an 'artificial' psychological calorie or nutrient constraint upon her existing diet in order to hit a certain target while another may feel satiated, metabolically, prior to reaching her calorie target, in which case the psychological constraint is unnecessary. Both constraints will affect the shape of consumers' satiation curves, discussed below.

With some modifications, Lancaster's framework can be adapted to compare the relative merits of many diets vis-à-vis existing consumer preferences. First, it is not obvious that the flavor profile of either diet will be preferred by any consumer. Therefore, flavor is too ambiguous of a dimension along which to compare these diets. Second, I cannot compare the satiety of these diets purely in terms of their calorie content because the low-carbohydrate diet does not have an upper limit on calories and because advocates claim that such diets are inherently more satiating than low-fat diets, calorie-for-calorie. However, for the purposes of this analysis, I will assume that a 2,000 calorie, low-carbohydrate diet is at least as satiating as a 2,000 calorie low-fat diet (if anything, favorable to the low-fat diet). By the same token, I assume a 2,000 calorie or less low-carb diet will, in fact, bring about weight-loss in at least some consumers. The value of 2,000 calories is used for convenience and an initial calorie target but  $\delta$  will determine the consumer's efficient calorie target.

Finally, for the sake of tractability and visualization, I simplify the recommendations of both the low-carbohydrate and low-fat diets such that neither diet requires consumers to change their protein intake. This is not far from reality because Americans' average protein intake (15% of calories=300 calories= 75 grams, in a 2,000 calorie diet) is currently at the upper-bound of what is recommended by the USDA and is close to the lower-bound of what some low-carbohydrate diets suggest. The two diets differ far more significantly in their recommended proportion of calories from fat and carbohydrates: the USDA recommends at most 30% of calories from fat and around 55% from carbohydrate whereas low-carbohydrate recommendations translate to less than 30% carbohydrate and at least 55% fat. Thus, regardless of which diet is settled upon, intake of some variety of fat or carbohydrate is more likely to be adjusted because of those two macronutrients' relative importance.

With protein intake safely ignored, I use grams of carbohydrate and grams of fat as the axes of the graphs in Figures 3 and 4. As in Lancaster's article, the satiation curves in Figure 3 are more "C"-shaped than indifference curves exhibiting non-satiation. Vertical segments signify "open satiation", meaning the consumer is indifferent to more of the y-good. The positively sloped portions represent "negative satiation", the segment where additional units of the x-good are regarded negatively.

Most attempts to model eating behavior, including Lancaster's, treat calories as the most salient variable with regard to both weight-loss and satiety, preventing finer-grained analysis. This application allows me to compare two or more diets whose macronutrient composition differs substantially *along the same indifference curve*, as though the consumer's range of possible alternative diets is being chosen. The ideal diet is the one which is the most satiating, a judgment which depends mostly on the relative weights the consumer attaches to her two types of satiety, metabolic (a feeling of fullness) or psychological (consistent with a plan of action). Diets located away from this most preferred point are higher in calories as a tradeoff for that diet's lack of overall satiety. The inherent difficulty of precise calorie-counting indicates that this tradeoff may occur without inexperienced consumers immediately knowing it.

The curves in Figures 3 and 4 (next two pages) represent the obese consumer's complete preference schedule for various diets (i.e., combinations of carbohydrate and fat). The slope of the curve at each point measures a mix of fat and carbohydrate. All the mixes on the curve represent potential choices in the short-term, but preferences are still subject to updating based on actual experience. The nature of habitual consumption is such that consumers are unlikely to jump around on the curve without some compelling reason for doing so.

Figure 3. Indifference Curve for Typical Consumer

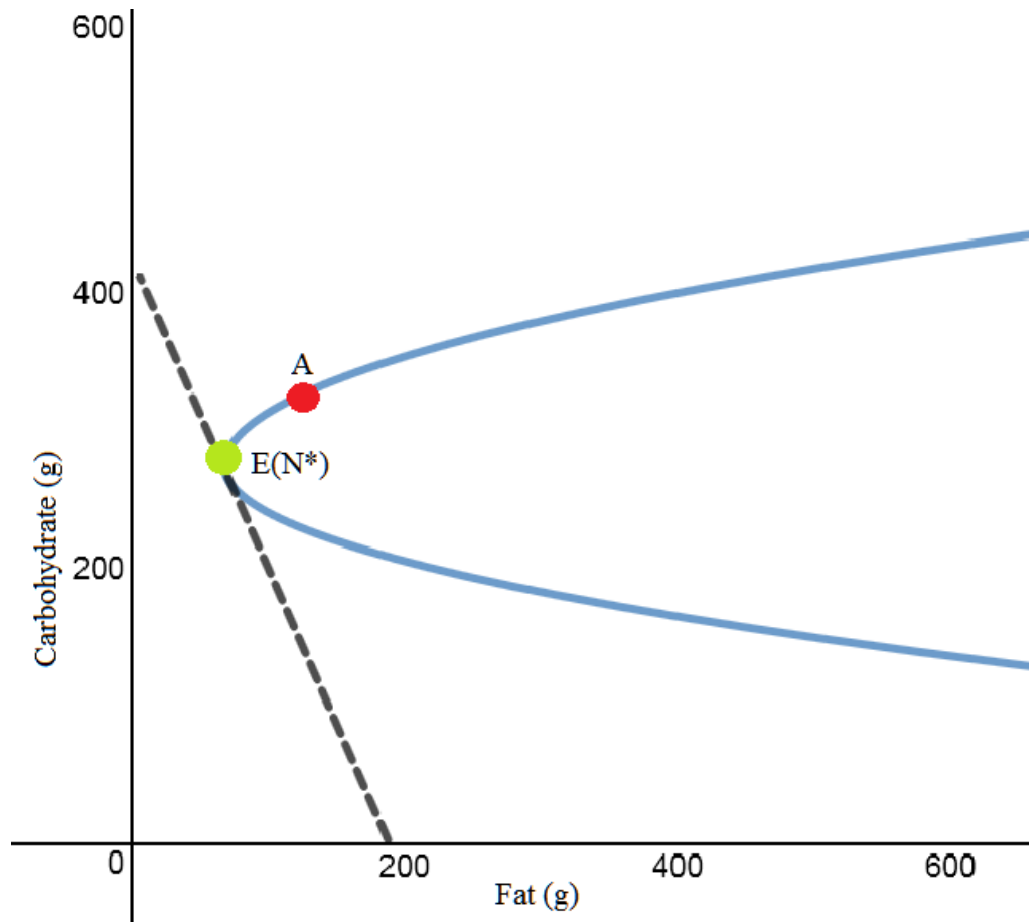
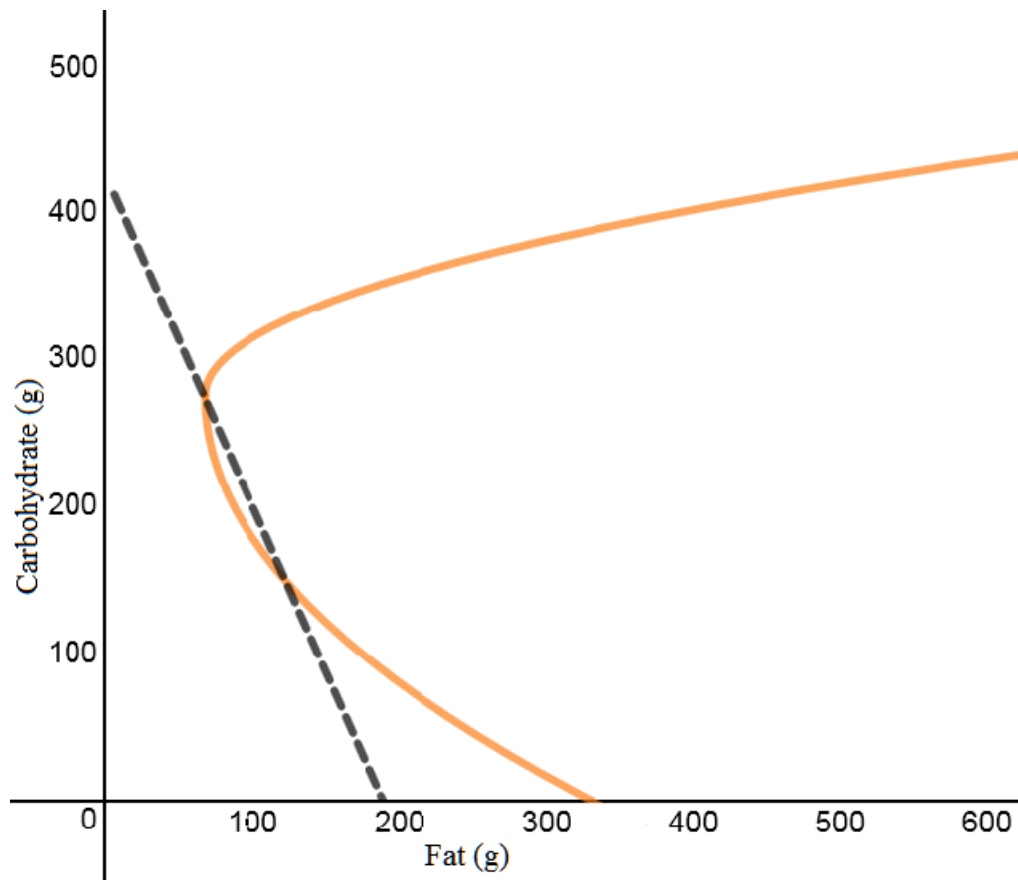


Figure 4. Indifference Curve for Atypical Consumer



The proposed framework allows for a comparison of disparate diets in terms of the different constraints they place upon the consumer. This is analogous to studying the likely effects of budget constraints in traditional demand analysis, but more flexible. Food represents a relatively small proportion of the budget share for most Americans, which means the budget line is more a matter of choice than a binding constraint compared to most demand analysis.

Traditionally, the main “price” obese consumers have worried about is the calorie content of their diet. The 2,000 calorie budget line is shown connecting the X and Y axes in Figures 3 and 4. Diets can now be compared in terms of their satiety by moving along an indifference curve. Given a calorie constraint and schedule of indifference curves, one can also determine which mixture of macronutrients is likely to be preferred at the constraint, according to which appears on the higher indifference curve.

Any insights one wishes to draw from such an analysis depend heavily on the shape of the indifference curves proposed for the representative consumer or, ideally, various sets of consumers. It has been my contention throughout that consumers mostly do not have full knowledge of the range of viable weight-loss diets and, as a result, their preferences are technically incomplete and distorted in favor of methods (bundles of characteristics) which may be inefficient or ineffectual. As a result, consumers are unlikely to prefer options which lie a considerable ‘distance’ from the credible, USDA option. In fact, if one visualizes the consumer standing on the point represented by her existing habits and planning for future changes, all of her attention is likely to be in that direction, to the exclusion of others, ultimately affecting the shape of the indifference curves in Figure 3.

The actual shape of the consumer’s indifference curves will hinge to a great extent on the information, beliefs and experiences she brings to her decision-making problem. The apex of the curve in Figure 3 represents an obese consumer who plans to follow USDA advice because she expects to lose weight and for her long-term utility to increase. Though her current diet is satiating in the metabolic sense, she believes her overall satiety would improve if her diet more closely resembled credible advice. It is expected to be more psychologically satiating in the short-term and to move the obese consumer to a higher overall indifference curve over time, as positive health outcomes accrue. She may think her metabolism will adjust, too. Low-carbohydrate diets are dismissed or not considered viable and so do not appear on the consumer’s indifference curves because she has either zero information or experience upon which to base her expected utility or has been actively discouraged from learning about them.

Although the shape of the indifference curves in Figures 3 and 4 are speculative, the exercise lends itself to some rather intuitive insights. For one, isocaloric diets (i.e., those which contain an equivalent number of calories) need not be equally satiating. This is self-evident if, as an extreme example, one considers the satiating effect of 1,000 calories of white sugar versus 1,000 calories of protein or fat. This point is often neglected, perhaps because the carbohydrate content of the USDA diet and the typical American diet is not so different. Rational consumers may tolerate a diet that is



significantly less satiating in the short term in exchange for an expected an increase in long-term utility. A more satiating diet predicts improved long-term compliance, all else equal.

In Figure 4, the obese consumer is indifferent between a 2,000 calorie low-carbohydrate diet and a 2,000 calorie low-fat diet—they are considered equally satiating. This represents an atypical consumer, one who is ambivalent toward both approaches but nevertheless wishes to lose weight and is flexible enough to try most things. By construction, the shape of the atypical consumer's indifference curve is somewhat provisional because she has not undertaken any sort of diet, but considers it safe to assume that either diet might work, enough to try either for a while anyway. She is analogous to a consumer in the “Open Mind” region of the graph in Figure 1 (p. 20). The large difference in shape or area of the two sets of curves illustrates just how different this atypical consumer is from the norm.

To understand the source of this difference, consider the marginal American consumer who knows the basic tenets of a USDA diet but mostly ignores them for whatever reason (e.g., her health is otherwise fine) and mostly eats the typical American diet. While she is unlikely to accidentally end up eating a truly low-fat, low-calorie diet prior to reaching her threshold, she might still make marginal changes here and there. However, she is altogether unlikely to follow a low-carbohydrate diet for any reason both because it differs so starkly from her existing habits and because she would perceive doing so as unnecessarily risky. Therefore, I assume that the expected diet of an obese consumer will generally lie in the region between the standard American diet and the USDA diet as long as procedural rationality holds.

In Figure 3, the typical obese consumers who has a plan to change her diet will try to make iterative substitutions in goods space to arrive at point  $E(N^*)$ . The more sophisticated among these consumers are more likely to be aware of their biases in the marketplace and will act rationally to avoid them, bringing them close to point  $E(N^*)$ , all else equal, i.e., independent of short-term results. Discouraged dieters are the exception to the typical-atypical distinction because they no longer believe in the merits of any diet and, all else equal, their diets would revert to their old habits, close to point A.

$E(N^*)$  is the point that the consumer expects to bring about weight loss, and its location is unknown to the consumer at the time of crossing her threshold but assumed to be interior to the calorie constraint. Its value depends on the underlying, unknown metabolism of the individual, which dictates the technical utility of different macronutrient mixes with respect to weight loss, leading to dietary uncertainty—uncertainty regarding the technically superior diet.

Under dietary uncertainty, either a low-carbohydrate or low-fat diet may be a strictly preferred weight loss method because of a combination of the consumer's underlying preferences and metabolism. The consumer has some knowledge of her preferences but does not know which diet is best suited to her metabolism, so she does not know with certainty which diet her future self will prefer, contributing to the uncertainty about the true value of  $N^*$  prior to any dieting behavior

When rationality holds, obese consumers who cross their thresholds and attempt to change their habits will almost always choose a strategy meant to bring about some combination of calorie reduction and a decrease in the proportion of calories from fat. In cases where the consumer's experience approximates their expected weight loss after changing their diet, rational expected utility models hold (e.g., Cawley, 2004). Those consumers will remain on the weight-reducing regimen or refine their strategies, in line with Figure 3, losing weight and increasing expected long-term utility over time until some new equilibrium near point  $E(N^*)$  is reached.

Ideally, typical consumers who do not experience weight-loss or other positive health outcomes in the medium-term would update their beliefs to correct for metabolic differences and embark on a different path of dietary change. But if consumers are procedurally rational, they will not be aware of the full range of alternatives available to them because the credible option is at the level of common knowledge (Geanakoplos, 1992).

It is tempting to argue, even assuming USDA advice is sorely mistaken, that the existence of a variety of market-based diet alternatives would be sufficient to at least avoid an obesity epidemic. That is, the fact that USDA advice is the most accepted does not preclude consumers from trying other options with more proven results, nor does it

preclude market-based dietary innovations, which have indeed emerged, though the most popular, credible options are indeed quite similar to USDA advice (U.S. News & World Report, 2016).

In reality, the fact that low-fat, calorie restricted diets have long-been the most credible alternative, aided by government policy and occupational licensing laws, narrows the boundaries of competition, limiting the variety and scope of credible options which might otherwise find market success (Commission on Dietetic Credentialing, 2016, Young, 1993). Competition from *rival* hypotheses will be particularly negatively affected because credibility cannot be shared with the government-sanctioned option. Credibility among certain diets is therefore a rivalrous characteristic in consumption which forces most consumers to choose the one credible option.

The most well-known low-carbohydrate diet, Atkins, enjoyed notable popularity at a time before the federal government had taken an official position on dietary fat and heart disease. It was notable precisely because it contradicted the advice of low-fat diets, which were already gaining in popularity at the time. Widespread interest in Atkins's diet quickly faded, though never completely, and Atkins remains synonymous with the low-carbohydrate diet although he was only modestly successful in bringing about a dietary 'Revolution', I suspect, consistent with my theory, that he would have had even less success had his book come a decade later, after the *Goals/Guidelines* were published.

Figure 4 depicts the preferences of a consumer who is indifferent between low-fat and low-carb methods of weight loss. This consumer has a widened consideration set relative to the status quo consumer, she has more options to choose from but a more difficult, uncertain choice to make. It is reminiscent of the fable of Buridian's Ass, in which a hungry donkey has a choice between two equally attractive piles of hay and dies of starvation because of his indecision. The story inspired Pareto and Edgeworth to come up with the methodology of utilitarian indifference curves that are now so common in microeconomic analyses. Normally, the logical extension of rational choice is to arrive at an indifference curve like the one in Figure 3, in which preferences are single-peaked and a best choice is easily made by the agent.

In a way, Figure 4 depicts a scenario that is more consistent with a theory of obesity based on an obese consumer's lack of self-control compared to Figure 3. Self-control theories implicitly assume the full-range of options for action are known to the consumer. In Figure 3 the consumer 'knows' what she is supposed to choose and is assumed to fail in the choosing. If consumers' have complete knowledge of their range of alternatives and *still* remain obese, self-control, rather than lack of knowledge, is a defensible hypothesis because the basic requirements for rational behavior are already met. In the absence of such knowledge, assuming that consumers lack self-control is premature.

Figures 3 and 4 both depict the difficulty of choosing to follow an unpopular diet. Economists typically assume preferences are fixed because they rarely change drastically and the sources of change are difficult to detect empirically. A radical change in preferences may require changes in beliefs, and a willingness to ignore trusted institutions, authorities, and even friends, all of which are psychologically costly. Even if the results of such a change are initially positive, remaining on such a diet still requires patience, self-control and continued confidence in one's results. As a result, the size of the region between the two curves, though large, may still understate the difficulty of changing one's preferences. The consumer has to, in effect, 'bend' her preferences while various credible institutions try to bend them the other way.

Therefore, I hypothesize that only in rare cases will consumers actively choose to contravene the rules given by nutrition or health authorities precisely because those same authorities have long-emphasized the supposed risks of violating their advice. Figure 3 depicts satiation curves with shapes that seem consistent with a reality where consumers believe there is a strong, negative association between saturated fat intake and cardiovascular health. Their failure to stay at the locus of the curve is the result of satisficing behavior based on incomplete information. At the margin, behavioral biases are relevant but remediable. In comparing Figure 3 to Figure 4, one gets a sense of how much consumer preferences would need to change in order for consumers to credibly consider weight-loss options that differ substantially from USDA advice, especially regarding fat intake.

I further hypothesize that the discrepancy in preferences between Figure 3 and 4 is a rough measure of the unwarranted certainty that permeates policy, the market and the obesity literature. That is, Figure 3 is a depiction of preferences based on a false sense of nutritional certainty which has led to preferences which bear some resemblance to credible advice. In Figure 4, the consumer knows she is uncertain about the best course of action, so she is not out of the woods, but she has a rough map of them—a range of options. In the scenario depicted in Figure 3, she has a segment of that map with a theoretical way out that she nevertheless believes to be the whole thing, possibly preventing an efficient escape.

While surprise functions are theoretically appealing, they are difficult to apply in this context because there is, by definition, little room for surprising results following habitual behavior. Neither low-carbohydrate nor low-fat diets promise immediate weight-loss so even short-term weight-loss requires some patience and consistency. Since feedback is not immediate and is subject to interpretation, the possibility of true surprise is exceedingly low. Few consumers who decide to undertake a dietary change would do so if they did not think there was some probability of success.

The concept may be salvaged using a thought experiment similar to an earlier one: If a consumer were told by an omniscient individual that she (the consumer) lost weight in the future by following an unspecified diet, how surprised would her current self be if a given diet worked, either in theory or in practice? That is, the consumer might be surprised by her ability to conform to the diet (e.g., due to unfamiliarity) or by the fact that the advice was actually reliable in the first place, because of her current beliefs.

#### The Role of Uncertainty in the Institutional Food Environment

If uncertainty is indeed a ‘real’ problem in this domain, the satiation curves (preferences) in Figure 3 are the result of a path-dependent learning process whose boundaries were unnecessarily and inefficiently restricted decades ago because relevant, credible, stakeholders in the nutrition domain, including policymakers, prematurely adopted a universal nutrition standard (Stack & Gartland, 2003, p. 487) and continue to ignore contradictory evidence and dissenting viewpoints (Hite, 2011). There is little argument about the lack of meaningful changes to the USDA *Guidelines* since they were

first adopted in 1980 but this alone is not sufficient evidence from which to conclude that that they, or any other single government policy, have “misshapen” preferences in the hypothesized way.

According to critics, the McGovern Committee’s decision to endorse one approach to healthy eating for all Americans and discourage most others was enough to settle or stifle most remaining scientific debate about important diet-related, and often inter-related, health issues such as cardiovascular disease, diabetes and obesity. According to Taubes (2007), passage of the *Guidelines* set in motion what amounts to a now decades-long experiment, testing the “calories in/calories out” hypothesis of obesity on the American public.

Although this may appear to be an extraordinary claim, it should be less-so to economists and policy analysts. According to Tullock (1971) there is a degree of publicness to any government decision in the sense that the government will underprovide the care needed to insure that its decisions are, indeed, correct and not overly burdensome. There is a similar insight out of the emerging field of behavioral political economy which says that even if policymakers recognize an opportunity to incorporate behavioral economics into policy, should it be assumed that they will not fall prey to similar behavioral shortcomings, among others, in trying to design those corrective policies?

Among the other behavioral shortcomings of policymakers, the outsized influence of “pressure groups” (Olson 1971) is under-explored in this policy area. If it is the case that, by passing the *Guidelines*, the government inefficiently redistributed credibility in favor of one viewpoint (thereby reducing the credibility of contradictory or otherwise competitive viewpoints), then any pressure groups associated with the credible viewpoint would likely increase in stature and attempt to further their agenda by attracting research dollars and erecting barriers to competition.

According to Hite (2011) this is more or less how the situation has played out. Consistent with the economic literature on occupational licensing, 45 states, the District of Columbia and Puerto Rico, now have regulations regarding, or laws prohibiting, the practice of dietetics without proper certification (Commission on Dietetic Credentialing, 2016). Certification is handled by the Committee on Dietetic Registration, the

credentialing agency for the Academy of Nutrition and Dietetics, which certifies university programs in nutrition education. RDs make up the majority of the Dietary Guidelines Advisory Committee. RDs are also the professionals to whom obese patients are likely to be referred by their doctors. Not surprisingly, up until relatively recently, the majority of government-sponsored observational, interventional and clinical nutrition research was devoted to testing or measuring the efficacy of low-fat, low-calorie diets.

Earlier, I discussed the well-known perverse effects that occupational licensing can have on economic efficiency due to reduced competition and innovation. Nevertheless, in the economics of obesity literature most researchers have implicitly assumed that the role of nutritionists in shaping policy has been benign, a view more consistent with old political science theories and older institutionalists like J.R. Commons on the proper role of pressure groups in shaping social outcomes. By implicitly assuming the government endorsed the ‘correct’ viewpoint, as Cawley (2004), for example, does, economists ignore the ways in which nutritionists and other authorities have acted to shape the policy debate, as well as the economic and institutional landscape, in their own favor (Olson, 1971).

Theoretically, once an RD or other nutrition professional endorses a particular viewpoint she has an economic and reputational interest in seeing that it is not contradicted, whether she is making policy or advising a patient. If word were to get out that patients seeing a competitor had drastically better outcomes while following wholly different advice, the RD’s career would be short-lived. Reputational incentives may help to explain why USDA advice has remained so consistent despite its apparent lack of efficacy. This tendency is further encouraged by the difficulty of even assessing a patient’s actual compliance with advice.

In addition to government and nutrition professionals, the popular media have also acted to shape how consumers think about nutrition issues. They report the results of nutrition studies, often without proper clarification or beneath sensational headlines. The studies themselves are almost always observational or on animals other than humans. Until recently, most nutrition research was directed at confirming the recommendations

within the *Guidelines* rather than subjecting them to rigorous testing, much less testing of alternative theories.

Compared to the above-mentioned institutions and their associated actors, the role played by firms has been more reactionary. No doubt firms act to influence policies demarcating which foods are deemed healthy and unhealthy, how foods are labelled, and so on. But firms are at least somewhat constrained in their actions by widespread, credible opinions on proper nutrition. This may be why old food advertising extolling the health benefits of foods like lard, vegetable shortening, and white sugar are considered comical today, now supplanted by others earnestly extolling the virtues of olive oil, coconut oil and artificial sweeteners.

At this juncture, it is not as though food firms *could* credibly embark upon their own nutrition research because any worthwhile research is likely to prove their product “safe and effective” but even honest reporting of the results (particularly if they differ from credible advice) is likely to be met with skepticism, undermining the predicted efficiency of the initial research investment. This is over and above the public good problems inherent to funding research that is likely to benefit competitors, of course.

#### Policy and Research Implications

In the previous chapter, I summarized some of the research suggesting that nutritionists have been pursuing an unfertile area of obesity research and that a diversity of viewpoints regarding the causes of obesity have been stifled for a long time. Past economic research on obesity has treated nutrition science itself as a sort of “black box” whose output can be used to understand consumers and design policy. Though I am far from an expert on nutrition or obesity, my reading of that literature (along with my own experience) suggests that more social scientists interested in obesity would do well to study the inner-workings of this black box. Outsiders are likely not in a position to correct disciplinary issues but, if groupthink is a relevant concern, they may be the only ones able to “see” the problem and point it out in the first place.

When it comes to America’s obesity epidemic, the relevant policy question is: Was the government’s decision to monopolize the credibility of one consumption



technology (and market it to the general public) utility-enhancing, on net, compared to plausible alternative arrangements, including no endorsement at all?

My model allows for the possibility that the federal government acted prematurely in advocating an unproven theory of diet and health. If true, the most obvious policy implication is that the government should never have done so and should have instead waited for more evidence to accrue before re-considering such actions. If uncertainty remains a real but unacknowledged problem in obesity research, the policy response would ideally be to fund research reassessing the scientific evidence objectively, including outsider viewpoints. If necessary, new research explicitly testing these rival hypotheses should be funded. Not long after writing *Good Calories, Bad Calories*, Taubes founded a non-profit with the purpose of funding research doing exactly that.

If uncertainty is of real concern, another possible policy response might be to intentionally reduce the credibility attached to conventional dietary wisdom, thereby expanding consumers' range of choice over both commitment devices and food characteristics. The latest version of the *Guidelines* does not inspire confidence that the federal government will change course any time soon. Public health, economic and policy researchers have been preoccupied with incorporating behavioral anomalies into their models of eating behavior for some time now, but even in combination, they are incapable of explaining more than a fraction of the dramatic increase in obesity's prevalence. So long as certainty regarding the proper consumption technology is assumed, there are few other obvious avenues of research in this area.

This is not an optimistic outlook but it is consistent with accepted theories of how institutions, government, and policy tend to interact (North, 1991). Economists tend to stress the positive value in most institutions other than government, perhaps because the negative aspects of various social institutions including markets often stand out and receive more emphasis elsewhere in society. All else equal, voluntary institutions are preferred to government as sources for rulemaking authority, particularly regarding the proper way to live one's life.

The model above assumes that the interaction between government and credible nutrition institutions has been rather dysfunctional for at least 36 years. Although public

policy may not have been necessary for the present situation to occur, government action probably made it more likely. When the *Guidelines* were passed, some uncertainty arguably remained regarding various relationships between diet and health—there was some room for disagreement among credible professionals. By passing the *Guidelines*, the credibility of a subset of those experts became associated with that government advice and the credibility of the field as a whole. This agreement signals to consumers that the advice being offered on federally mandated nutrition labels and by licensed RDs is basically the same and should be considered credible while rivals are considered incredible. Since licensed RDs enjoy a competitive edge, would-be nutritionists are funneled into RD programs that teach them to think in a way consistent with federal advice.

In a counterfactual world in which the McGovern Committee chose not to weigh in at all on what constitutes healthy dietary advice, the field of nutrition may or may not have taken a different path. Scientists who disagreed with the low-fat consensus may have felt more confident in questioning a status quo that was not endorsed and funded by the government. Consumers and would-be nutritionists might have experimented with a wider variety of remedies. Over the course of 35 years, it is impossible to predict what direction nutrition research, nutrition policy or society would have taken. Of course, I cannot reject the possibility that the same institutional rules would have come about through means other than official government endorsement.

So long as public policy continues to grant monopoly privileges to one nutrition paradigm, it is hard to imagine how competing paradigms could possibly carve out a sizeable “market-share”. This designation has meant that, up until relatively recently, most nutrition research has tended to study the precise benefits of eating in a way consistent with USDA advice or the costs of not doing so. As a result, proponents of typical nutrition advice have a much larger body of research to refer to when trying to attract clients. Critics will argue that these studies do not prove anything definitive, but the nature of reputation, experts, and credence goods means that consumers are unlikely to know the difference between “good” and “bad” research, just as they cannot distinguish between experts and quacks in other contexts (Sandford, 2010).

Furthermore, Horner (2002) points out that consumers can observe other consumers in order to determine whether a given firm is as high in quality as it appears—i.e., to determine whether the firm’s reputation is deserved or not. Since low-calorie, low-fat diets remain the most credible option by far (U.S. News & World Report, 2016), consumers interested in losing weight would need to take something of a ‘leap of faith’ in order to determine whether the promises made by other diet peddlers are reputable, making incredible options unlikely to be among the highest ranked options.

A further complication in the study of obesity is the evolution of the American healthcare system, which is likely to continue to encourage more of the same thinking and advice. As part of the Affordable Care Act (ACA), many chain restaurants are, or will be, required to print nutrition information along with their menu items, in order to comply with Section 4205 of the ACA, which also requires restaurants to register with the FDA so that it may monitor compliance. The FDA estimated that the total costs of the final requirements for the rule would be between \$311 and \$481 million initially and between \$28 and \$81 million per year.

In their assessment of the costs and benefits of the rule, the FDA notes, “Abaluck (2011) is the only study that translates the potential effect of increasing nutrition information on consumption into estimates of welfare gains using willingness-to-pay based on revealed preferences” (FDA, 2014, p. 64). He estimates that extending nutrition labels to restaurants will result in an average of \$116 (2011 dollars) per year per label user. The FDA argues that Abaluck’s estimate for consumer’s willingness to pay for additional labeling is too low because the new rule covers more than just restaurant menus and adjust their model accordingly. It will be interesting to observe whether the new rule leads to the between \$5.8 billion (7% discount rate) and \$8.1 billion (3% discount rate) in net benefits of the next 20 years (p. 78).

## **Chapter 4. Empirical Estimation**

### **Introduction**

In this chapter I investigate the ways in which American food and dietary preferences may have changed over time. In the first section, I perform a content analysis of historical American cookbooks to determine whether Americans preferred a different array of food items between the post-colonial period and the early 20<sup>th</sup> century versus the period from the middle of the 20<sup>th</sup> century to the present. In the second section, unrelated to obesity, I replicate Butler (1982), modelling the relationship between the social stigma of food stamp participation and food expenditure.

I employ two approaches to analyze the preferences and behavior of the American public, based on data from the Dietary Health and Knowledge Survey (DHKS) phone survey conducted by the USDA from 1994 to 1996. First, I use standard regression analysis to model the association between consumer beliefs about diet and health and their consumption behavior, based on their individual characteristics. The results indicate that consumers were relatively well-informed about the tenets of eating in a healthy manner at that time and that their consumption behavior was roughly consistent with those beliefs. The implications of these findings, in light of the obesity epidemic that has emerged in the interim, are discussed.

Finally, I use a finite mixture modelling (FMM) procedure to investigate whether American consumers might be better modelled as belonging to one of various subpopulations, rather than being treated as a homogenous group with respect to their food and health preferences. I construct models of the demand for five different nutrients (calories, total fat, carbohydrate, cholesterol, and protein) which are similar to the earlier regression model. My results show that American consumers can be appropriately modelled as though they belong to one of three subpopulations for all nutrients but protein, which appears to have two. I show that behavioral predictions are highly sensitive to the parameters that are used to model a given subpopulation because both the value and statistical significance of the variables in the model differ substantially between subpopulations.

## **Section 1.**

### Introduction

The prevailing narrative used to explain and understand obesity often emphasizes the ways in which consumers' consumption plans fall short of their long-term health preferences. The relatively rapid and steady rise in obesity's prevalence suggests that there may be a larger issue with how American preferences have evolved. As discussed above, the mainstream view holds that changes to the modern food environment make it exceedingly difficult for Americans to cultivate habits that lead to weight loss.

The source and reason for widespread changes in social habits is theoretically and empirically difficult to explain (Hodgson 2003). Most economists theorize that economic growth and change are, ultimately, demand-driven phenomena. Therefore, the modern food environment itself may have come about because of an earlier change to the overall environment, such as changes in society's beliefs about the safety of consuming certain foods or food characteristics. In order to determine the extent to which this is true, data on preferences in the pre-modern era is required. Below, I use content analysis to arrive at a rough picture of what Americans preferred to eat long before obesity became a widespread public health problem.

### Content Analysis of American Cookbooks

Content analysis "describes a family of analytic approaches ranging from impressionistic, intuitive, interpretive analyses to systematic, strict textual analyses" (Hsieh 2005, p. 1277) and "qualitative content analysis is defined as a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (Hsieh 2005, p. 1278). Here, I perform a qualitative content analysis of 874 American cookbooks written between 1814 and 1939.

The data come from the website Archive.org, which publishes books and other documents that have entered the public domain. All cookbooks were categorized under the subject heading "American Cookery", which initially included over 1,000 books. Not all results included a text document for analysis and not all books were strictly or mainly

about cooking or food, and were therefore discarded from the sample. Others were published since the 1950s and are too recent to be considered in my sample, leading to my sample size of 874.

My theoretical motivation for using this sample is that cookbooks should convey some information about the preferences of the consumers for whom they are intended. Further, authors must convince publishers to print their work so they, in turn, must have had some economic rationale for agreeing to do so. It stands to reason that books appearing on Archive.org were more popular or at least more widely published than their counterparts who do not appear. This could introduce some bias if unpopular cookbooks are included in the sample because they would not reflect broad social preferences. However, it seems more likely that the most popular cookbooks are the ones that survived and were eventually uploaded to the internet.

I used the software program RStudio and the R programming language (R Core Team, 2016) to compile and “clean” the texts of punctuation and extraneous, common words. The output of this exercise was a matrix of term frequencies and their associated documents. Many of the remaining terms had nothing to do with food and were discarded.

My aim was to detect broad trends in American preferences so it was important to remove food-related words whose meanings are ambiguous with respect to nutrient content, which required some judgement. Most adjectives had to be removed for this reason. For example, the word “creamy” might refer to a dish with heavy cream in it or to the texture of a dish that contains little dairy or fat. “Cream”, on the other hand, is more likely to refer to the actual ingredient.

Some terms that did refer to food had to be removed because the range of characteristics associated with them was too varied. “Salad” and its variations was one of the most frequently used words but, particularly during this period, includes various meat salads and other mayonnaise heavy dishes—a far cry from the image the word conjures up today.

More practically, some words were similar enough nutritionally and qualitatively that they can be treated as equivalent. Spelling variations are the most obvious example: sweets, sweet, and sweeten all become “sweet”. I collapsed the word “sugar” into this term as well. Similarly “Jam” and “Jelly” were converted to the single term “jamjelly” and “poultry” “chicken” and “birds” were combined into the made-up term “poultchickbird”, and so on. The total number of terms is a manageable 284.

Mine is what Hsieh and Shannon (2005) call a summative content analysis because I am subjectively identifying keywords in the texts under study. It is therefore rather rudimentary. Future work could take up the task of comparing this corpus of texts to a modern equivalent in order to get a clearer understanding of changes over time. Unfortunately, I did not have access to a comparison body of texts in the public domain.

The word cloud below depicts the 50% of terms that were used most frequently over the sample population. The larger a word is, the more frequently it occurs in the sample. There are many familiar food items but some appear more prominent than they might in cookbooks printed today, such as eggs, cream or butter. These are more likely to take the form of foods that contain less saturated fat, such as olive oil or half and half. Words like flour, bake, and bread are quite familiar and likely have not changed as much in prominence over time. It is unclear whether terms like “meat” or “poultchickbird” (i.e., all poultry) would have risen or fallen in popularity, given the increased popularity of lean meats and vegetable-based diets.

Figure 5. Word Cloud of Top Half of Terms



To get some sense of how consumer tastes developed over the 125-year period, I decided to try the same exercise on separate halves of the data, cookbooks from 1814-1877 and 1878-1932. In the remainder of this section, I refer to them as the “early” and “late” periods. No clear, visual trends emerge but this may simply reflect the lack of detail that this method allows for.





Figure 7. Word Cloud of Top Half of Late Terms



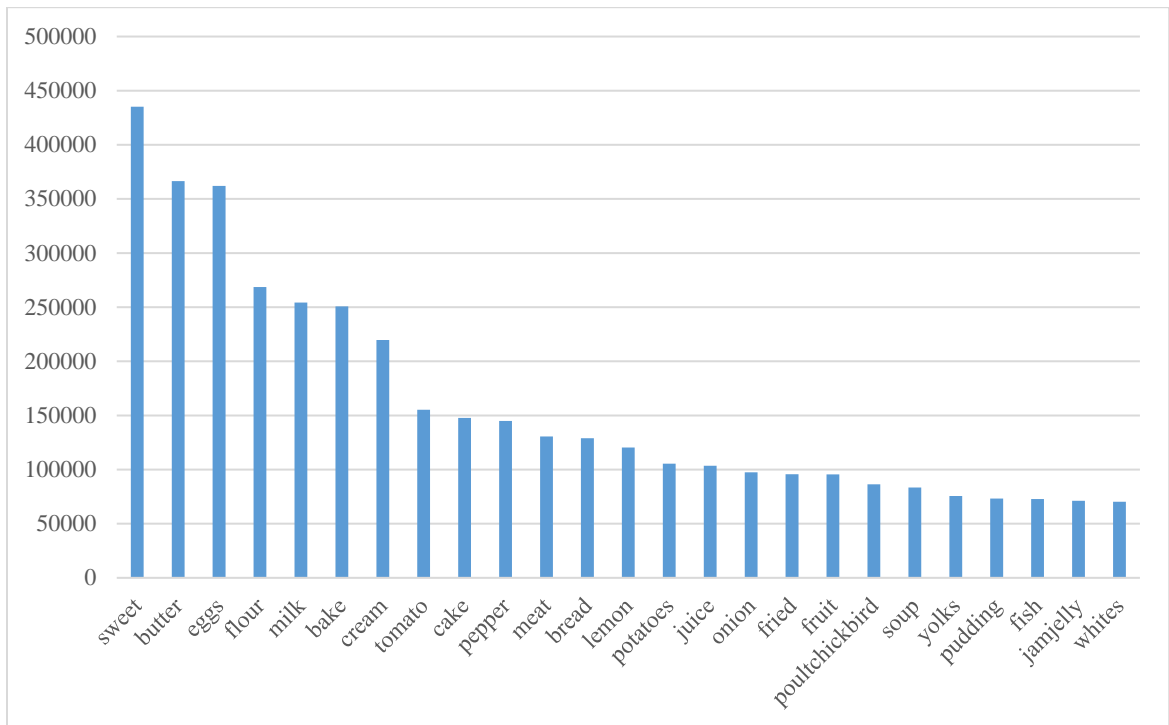
For a clearer picture of which of these terms was most popular over the three intervals, I produced a word cloud plotting the 100 most popular terms for each. This is only a slight refinement over the word clouds above since the dataset contains only 284 terms to begin with. There are not many changes but the words “fried”, “cake”, “cream”, “bake”, “sweet”, and “eggs” all appear to have increased in size, an indication of their relative frequency within the cloud.







**Table 1. Frequency of 25 Most Used Terms**



**Table 2. Frequency of 25 Most Used Early Terms**

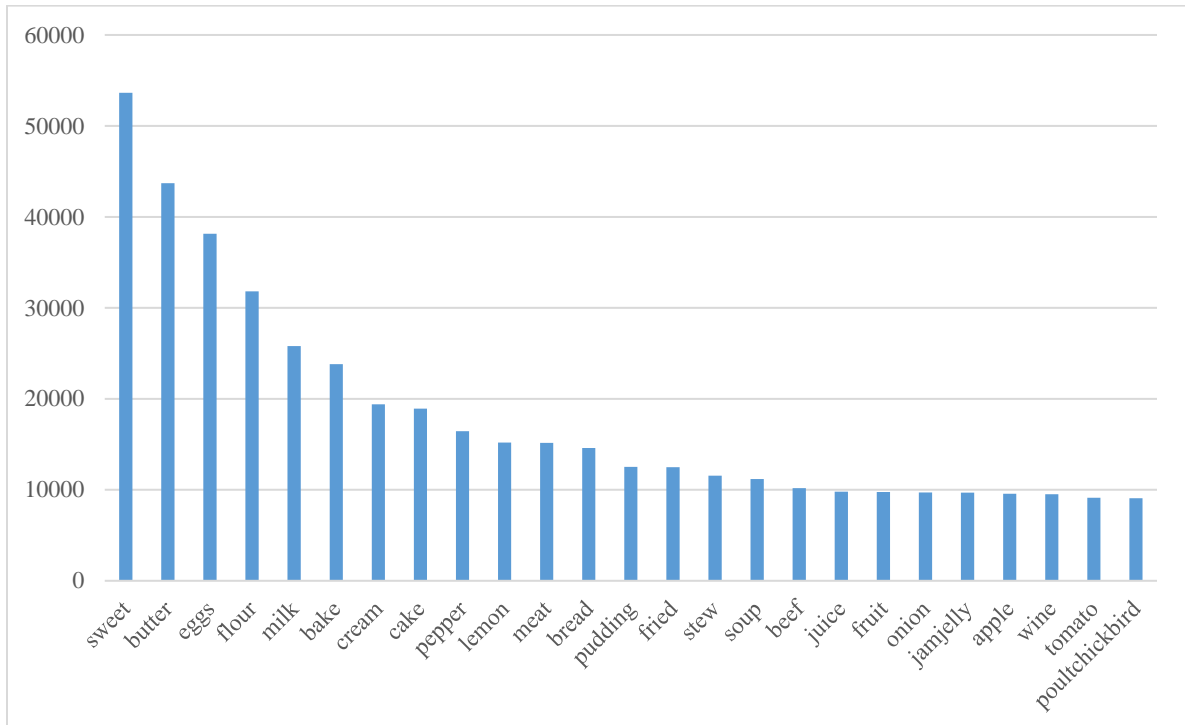
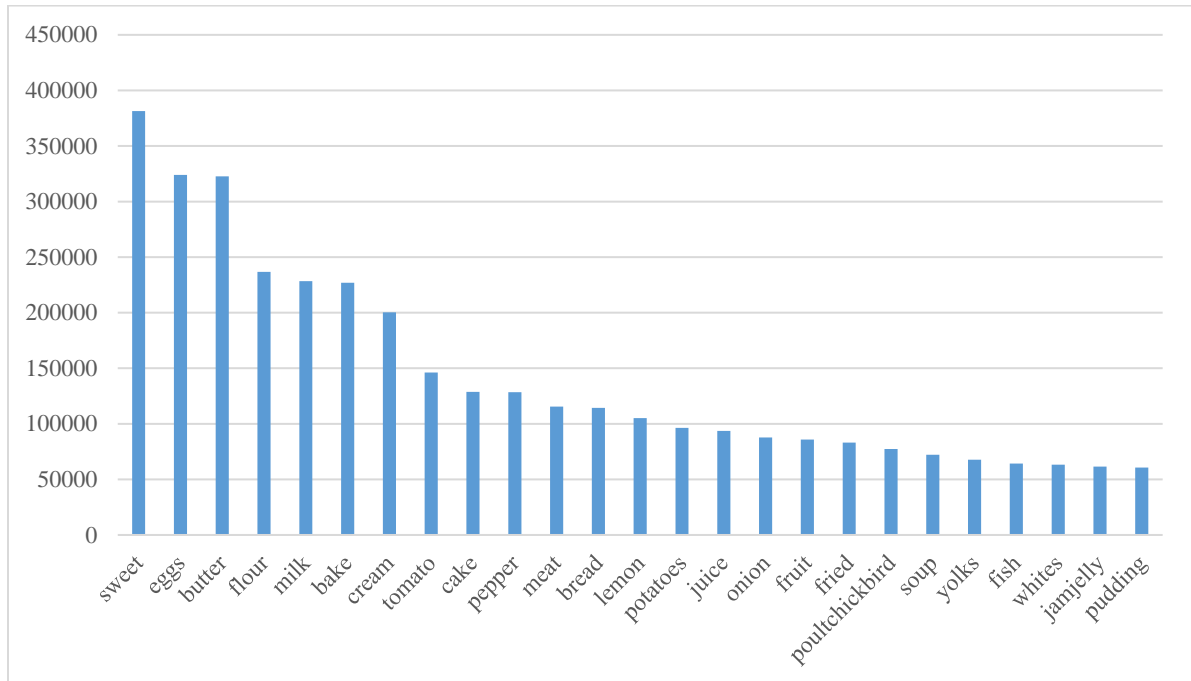


Table 3. Frequency of 25 Most Used Late Terms



While the results in this section do not reveal anything groundbreaking about the evolution of American food preferences over the time period, the advent of nutrition advice and common experience suggest that some of these ingredients have probably fallen in popularity since these cookbooks were published. Butter probably ceded some market share to margarine in the middle of the 20<sup>th</sup> century, which has since given way to olive oil or coconut oil as the preferred, healthy cooking fats in some circles. Sugar may have lost some of its market to artificial sweeteners for similar reasons. The same logic could apply to eggs, cream and meat, none of which are necessarily easy to fit into a USDA-style diet.

The reason for the rise or fall in consumption of any of these items is open to considerable interpretation and speculation but would be difficult to test for empirically without much better data. Have Americans shied away from eggs and butter because they have become more health-conscious, because sugar and starch have gotten cheaper, or because their basic tastes have or have not changed over time? Further research is needed to answer such questions, particularly research comparing this period to the present day.

The nature of preferences, habits, and institutions mean that precise, reliable relationships will be hard to measure.



## **Section 2.**

### **Measuring the Effect of Stigma on Food Stamp Participation and Spending**

Here, I replicate Butler's (1982) work by measuring the effect of social stigma on Americans' decision to enroll in what was then called the Food Stamp program, and is now called the Supplemental Nutrition Assistance Program (SNAP). I do so using a dataset published by the USDA derived from the Dietary Health and Knowledge Survey, conducted between 1994 and 1996, comprising over 5,000 respondents. Fortunately, the survey respondents answered many similar questions to those asked in Butler's study, which was more directly related to the Food Stamp Program.

The equations I test are based on the variables included in Butler's "Preferred Model" (p.122) for food stamp expenditures, reproduced below. In several cases, I was forced to use a different variable to measure a similar concept. The DHKS did not ask respondents for their state of residence but their region was coded. There is no "cashout site" because these were specific to the study upon which Butler's data was based. The categorization "rural" was not used but, rather, the respondent's relation to a Metropolitan Statistical Area (MSA) so I coded respondents outside of MSAs as rural even though this may not be strictly true. Respondents were not asked how often they get out but were asked how often they go food shopping, variables which could plausibly be positively correlated so I use it instead. Positive and negative health effects were also not measured but individuals were asked about their health status, which I used to create dummy variables dividing them into positive and negative affect. Subjects were not asked whether they had a car available so I cannot include that variable.

In order to control for differences in prices, I consulted the Department of Labor's (DOL) Consumer Expenditure Survey (CE). In Butler's paper, he uses their figures for elderly, single-member households to construct regional price indices. I was unable to find these exact figures and, instead, constructed my own regional price index for food and non-food items based on average expenditures for similar households between 1994 and 1996. The DOL did have national average expenditures for the elderly (65 and over) and single-member households. I first took the average of these two figures from 1994-1996. In order to control for regional differences in prices, I used the DOL's figures on

the average regional food and total expenditures per household, which was not broken-down by household size. Taking the mean of the 4 regions (Northeast, Midwest, South, and West) and dividing each region's average total expenditures by that number produced an appropriate adjustment factor. Fortunately, the DHKS did ask for fairly specific income and food expenditure information. The DOL numbers are shown in Tables 4 and 5, below. Table 6 (next page) provides a comparison of Butler's original model and the one I was able to create using the DHKS data set.

Table 4. Average Food Expenditures

<b>Food</b>	<b>&gt;65 Avg.</b>	<b>Single Avg.</b>	<b>Mean</b>	<b>Region</b>	<b>Price Adjustment</b>	<b>Final</b>
NE	3339	2520.67	2929.83	4839	1.056	3094.01
S	3339	2520.67	2929.83	4318	0.942	2761.08
W	3339	2520.67	2929.83	4761	1.039	3044.35
MW	3339	2520.67	2929.83	4410	0.962	2819.90

Table 5. Average Non-Food Expenditures

<b>Non-Food</b>	<b>&gt;65 Avg.</b>	<b>Single Avg.</b>	<b>Mean</b>	<b>Region</b>	<b>Price Adjustment</b>	<b>Final</b>
NE	22935	19604.7	21269.8	33240.3	1.011	21504.2
S	22935	19604.7	21269.8	31077.0	0.945	20104.9
W	22935	19604.7	21269.8	35439.7	1.078	22927.0
MW	22935	19604.7	21269.8	31755.0	0.967	20543.3

Table 6. Butler Model Comparison

<b>Butler Variable</b>	<b>DHKS</b>	<b>Explanation</b>
participation	fs_rcv12	Anyone receive food stamps in last year?
black	black	1 if race is black
Age 70-74	age70	1 if age between 70 and 74
Age>75	age75	1 if age is 75 or more
Two or more in household	hhtwo	1 if household is 2 or more people
Negative affect (0-5)	neghealth	1 if health rating is 1 or 2
Positive affect (0-5)	poshealth	1 if health rating is 3, 4 or 5
Male head of household	headman	1 if head of household is a man
Female head of household	headwom	1 if head of household is a woman
Log-income	logincome	Natural log of income
Getting SSI	minc_s2	Any member of hh receiving SSI
New York, South Carolina	region dummies	Northwest, Midwest, South, West
Hispanic	hispanic	1 if of Mexican, Puerto Rican, Cuban, or other Hispanic descent
Education 8-11 yrs	grade8	1 if highest grade level is 8-11
Education $\geq$ 12 yrs	grade12	1 if highest grade level is 12 or greater
Rural	rural	1 if outside MSA
Out daily	shp_alot	1 = More than once a week
Out often	shp_ofTEN	2 = Once a week
Out some	Shp_some	3 = Once every two weeks
Food budget	annufoodexp	Total Food Budget <sup>1</sup>
Log-price non-food	lognonfood	Log of DOL nonfood budget

Continued From Table 6.

N/A	shp_groc	Expenditures on groceries last 3 months
N/A	shp_grou	Unit of Time
N/A	shp_nonf	Non-food grocery expenditures past 3 months
N/A	shp_nonu	Unit of Time
N/A	shp_spec	Expenditures on specialty foods past 3 months
N/A	shp_speu	Unit of Time
N/A	shp_fast	Expenditures on fast food
N/A	shp_fasu	Unit of Time
N/A	shp_away	Other Food expenditures away from home
N/A	shp_awau	Unit of Time

$$^1=[shp\_groc*shp\_grou][shp\_nonf*shp\_nonu]+[shp\_spec*shp\_speu]+[shp\_fast*shp\_fasu]+[shp\_away*shp\_awau]*4$$

Table 7 (next page) reports the results of estimating my food expenditure model. In the original regression, northeast, west, south, grade8, grade12, rural, and neghealth were omitted due to collinearity and so the estimation was performed again without them. The model has an adjust R-squared of 0.1712. Variables that were significant at the 5% level are double-starred.

Table 7. Stigma Model Estimation Results

<b>annufoodexp</b>	<b>Coef.</b>	<b>Std. Err.</b>	<b>t</b>	<b>p-value</b>	<b>[95% Conf.</b>	<b>Interval]</b>
fs_rcv12	-164.46	37.70	-4.36	<0.001	-238.37	-90.55
b_race	41.57	67.39	0.62	0.537	-90.54	173.69
headman**	-124.05	51.10	-2.43	0.015	-224.23	-23.86
headwom	3.32	111.48	0.03	0.976	-215.22	221.87
Logincome**	371.63	27.70	13.42	<0.001	317.33	425.94
minc_s2	20.47	24.50	0.84	0.404	-27.57	68.51
age70**	-336.92	87.82	-3.84	<0.001	-509.08	-164.76
age75**	-315.51	78.24	-4.03	<0.001	-468.90	-162.12
onemanhh	-228.52	162.78	-1.40	0.160	-547.64	90.59
Malehhh	-37.62	78.35	-0.48	0.631	-191.23	115.98
Hhtwo**	465.08	128.26	3.63	<0.001	213.63	716.53
Hispanic	-9.27	80.95	-0.11	0.909	-167.95	149.42
Midwest	6.70	48.89	0.14	0.891	-89.15	102.56
shp_alot**	-866.32	72.22	-12.00	<0.001	-1007.91	-724.74
shp_ofTEN**	-914.81	59.26	-15.44	<0.001	-1030.98	-798.65
shp_some	-79.59	63.46	-1.25	0.210	-204.01	44.82
Lognonfood**	5044.25	833.98	6.05	<0.001	3409.27	6679.22
Logrefbudget**	-2855.99	862.42	-3.31	0.001	-4546.71	-1165.26
Poshealth	-47.95	42.14	-1.14	0.255	-130.57	34.67
constant**	-29142.37	4357.85	-6.69	<0.001	-37685.64	-20599.09

These results mirror much of what Butler found: income is significant, as is household size, the price of food and non-food items, old age, living in a household of one male. The negative coefficient on the food stamp participation may serve as a rough measure of stigma in this model. More generally, the above results show that decisions relating to food expenditure can be quite complex and difficult to model.

### **Section 3.**

#### **Introduction**

My purpose in this section is to test whether there is a relationship between individuals' knowledge, beliefs, and priorities regarding a healthy diet, their eating decisions and, ultimately, eating habits. It is an attempt to measure individuals' actual preferences for a healthy diet, relative to their own claimed beliefs, knowledge, and priorities as well as to that of a "healthy" diet defined by a nutrition authority, in this case the United States Department of Agriculture (USDA) and Department of Health and Human Services (HHS), the agencies that have released the Dietary Guidelines for Americans every five years since 1985, as mandated by Section 301 of the National Nutrition Monitoring and Related Research Act of 1990 (7 U.S.C. 5341). HHS's Office of Disease Prevention and Health Promotion (ODPH) had the administrative leadership for the 2015 edition of the *Guidelines*, with support from the USDA's Center for Nutrition Policy and Promotion in Committee. HHS and USDA also appoint a panel of experts in the field of nutrition, the Dietary Guidelines Advisory Committee (DGAC), "consisting of nationally recognized experts in the field of nutrition and health" (Dietary Guidelines for Americans, 2015).

Economic theory argues that Americans will make consumption choices in accordance with their preferences, based on the information they have at their disposal (Allen, 2001, Beales et al., 1981, Stigler, 1961). Americans who face uncertainty with respect to losing weight or eating an otherwise healthy diet have ready access to information that should allow for them to remedy this problem, assuming they find it utility-enhancing to do so in the first place.

In this paper, I assume individuals have a preference for maintaining a healthy, normal weight, all else equal. I also assume that they may be endowed with food preferences that lead to the gradual onset of obesity. Given their personal incentive to avoid or alleviate their condition, economic theory suggests that obese individuals seek out information and, if feasible, go about aligning their short-term preferences to their long-term goals.

## Data

I rely on the United States Department of Agriculture's (USDA) Dietary Health and Knowledge Survey (DHKS) 1994-1996, a sub-survey of their Continuing Survey on Individual Intake (CSFII). The DHKS was ultimately administered to 5,765 respondents who answered a battery of questions about the foods they ate, their individual health characteristics and demographics, and their knowledge and beliefs surrounding food, nutrients, vitamins, and minerals. Respondents were asked for their food intake on two separate days, which I averaged to proxy their average meal (i.e., what the individual eats habitually).

My hypotheses are that consumers who claim to have more knowledge, better beliefs, and who place a higher priority on nutrition in their buying decisions will act accordingly—they will eat healthier compared to a similar individual without those characteristics. Again, "health" is defined and assessed by a nutrition authority in the form of the USDA, whose questions go into some detail about what respondents think about particular macronutrients, foods and their associated health problems. I also hypothesize that respondents who engage in other healthy behaviors (such as exercise and not smoking) will eat more healthily, all else equal.

I further hypothesize that consumers with diet-related health problems and other demographic characteristics will be more likely to know about and follow the healthy diet. Individuals with higher body-mass indexes (BMIs) have an incentive to seek out information and use it to lose weight. I predict that older individuals will eat more healthily since they are more likely to know about and have direct or indirect experience with diet-related illnesses making the incentives associated with eating well more temporally relevant. I am unsure of what the effect of education, income, or other demographic variables will be because food represents a relatively small expenditure in American households and these other considerations may override pure income or education effects.

### Summary Statistics

Summarizing the data, the average woman in the survey population is age 46, 5'4" tall, weighs 177 pounds and has BMI of 28.6. The average man in the survey population is age 44, 5' 10" tall, weighs 187 pounds and has a BMI of 27.0, putting both in the “overweight” categorization. The USDA *Guidelines* recommend that the average American consume 2,000 calories per day, 55% coming from carbohydrate, 15% from protein and 30% of energy from fat, including less than 10% from saturated fat. The table and summary statistics below and on the following page seem to indicate that Americans were not too far from these recommendations at the time of the survey.

Table 8. Mean Macronutrient Intake of Survey Population

<b>Macronutrient (g)</b>	<b>W</b>	<b>M</b>	<b>%Cal(W)</b>	<b>%Cal(M)</b>
Carbohydrate	209.13	294.86	51.46	48.41
Protein	62.51	95.91	15.38	15.75
Total fat	59.97	92.44	33.21	34.15
Calories	1625.29	2436.44		



Table 9. Summary Statistics, All variables

<b>Nutrient</b>	<b>Mean</b>	<b>Linearized Std. Error</b>	<b>[95% Conf. Interval]</b>	
calories	2014.12	21.75	1970.26	2057.98
grade	14.09	0.20	13.68	14.49
height	67.17	0.09	66.98	67.36
foodstamp	0.13	0.02	0.09	0.16
age	45.22	0.43	44.36	46.08
sex	0.52	0.01	0.50	0.54
race	1.37	0.04	1.29	1.44
bmi_sp	27.84	0.26	27.32	28.36
exercise	3.84	0.05	3.75	3.93
health	2.37	0.02	2.33	2.42
knowledge	3.44	0.02	3.41	3.48
priosafe	3.86	0.01	3.83	3.88
prionutr	3.62	0.02	3.59	3.66
priopric	3.28	0.02	3.23	3.33
priokeep	3.50	0.02	3.45	3.54
prioease	3.14	0.02	3.10	3.18
priotast	3.84	0.01	3.82	3.87
lcdiet	0.07	0.00	0.06	0.08
smk_100	0.50	0.01	0.48	0.52
smk_now	0.25	0.01	0.24	0.27
urb	1.89	0.02	1.84	1.94
income	42055.59	951.08	40137.55	43973.63

## The THANKS Model of Dietary Decision-Making

To measure the extent to which demand for different nutrients is a function of the consumers' personal characteristics, I focus on predicting consumption quantities of calories. I expect that individuals who are more health-minded, in that they know more or place a higher priority on nutrition in their purchasing decisions, will eat fewer calories. Those who derive greater utility from other considerations (e.g., taste) are hypothesized to eat more calories, all else equal. The federal government has been consistent in recommending low-calorie, low-fat diets for individuals suffering from overweight or obesity and healthy individuals wishing to avoid chronic disease since the original publication of the *Guidelines* in 1980.

The *Guidelines*, along with other health authorities, provide consumers with a set of *acts* for consumers in various *states*, which are themselves a function of past actions and nature. Nutrition information also provides a simple *consequence function* for individuals wishing to lose weight wherein calories consumed and expended are the primary variables. Because dietary advice is a credence good (Dulleck, Kerschbamer, 2006), a rational consumer presumably attaches a high probability to the belief that the advice they receive correctly maps *acts* to their corresponding *states*. Consumers also have a utility function which measures the utility derived from the various possible consequences of their acts (Hirshleifer, 1992).

In the language of uncertainty (since consumers are not assumed to be nutrition experts), the *Guidelines* are one tool (among many, similar, market-provided ones) available to weight-conscious consumers (i.e., those who rank the utility of losing weight highly) which enjoys a credible consequence function that will allow said consumers to navigate the market for food, improve their diets, and lose weight.

The DHKS asked a long list of potentially pertinent questions to ascertain respondents' nutritional knowledge. To refine my model, I performed a linear regression, with the correct survey probability weights attached and a long list of potentially relevant questions about different foods and nutrients. A factor analysis revealed five factors with Eigen Values greater than 1, each corresponding to a much smaller subset (2-6 questions)

of the dozens of knowledge questions. These were readily collapsed into 5 individual variables which I initially labelled: knowledge, sugar, priority, labeluse, and labelme.

#### Likert scales

The series of questions that make up the ‘knowledge’ variable ask if consumers personally believe in the importance of maintaining a healthy weight, of eating a diet with moderate amounts of sugar, foods low in saturated fat, low in overall fat, a diet low in cholesterol and one with plenty of carbohydrate-containing foods on a 1 (not at all important) to 4 (very important). Since a higher number corresponds to better knowledge for each question, the average of those six responses should give some indication of how knowledgeable the respondent is about the tenets of USDA advice.

The six priority questions ask for the importance respondents’ attach to: safety, nutrition, price, food keeping well, ease of preparation and taste in their buying decisions, again on a 1 (not important) to 4 (very important) Likert scale. Since my intention with this study is to test the effect of nutrition priorities on consumption, independently of other priorities, treating the ‘priority’ variable as representing a single effect would mask the effects of a consumer placing a priority on nutrition itself. As a result, I found it more theoretically appealing to leave these questions as separate variables in the final model. The other questions did not suffer from this issue.

The two sugar-related questions included ask if the respondent is or is not aware of the link between sugar consumption and diabetes, and sugar consumption and heart disease (yes or no). The four ‘labeluse’ questions ask what parts of nutrition labels consumers pay the most attention to and what parts they find easiest to understand: calories, grams or milligrams of nutrients per serving, and percent of daily values (1=very easy, 2=somewhat easy, 3=not too easy, 4=never seen) and a question on whether labels are hard to interpret, on a 1 (not difficult) to 4 (difficult) scale. Finally, the five ‘labelme’ questions ask how consumers personally use nutrition labels and whether the labels affect their buying decisions. They ask if nutrition labels: are useful to the individual, are used by the respondent because she values her health, make it easier to choose foods, lead to better food choices, and whether they are better than using her own knowledge (1=strongly disagree, 4=strongly agree). I decided not to include these three variables in

the final model because the knowledge and priority questions capture essentially the same information in a less ambiguous way and to keep the model relatively simple.

I include highest grade-level achieved to control for the effects of education. The foodstamp variable measures whether the respondent was eligible for food stamps at the time of the survey. Bmi\_sp measures the individual's Body Mass Index (BMI), a rough measure of individual fatness. Exercise measures how often the respondent exercises vigorously (1=daily, 6=rarely). Health asks for the respondent's subjective health evaluation (1=excellent, 5=poor). Lcdiet asks if the individual is on a low-calorie or weight loss diet. Smk\_100 asks if the individual has smoked 100 cigarettes in her lifetime and smk\_now asks if they are a current smoker. Urb classifies respondents as being in a Metropolitan Statistical Area (MSA), central city (1), MSA, outside central-city (2), and non-MSA (3). Income measures before-tax household income from all sources. Gender is coded as women, '1s', and Men, '0s'. Height is included as a control for body size—taller individuals have greater caloric needs, all else equal. Age is reported in years.

With these independent variables, I estimated a linear regression analysis with survey weights to model calorie consumption. My model is similar to the one used by Wang, Beydoun, Caballero, Gary, and Lawrence (“Trends and correlates in meat consumption patterns in the US adult population”, 2010) which uses the same dataset and many of the same survey questions about consumer nutrition knowledge and habits to estimate a model of demand for meat.

Table 10. THANKS Model of Calorie Consumption—Estimation Results

Variable	Coefficient	Linearized Std. Err.	t	P>t	[95% Conf. Interval]	
lcdiet	-236.86	45.96	-5.15	<0.001	-329.54	-144.17
priotast	77.30	25.45	3.04	0.004	25.97	128.63
height	17.79	3.44	5.18	<0.001	10.87	24.72
age	-10.17	0.83	-12.17	<0.001	-11.85	-8.48
prionutr	-69.45	30.29	-2.29	0.027	-130.54	-8.36
knowledge	-93.52	35.35	-2.65	0.011	-164.81	-22.23
sex	-617.43	39.40	-15.67	<0.001	-696.90	-537.97
smk_100	60.26	22.86	2.64	0.012	14.15	106.37
health	-40.33	23.77	-1.70	0.097	-88.27	7.60
grade	-1.44	1.21	-1.19	0.241	-3.89	1.01
foodstamp	1.63	18.67	0.09	0.931	-36.02	39.29
race	17.97	17.07	1.05	0.298	-16.46	52.40
bmi_sp	-1.17	1.20	-0.98	0.332	-3.59	1.24
exercise	-14.13	11.33	-1.25	0.219	-36.99	8.73
priosafe	-13.67	27.43	-0.50	0.621	-68.99	41.66
priopric	-16.89	22.86	-0.74	0.464	-62.99	29.22
priokeep	-26.92	15.82	-1.70	0.096	-58.83	4.98
prioease	24.42	25.11	0.97	0.336	-26.22	75.06
smk_now	67.87	57.56	1.18	0.245	-48.21	183.94
urb	-11.35	36.86	-0.31	0.76	-85.68	62.99
income	0.00	0.00	0.36	0.719	0.00	0.00
constant	2156.77	305.65	7.06	<0.001	1540.36	2773.18

Table 11. Significant (P <0.05) Coefficients & Estimates at Population Means

Variable	Coef.	P	Mean (Women)	Mean (Men)	Est.(W)	Est. (M)
Priotast (T)	77.30	0.004	3.80	3.88	293.75	299.94
Height (H)	17.80	0.011	64.42	70.10	1146.35	1247.43
Age (A)	-10.16	0.000	46.10	44.10	-468.61	-448.28
Prionutr (N)	-69.45	0.004	3.72	3.10	-258.35	-215.29
Knowledge (K)	-93.52	0.027	3.36	3.52	-314.22	-329.19
Sex s	-617.43	0.000	1	0	-617.43	0
lcdiet	-236.86	0.000	9.3%	4.0%	-236.86	-236.86
smk_100	60.26	0.012	42.1%	56.1%	60.26	60.26
Constant	2156.77	<0.0001				

Table 12. Mean Calorie Predictions from THANKS Model

Category	Women	Men
Non-smoker, LC*	-455.36	-317.76
LC	1,701.40	2,474.52
non-LC	1,938.26	2,711.38
smk_100, non-LC	1,998.53	2,771.64

\*low-cal diet

### Results

The results of the regression indicate that many of the hypothesized variables are significant at the 5% level and are generally in the expected directions. Taller people eat more calories than short people, older people less than younger people, and women eat less than men. More knowledgeable consumers eat less, as do individuals who place a high priority on nutrition in their buying decisions. Not surprisingly, a higher priority on taste is associated with eating more calories. Individuals on a weight loss diet do appear to make significant reductions in their calorie consumption. I named the model “THANKS” because Taste (T), Height (H), Age (A), Nutrition priority (N), Knowledge

(K) and Sex s were among the most important variables in explaining calorie consumption, along with whether the individual is on a weight loss diet.

In light of the obesity epidemic that has taken hold since, perhaps the most surprising result is the mean value and rather large, negative coefficient on both the Knowledge and Prionutr variables. If these results are indicative of trends at the time, basic economic theory suggests that the priority of nutrition and the importance of acquiring nutrition knowledge might be enough to mitigate obesity's rise. Since height does not change much after adulthood and Priotast is the only remaining coefficient with a positive sign, one has to wonder what other concerns may have come to override or supersede these priorities.

As the chart above shows, the model predicts that the mean woman will consume 1,701 calories if she is on a low-calorie or weight loss diet, and 1,938 calories if she is not, a 12.2% difference. The mean BMI for a woman in the survey population was 28.6. The mean man, meanwhile, consumes 2,475 calories if he is on a low-calorie or weight loss diet, 2,711 if not, an 8.7% difference. Mean BMI for men was 27.01.

The results of the model also indicate that taste and nutrition priority have opposite signs, which was expected, and that they almost cancel one another out, on average. I ran a cross-tabulation for those two questions to get a better understanding of how these priorities interact. The chart below shows that over half (53%) of consumers attached the highest importance possible to both taste and nutrition. Twenty-five percent of respondents gave taste a 4 and nutrition a 3 while only 7.7% gave nutrition a 4 and taste a 3. Though Americans clearly prioritize both factors, this may be evidence that taste preferences can override preferences for a healthy diet.

Table 13. Priority Placed on Nutrition and Taste in Buying Decision

	<b>Prionutr</b>				
<b>Priotast</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Total</b>
1	<0.0001	<0.0001	<0.0001	0.0022	0.0028
2	<0.0001	<0.0001	0.0040	0.0088	0.0142
3	0.0015	0.0087	0.0619	0.0765	0.1493
4	0.0070	0.0339	0.2495	0.5319	0.8274
Total	0.0091	0.0437	0.3154	0.6203	1

Obviously much of the differences in consumption between men and women reflects physiological differences (men tend to be larger than women, on average) but it could also reflect differences in priorities. To see if this was the case, I performed several cross-tabulations (non-responses omitted from tables) between sex and the priority respondents' placed on nutrition and taste in their buying decisions. The results indicate that 10% more women than men place the highest priority on nutrition. Tables 8 and 9 also show that nearly 61% of women place the highest priority on nutrition and taste while only 45% of men felt the same. Nearly 70% of women gave nutrition a 4 while only 54% of men did the same.



Table 14. Sex and Priority Placed on Nutrition in Buying Decision

<b>Prionutr</b>	<b>Men</b>	<b>Women</b>	<b>Total</b>
1	0.0066	0.0024	0.0091
2	0.0296	0.0142	0.0437
3	0.179	0.1364	0.3154
4	0.2586	0.3617	0.6203
Total	0.4794	0.5206	1

Table 15. Priority Placed on Nutrition and Taste: Women Only

	<b>Prionutr</b>				
<b>Priotast</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Total</b>
1	<0.0001	<0.0001	<0.0001	0.0020	0.002
2	<0.0001	<0.0001	0.0019	0.0076	0.0101
3	0.0018	0.0022	0.0407	0.0745	0.1201
4	0.0029	0.0247	0.2193	0.6093	0.8627
Total	0.0047	0.0272	0.262	0.6947	1

Table 16. Priority Placed on Nutrition and Taste: Men Only

	<b>Prionutr</b>				
<b>Priotast</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Total</b>
1	<0.0001	<0.0001	<0.0001	0.0025	0.0037
2	<0.0001	0.0017	0.0062	0.0101	0.0187
3	0.0011	0.0157	0.0849	0.0788	0.181
4	0.0115	0.0439	0.2823	0.4479	0.7892
Total	0.0138	0.0617	0.3734	0.5395	1

### Discussion

Great caution should be exercised in interpreting these results. It is probably most important not to take the estimates and coefficients derived from the THANKS model too literally. A calorie is a small unit of measurement and misreporting is always a concern

when asking individuals about their own behavior. Furthermore, social-desirability bias may lead individuals to over-estimate their knowledge or exaggerate about the extent to which they care about nutrition. They may under-report consumption of unhealthy foods or over-report consumption of healthy foods for similar reasons. Since intake data was only collected over a two-day period, at a single point in time, it is an open question whether these intake patterns truly reflect prevailing consumer habits. Nevertheless, most, if not all, of the coefficients are what one would expect in this particular domain and the signs of the coefficients are theoretically consistent.

In comparing women and men, an interesting picture emerges: it appears that women prioritize nutrition in their decisions, are generally quite knowledgeable about nutrition, they are more likely to be on a weight-loss diet (9.3% of women versus 4.0% of men), and they do, indeed consume significantly fewer calories than men. Despite all of this, on average, women's BMIs are higher (28.06 for women versus 27.01 for men). There are many possible explanations for this apparent contradiction—the most obvious is that women are under-reporting their calorie intake relative to men, who could be overestimating theirs. Women may simply not be doing enough to change their habits for the results to show up in BMI figures.

Another, speculative, possibility is that there is unacknowledged uncertainty in the model and insufficient data with which to reduce it. Under the assumption that many women had begun adopting healthy eating patterns, to the extent that these habits resulted in the desired consequences, one would expect for the desired behavior to rationally continue. The high prevalence of obesity today belies that possibility. If it is the case that calories are not the most important variable for explaining weight loss (i.e., they should not be prominent in the overweight consumers' consequence function) then consumers may have failed to continue these habits simply because they were not working—they were not net-utility enhancing.

### Conclusion

Unfortunately, these results do not provide much guidance with respect to how to improve consumers' eating decisions. They do suggest that, at the time anyway, many Americans were aware of what constitutes a healthy diet and were making improvements

to their diets, consistent with economic theory. On average, American eating habits were not completely out of line with recommendations and average calorie intake was close to the 2,000 recommended, particularly among women. People who prioritized nutrition or were more knowledgeable about healthy diets ate fewer calories as well, which is consistent with more recent survey research (Gregory et al., 2014). The recent economic downturn seems to have had a positive effect on American eating habits, though this does not bode well for treating the United States' ability to lose weight when the economy does eventually recover (Todd, et al., 2014). Based solely on the DHKS data, the positive trends in eating habits found therein might have been predicted to continue and lead to improved diet-related health outcomes. The reason for this discrepancy in results may lie in Americans' inherently unhealthy underlying habits (the most prominent, accepted theory) or in the quality of advice consumers have received from credible sources over the years; clearly more research is needed along both dimensions of this problem.

#### **Section 4.**

##### **Analysis of DHKS Population Using Finite Mixture Modelling**

While the THANKS model provides some interesting insights into the behavior of the average American in the mid-1990s, it may be inadequate to capture more fine-grained differences between different groups of consumers. In light of the discussion above, it may not be appropriate to treat all consumers as though they will all respond favorably to a low-fat, low-calorie diet because of unacknowledged dietary uncertainty regarding that diet's technical efficacy. Finite-Mixture Modelling (FMM) is one tool for probabilistically identifying subpopulations within a larger population using maximum likelihood estimation. FMM is useful in applications where the subpopulations are thought to be heterogeneous but lack identifying information (Deb, 2012).

Since subpopulations are not easily identifiable, FMM takes an iterative approach to identifying the number of subpopulations (the distribution of the subpopulations is specified beforehand), or latent classes, within a given population. Classes are added and compared to previous models (with fewer classes) to see which fits the data better. FMM can also be combined with regression analysis in order to identify subpopulations on the basis of their covariates.

In this section, I use FMM, and a simplified version of the THANKS model to identify potential systematic differences in consumption patterns among (possible) American subpopulations. I assume the overall population is a mixture of Gaussian distributions. My analysis cannot identify the source of these differences, but it may provide some preliminary evidence that a “one-size-fits-all” approach to nutritional advice is liable to be inefficient. This is particularly true if classes of consumers are sufficiently different in terms of their metabolism or food preferences.

My dependent variables are calories, total fat, carbohydrate, protein, and cholesterol. They, my independent variables, and their summary statistics are listed in Table 17 (next page, “R” refers to the survey respondent). All statistics were computed using the survey weights provided by the DHKS.

BMI\_prime is meant to capture the extent to which consumers are technically considered “overweight” as 25 is the lower bound for that category. Knowledge is a composite measure of the respondent’s knowledge of the advice contained within the *Guidelines*, based on survey responses. Eleven observations were dropped because respondents did not provide answers, leading to a sample population of 5,092.

Table 17. Summary Statistics for Finite Mixture Models

<u>Variable</u>	<u>Type</u>	<u>Explanation</u>	<u>Mean</u>	<u>Linearized</u> <u>Std. Error</u>
Calories	Ratio	Consumption, in kilocalories	2031.71	22.81
Total Fat	Ratio	Consumption, in grams	76.066	1.108
Carbohydrate	Ratio	Consumption, in grams	252.591	2.692
Protein	Ratio	Consumption, in grams	79.002	0.991
Cholesterol	Ratio	Consumption, in milligrams	268.664	4.613
Notgrad	Dummy	1 if R did not graduate HS	0.144	0.127
Povcat	Dummy	1 if R is below Poverty Line	0.145	0.126
Age	Ratio	Age in years	44.66	0.455
B_race	Dummy	1 if R is Black	0.113	0.010
Exercise	Likert (1-6)	Daily—Rarely	3.789	0.047
Bmi_prime	Ratio	R's BMI divided by 25	1.049	0.005
Health	Likert (1-5)	R's health: Excellent—Poor	2.316	0.027
Knowledge	Likert (1-4)	Measure of R's nutrition knowledge	3.389	0.015
Prionutr	Likert (1-4)	Priority of nutrition	3.567	0.0138
Priopric	Likert (1-4)	Priority of price	3.242	0.024
Priotast	Likert (1-4)	Priority of taste	3.818	0.009
Prioease	Likert (1-4)	Priority of ease of preparation	3.091	0.022
Lcdiet	Dummy	1 if R is on a low-calorie diet	.067	0.005
Sex	Dummy	1 if R is female	.517	0.011

Similar to the THANKS model, these figures do not appear particularly worrying if they were used to speculate about the future trajectory of American health outcomes, including obesity. On average, Americans appear relatively knowledgeable about the nature of a healthy diet and, based on their reporting, the average American was not far from conforming to USDA recommendations for both calories and fat, broadly consistent with a satisficing model of behavior.

FMM analysis reveals that a consumer's demand for each dependent variable may depend on which latent class a particular respondent belongs to. The results of each

model are reported separately in the pages that follow. The first 15 lines of each table report the regression results for each component, with linearized standard errors for each coefficient shown in parentheses. On the remaining four lines, I report the predicted mean (PredMean) for each component, the classification of respondents based on their estimated posterior probability (PostProb), the classification of each respondent based on their most likely latent class membership (LClassMemb), and the average posterior probabilities (AvgPP) for each latent class.

PredMean gives the predicted mean for the sample population if the parameters for a given latent class were used to model all respondents. If these predictions are significantly different from one another, it may be an indication that an FMM approach is valid because of unobserved heterogeneity within the population. Significant, theoretically valid, differences in coefficients between subpopulations may be further evidence for real differences between groups of consumers, be they metabolic, behavioral or both.

The FMM procedure, implemented using the ‘fmm’ and ‘fmmlc’ (Luedicke, 2011) packages in Stata, revealed that the survey population can be decomposed into three different subpopulations to model overall demand for all nutrients except protein, which was broken into only two latent classes (referred to as “components” in the tables on the following pages). When I attempted to add a third class to the protein model, Stata did not appear to be converging to a solution after over 1,000 iterations. As such, it is difficult to say whether demand for protein is better modelled with 1, 2, or more components because both the Bayesian Information Criteria (BIC) and Akaike Information Criterion (AIC) are only useful when comparing competing FMM models, not in isolation (Raftery, 1995).

In the case of the other four dependent variables, the AIC and BIC were both reduced after the addition of the third component while adding a fourth did not improve the models or prevented it from converging to a solution, indicating a 3-component model leads to the best fit with the data (Raftery, 1995). Further, the average posterior probability was over 0.70 for all latent classes, indicating the model performs reasonably well at predicting the correct class to which respondents belong. Estimation results and discussion follow.

Table 18. FMM-Calories-Estimation Results

<b>Variable</b>	<b>Component 1</b>	<b>Component 2</b>	<b>Component 3</b>
notgrad	-24.08 (64.80)	485.4** (199.1)	-256.7*** (65.80)
povcat	-136.6* (77.51)	1,029*** (231.9)	-11.67 (50.23)
age	-14.58*** (1.896)	-22.19*** (8.263)	-2.756** (1.160)
b_race	-162.4* (91.60)	2,051*** (228.5)	-23.49 (66.60)
exercise	-5.579 (22.11)	28.45 (65.87)	1.878 (10.49)
bmi_prime	154.9 (124.9)	686.4** (334.9)	-122 (80.93)
health	-1.984 (23.91)	-254.0** (104.5)	-12 (16.10)
knowledge	-119.8 (73.21)	-259.5* (133.3)	-40.24 (36.03)
prionutr	-63.25 (41.94)	-195.8 (151.6)	-13.06 (32.36)
priopric	-66.02* (34.63)	-533.6*** (193.6)	13.21 (24.61)
priotast	72.49 (53.48)	-160.2 (139.8)	53.83 (44.14)
prioease	7.986 (41.95)	530.2*** (115.0)	-47.96 (29.25)
lcdiet	-184.4** (93.07)	-992.9*** (335.4)	-191.5*** (70.56)
sex	-927.5*** (68.42)	-1,984*** (192.1)	-355.0*** (58.49)
Constant	3,898*** (448.1)	7,034*** (865.2)	2,218*** (301.7)
PredMean	2228.164 (580.777)	3371.163 (1549.89)	1601.396 (242.61)
PostProb	2,120 [0.425]	246 [0.046]	2,622 [0.526]
LClassMemb	1,638 [32.8%]	123 [2.5%]	3,227 [64.7%]
AvgPP	0.743	0.828	0.710

Robust standard errors in parentheses, Population proportions & percentages in brackets  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

According to these estimation results over 96% of consumers can be divided into one of two subpopulations (component 1 and 3). The mean intake for component 1 is within about 10% of recommendations while it is 400 calories (25%) lower for members of group 3. Consistent with the THANKS model, both women and individuals on weight-loss diets consume significantly fewer calories than others. The size of the coefficient on ‘sex’, however, is rather surprising because, for component 1, it is lower than the coefficient in the THANKS mode (-617.4) but higher than it is for component 3. Similarly, the coefficient on age is negative, but much smaller for component 3. The model for component 2 appears to fit the data quite well and many of the same coefficients from the THANKS model are also statistically significant. I can only speculate as to why non-high school graduates in group 2 eat much more than high school graduates while those in group 3 eat much less. Group 2 is quite different and consists of people consuming a large amount of calories.

**Table 19. FMM-Total Fat-Estimation Results**

<b>Variable</b>	<b>Component 1</b>	<b>Component 2</b>	<b>Component 3</b>
notgrad	-8.623*** (1.961)	30.23* (17.51)	-1.217 (3.150)
povcat	1.563 (1.740)	39.21** (16.85)	-7.529** (3.291)
age	-0.134*** (0.0378)	-0.549 (0.348)	-0.466*** (0.0677)
b_race	-1.21 (2.165)	98.32** (44.46)	2.732 (5.382)
exercise	0.648* (0.364)	-4.887 (3.317)	0.186 (0.617)
bmi_prime	-1.404 (3.463)	36.98 (31.14)	15.41*** (5.213)
health	-0.524 (0.618)	-7.333 (9.815)	0.301 (1.139)
knowledge	-6.935*** (1.569)	-18.45 (15.67)	-3.288 (2.207)
prionutr	-1.778 (1.182)	-4.992 (8.810)	-6.453*** (2.240)
priopric	0.158 (0.950)	-12.88 (16.48)	-0.967 (1.445)
priotast	2.472 (1.701)	-3.762 (21.55)	6.463*** (2.332)
prioease	-0.818 (0.927)	6.542 (6.499)	0.549 (1.444)
lcdiet	-7.100** (2.878)	-2.66 (48.64)	-14.78*** (4.393)
sex	-13.01*** (1.736)	-48.96*** (16.77)	-38.22*** (2.818)
Constant	91.72*** (10.45)	293.2** (126.1)	124.5*** (17.69)
PredMean	53.84 (10.04)	153.52 (53.53)	86.21 (23.41)
PostProb	2,459 [0.493]	269 [0.054]	2,260 [0.453]
LClassMemb	2,906 [58.3%]	160 [3.21%]	1,922 [38.5%]
AvgPP	0.734	0.836	0.773

Robust standard errors in parentheses, Population proportions & percentages in brackets  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1



For the total fat model, most consumer fell again fell into either component 1 or component 3. Based on their predicted means and the significant coefficients in each, respondents in class 1 appear to be more health conscious because they eat less fat and nutritional knowledge appears to have more of an impact on behavior. This may overstate the difference between the two groups, particularly among women, because the coefficients on lcdiet are much higher, and equally significant, for consumers in component 3. The coefficients on prionutr and priotast for component 3 are analogous to those found in the THANKS model but it is hard to know what to make of the large, positive coefficient on bmi\_prime. As in the calorie model, consumers in component 2 appear to be the least healthy but are also vastly outnumbered by the members of the other two classes. Group 2 consumes a large amount of fat.

Table 20. FMM-Carbohydrate-Estimation Results

Variable	Component 1	Component 2	Component 3
notgrad	-11.74 (9.015)	10.34 (45.03)	-24.53*** (7.112)
povcat	-2.133 (9.307)	118.6** (48.18)	-9.904** (4.851)
age	-1.782*** (0.202)	-3.141*** (0.898)	-0.303** (0.122)
b_race	-31.75*** (9.577)	96.09* (56.14)	-8.206 (7.284)
exercise	-0.238 (1.986)	-3.299 (8.348)	-0.317 (1.160)
bmi_prime	-25.81 (20.64)	-50.7 (63.11)	-3.047 (13.38)
health	5.048 (3.554)	-11.15 (20.75)	-3.032 (2.073)
knowledge	-4.593 (8.068)	-34.22 (22.18)	2.339 (4.812)
prionutr	-0.887 (5.368)	-21.32 (38.38)	-3.91 (4.231)
priopric	-9.882** (4.987)	-14.85 (31.23)	2.698 (2.773)
priotast	-7.229 (7.405)	31.59 (37.19)	2.88 (5.467)
prioease	3.713 (4.213)	53.36*** (17.20)	-3.52 (2.874)
lcdiet	-16.68 (10.52)	-99.44* (59.01)	-29.50*** (10.80)
sex	-101.6*** (8.642)	-209.3*** (37.78)	-33.05*** (5.573)
Constant	511.4*** (48.27)	695.8*** (187.5)	240.4*** (38.21)
PredMean	280.85 (63.53)	420.76 (149.81)	189.84 (25.38)
PostProb	2203 [0.442]	280 [0.056]	2505 [0.502]
LClassMemb	1,910 [38.3%]	136 [2.7%]	2,942 [59%]
AvgPP	0.745	0.838	0.727

Robust standard errors in parentheses, Population proportions & percentages in brackets  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

In the carbohydrate model, age turns out to have a significant and negative effect for all three subpopulations. Race and the priority of price are significant for component 1 but not above the 10% level for the other two groups. Poverty status is only significant for groups 2 and 3 but takes on opposite signs. Meanwhile, the priority of ease of preparation is significant for class 2 but not the others while lcdiet only predicts lower calorie consumption for members of component 3. Again, the coefficient on sex is significant and negative for all three subpopulations, which may simply be because women tend to be smaller, and thus have lower calorie requirements, than men. Group 2 also consumes more carbohydrates than others; group 2 just eats a lot of food.

Table 21. FMM-Cholesterol-Estimation Results

<b>Variable</b>	<b>Component 1</b>	<b>Component 2</b>	<b>Component 3</b>
notgrad	-16.71** (7.909)	39.17 (46.37)	18.03 (14.91)
povcat	-2.961 (6.322)	101.0* (55.24)	27.15** (13.82)
age	-0.0259 (0.131)	-2.052* (1.178)	-0.735** (0.330)
b_race	11.73 (7.538)	167.0*** (50.72)	36.73* (20.18)
exercise	1.466 (1.175)	-14.93* (9.031)	0.0307 (2.928)
bmi_prime	20.01 (12.49)	75.65 (106.4)	25.21 (24.81)
health	0.503 (2.177)	-57.55 (40.79)	6.053 (5.028)
knowledge	-13.57** (5.283)	-43.43 (44.43)	-15.38* (9.178)
prionutr	-8.320* (4.518)	-29.36 (45.62)	-12.63 (10.95)
priopric	4.139 (3.307)	-38.57 (33.19)	0.9 (8.003)
priotast	9.500* (5.511)	-8.014 (102.8)	13.48 (12.72)
prioease	-1.673 (2.983)	-9.581 (19.90)	0.691 (7.388)
lcdiet	-19.76*** (7.078)	-33.8 (88.47)	-22.58 (30.68)
sex	-51.96*** (5.175)	-205.5*** (70.78)	-122.7*** (22.36)
Constant	191.2*** (36.64)	1,282 (899.5)	416.9*** (69.81)
PredMean	157.1 (31.37)	568.9 (165.78)	332.9 (69.44)
PostProb	4,409 [0.884]	579 [0.116]	2,133 [0.428]
LClassMemb	2,786 [55.9%]	244 [4.9%]	1,958 [39.3%]
AvgPP	0.802	0.838	0.811

Robust standard errors in parentheses, Population proportions & percentages in brackets  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

At the time this survey was administered, nutrition authorities were recommending that Americans limit their cholesterol intake to fewer than 300 mg/day. By that measure, component 1, the largest of the three and the majority of the overall population, appears to be the healthiest of the three, based on its predicted mean. The significant, negative coefficients on lcdiet and knowledge are also indicative of a class of consumers that is rather health-conscious. Again, component 2 appears to be the least healthy but the estimation results do not provide much guidance as to why. It is interesting that the coefficient on povcat is positive for cholesterol among class three but the same coefficient is negative in the carbohydrate model. In addition to problems of being overweight, group 2 is also moving toward problems with cholesterol.

Table 22. FMM-Protein-Estimation Results

<b>Variable</b>	<b>Component 1</b>		<b>Component 2</b>	
notgrad	-6.420**	(2.586)	24.15	(19.08)
povcat	-0.116	(1.564)	24.7	(18.41)
age	-0.181***	(0.0490)	-0.894***	(0.289)
b_race	-3.222*	(1.803)	53.18**	(25.32)
exercise	0.169	(0.342)	-3.212**	(1.567)
bmi_prime	0.213	(3.058)	37.20*	(19.02)
health	-0.42	(0.562)	-7.772*	(4.347)
knowledge	-1.495	(1.248)	5.527	(8.297)
prionutr	0.352	(1.172)	-11.48	(11.07)
priopric	-0.58	(0.876)	-2.529	(4.238)
priotast	2.679*	(1.419)	-11.7	(14.93)
prioease	-0.686	(0.669)	-2.171	(3.491)
lcdiet	-0.791	(2.380)	-16	(10.38)
sex	-24.36***	(2.427)	-64.40***	(7.830)
Constant	92.54***	(11.47)	250.9**	(98.01)
Pred. Mean	72	(13.38)	116.03	(46.68)
PostProb	4,409	[0.884]	579	[0.116]
LClassMemb	4,713	[94.5%]	275	[5.5%]
AvgPP	0.925		0.822	

Robust standard errors in parentheses, Population proportions & percentages in brackets  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The fact that the protein model could only be decomposed into two subpopulations, one of which represents over 90% of the overall population, appears to support my assumption in the THANKS model that protein intake tends to vary much less than the other nutrients discussed above. As before, women eat less protein than men in both models and age tends to predict lower protein intake over time for both groups while African Americans in component 2 are predicted to eat quite a bit more. The negative coefficient on exercise for component 2 may reflect the fact that people who do not exercise have lower protein needs. The reason for the negative coefficient on notgrad is somewhat unexpected but it may simply reflect the income effect of not being able to afford as much meat as graduates.

### Conclusion

I performed an FMM analysis in an effort to statistically distinguish between heterogeneous groups of consumers who are part of a large subpopulation. My estimation results seem to show that there are, indeed, significant differences between these groups in terms of how their knowledge, beliefs, and preferences affect their nutrient intake. I cannot investigate the extent to which these customers vary in terms of their metabolism so I cannot comment on whether their behavior would be different if they had more dietary options available to them.

Regardless of whether current USDA recommendations are correct, it is certainly relevant to consider the different ways in which consumers might respond to new information or perceived risks. Otherwise, advice directed at the entire population may only have the intended effect on a portion of it. It would be ideal if publicly provided dietary advice were tailored and marketed to reach only the consumers who are likely to benefit from it.

This could also be taken as evidence against the claim that American eating habits are, and have been, inherently poor. Both the THANKS and FMM models appear to show that Americans were relatively close to USDA advice 15 years on and, given the slow pace of habit change and the obvious downsides to diet-related health problems, it is not obvious that habits should have gone in a different direction in the time period since. The fact that habits have not improved or gotten worse may mean that a large proportion of Americans have become discouraged from changing their eating habits altogether.

## **Chapter 5. Conclusion and Policy Implications**

Unfortunately, I do not know of any reliable methods for testing the hypothesis that public policy and major social institutions have affected consumer preferences drastically enough to give rise to obesity at the levels we now observe in 2016. In the pages above, I have explored the question indirectly by trying to understand the policy and institutional environment before, during, and after the onset of the U.S.'s obesity epidemic. The evidence from my analysis of American cookbooks shows that consumer preferences have, indeed, changed since the post-colonial period. Whether the change was for better or worse is difficult to ascertain without more information.

By replicating Butler's work, I have some further evidence that consumers respond to more abstract incentives than simply the price and taste of food. If that is the case, then the lack of consumer response to major health-related incentives appears all the more perplexing. Though increasingly popular, behavioral economics, too, has proven rather inadequate to the task of explaining the drastic uptick in rates of obesity.

The THANKS model, on the other hand, shows that, around 1994, American consumers were aware of, and responding to the incentives the USDA first began emphasizing in 1980, a period of about 14 years. Based on that finding, one might have predicted a levelling out in obesity rates. Instead, nearly as many years later, there is little reason to expect a reversal, or even halt, to current trends. Have consumers simply been lying to obesity researchers and themselves or are the tradeoffs required to make dietary changes really severe?

I offer a third explanation—that the government's decision to endorse a particular viewpoint was premature and has since evolved into an institutional environment which dissuades consumers from trying efficient, weight-reducing diets. This may help to explain the apparent heterogeneity among the subpopulations identified in the FMM models. While the federal government may have set the stage for the current state of affairs by endorsing one viewpoint, that alone is not sufficient to explain current obesity rates, but that endorsement has given rise to a variety of organizations who are economically invested in the credibility of that advice. As a result, the possibility for major changes in this policy area seems quite remote. Even if a policymaker wanted to change course, the backlash from individuals and groups with a long-standing

commitment to the USDA message would be immense. In light of this, the most obvious implication is that the McGovern Committee should have excused itself from weighing in on matters of diet and health altogether.

A significant change in policy may not lead to any improvement, either, because who says this time will be different? Most nutritionists have been busy studying the efficacy of USDA's message, not testing new hypotheses. Though I have discussed the more recent, strong evidence favoring the safety and efficacy of various 'new' diets, it would be foolish in the extreme to suggest that such evidence is sufficient to form the basis for dietary advice to be given to an entire country, especially one as large as the United States. What is really needed is better science related to obesity, among other diet-related health problems.

It seems the most effective policy solution would be for USDA advice, and that which resembles it, to somehow lose all the credibility it now enjoys. Until and unless some new, convincing scientific breakthrough occurs, Americans will continue struggling to lose weight or, understandably, become resigned to an unhealthy existence which at least allows them to derive pleasure from their food.

The empirical estimation, including the regressions and the three groups estimated from the data, showed that most Americans are following on average the 2,000 calorie diet with 50% of calories from carbohydrates. A few percent of Americans are clearly overeating relative to health needs, but not enough to explain the obesity epidemic. One possibility, then, is that the obesity epidemic is occurring because the low carbohydrate diet is not visible in the overall data. That is the point of the literature, theory, and estimation in this work. The present regime is not working, and the low carbohydrate regime has theory to suggest it and it might work. It should be tried.

## References

- Ackerberg, D. A. (2003). Advertising, learning, and consumer choice in experience good markets: an empirical examination. *International Economic Review*, 44(3), 1007–1040.
- Allen, B. (2001). Information as an Economic Commodity. *New Developments in Economic Theory*, 80(2), 268–273.
- American Diabetes Association. (Nov. 2013). History of Diabetes. Retrieved from <http://www.diabetes.org/research-and-practice/student-resources/history-of-diabetes.html>
- Arora, S. K., & McFarlane, S. I. (2005). The case for low carbohydrate diets in diabetes management. *Nutrition & Metabolism*, 2(1), 16.
- Asp, E. H. (1999). Factors affecting food decisions made by individual consumers. *Food Policy*, 24(2), 287–294.
- Atkins, R. C. (1972). Dr. Atkins' diet revolution; the high calorie way to stay thin forever. D. McKay Co.
- Atkins, R. C. (2001). Dr. Atkins' New Diet Revolution. HarperCollins.
- Aubrey, A. (2016). Souring On Sweet? Voters In 4 Cities Pass Soda Tax Measures. NPR. Retrieved from <http://www.npr.org/sections/thesalt/2016/11/09/501472007/souring-on-sweet-voters-in-4-cities-pass-soda-tax-measures>
- Banting, W. (1993). Letter on corpulence, addressed to the public. *Obesity Research*, 1(2), 153–163.
- Barzun, J. (1966). Science as a Social Institution. *Proceedings of the Academy of Political Science*, 28(2), 3. <http://doi.org/10.2307/1173523>
- Basciano, H., Federico, L., & Adeli, K. (2005). Fructose, insulin resistance, and metabolic dyslipidemia. *Nutrition & Metabolism*, 2(1), 5.
- Beales, H., Craswell, R., & Salop, S. C. (1981). The efficient regulation of consumer information. *Journal of Law and Economics*, 491–539.
- Becker, G. S., & Murphy, K. M. (1988). The Family and the State. *JL & Econ.*, 31, 1.
- Becker, G. S. (1992). Habits, addictions, and traditions. *Kyklos*, 45(3), 327–345.
- Bhattacharya, J. and N. Sood. “Who Pays for Obesity?” *Journal of Economic Perspectives* 25 (Winter 2011): 139-158.
- Blaylock, J., Smallwood, D., Kassel, K., Variyam, J., & Aldrich, L. (1999). Economics, food choices, and nutrition. *Food Policy*, 24(2), 269–286.

- Board, N. R. C. (U.S.) F. and N. (1966). *The Food and Nutrition Board: 1940-1965: Twenty-five Years in Retrospect*. National Academy of Sciences-National Research Council.
- Boden, G., Sargrad, K., Homko, C., Mozzoli, M., & Stein, T. P. (2005). Effect of a low-carbohydrate diet on appetite, blood glucose levels, and insulin resistance in obese patients with type 2 diabetes. *Annals of Internal Medicine*, *142*(6), 403–411.
- Brehm, B. J., Seeley, R. J., Daniels, S. R., & D'Alessio, D. A. (2003). A Randomized Trial Comparing a Very Low Carbohydrate Diet and a Calorie-Restricted Low Fat Diet on Body Weight and Cardiovascular Risk Factors in Healthy Women. *The Journal of Clinical Endocrinology & Metabolism*, *88*(4), 1617–1623. <http://doi.org/10.1210/jc.2002-021480>
- Brehm, B. J., Spang, S. E., Lattin, B. L., Seeley, R. J., Daniels, S. R., & D'Alessio, D. A. (2005). The Role of Energy Expenditure in the Differential Weight Loss in Obese Women on Low-Fat and Low-Carbohydrate Diets. *The Journal of Clinical Endocrinology & Metabolism*, *90*(3), 1475–1482. <http://doi.org/10.1210/jc.2004-1540>
- Brinkworth, G. D., Noakes, M., Buckley, J. D., Keogh, J. B., & Clifton, P. M. (2009). Long-term effects of a very-low-carbohydrate weight loss diet compared with an isocaloric low-fat diet after 12 mo.. *American Journal of Clinical Nutrition*, *90*(1), 23–32.
- Bryan, G., Karlan, D., & Nelson, S. (2010). Commitment devices. *Annu. Rev. Econ.*, *2*(1), 671–698.
- Buchholz, A.C., & Schoeller, D.A. (2004). Is a calorie a calorie? *American Journal of Clinical Nutrition*, *79*(suppl), 899S–906S.
- Butler, J.S. (1982). A Study of Participation in the Food Stamp Program and Allocation of the Household's Budget Using a Translog Utility Function Including Stigma (Thesis).
- Caballero, B. (2005). A nutrition paradox—Underweight and Obesity in Developing Countries. *New England Journal of Medicine*, *352*(15), 1514–1516.
- Caplin, A., & Nalebuff, B. (1992). Competition among institutions. Retrieved from <http://academiccommons.columbia.edu/catalog/ac:99781>
- Cawley, J. (2004). An economic framework for understanding physical activity and eating behaviors. *American Journal of Preventive Medicine*, *27*(3), 117–125.
- CDC. (2016). Heart Disease Fact Sheet. Retrieved from [http://www.cdc.gov/dhdsp/data\\_statistics/fact\\_sheets/fs\\_heart\\_disease.htm](http://www.cdc.gov/dhdsp/data_statistics/fact_sheets/fs_heart_disease.htm)



- CDC. (2015). Obesity and Overweight for Professionals: Data and Statistics: Adult Obesity – DNPAO. Retrieved from <http://www.cdc.gov/obesity/data/adult.html>
- Center for Nutrition Advocacy | Empowering Professionals to Transform Health Through Nutrition. (n.d.). Retrieved May 1, 2015, from <http://nutritionadvocacy.org/laws-state>
- Commission on Dietetic Credentialing. (2016). *State Licensure Agency List*.  
<https://www.cdrnet.org/state-licensure-agency-list>
- Cordain, L., & others. (1999). Cereal grains: humanity's double-edged sword. *World Review of Nutrition and Dietetics*, 84, 19–19.
- Cusumano, D. L., & Thompson, J. K. (1997). Body image and body shape ideals in magazines: Exposure, awareness, and internalization. *Sex Roles*, 37(9), 701–721.
- Cutler, D.M., Glaeser, E.L., Shapiro, J.M. (2003). Why Have Americans Become More Obese? *Journal of Economic Perspectives*, 17(3), 93–118.
- Cutler, D. M., Jessup, A., Kenkel, D., & Starr, M. A. (2015). Valuing Regulations Affecting Addictive or Habitual Goods. *Journal of Benefit-Cost Analysis*, 6(02), 247-280.
- Deb, P. (2012). FMM: Stata module to estimate finite mixture models. Retrieved from <http://econpapers.repec.org/software/bocbocode/s456895.htm>
- Dodd, L. (2011). Critical Thinking: Thinking Reflexively about a 'Problem Situation' [PowerPoint Slides]. Retrieved from <http://www.slideshare.net/loridodd/critical-thinking-2011>
- Davis, W. (2011). *Wheat Belly: Lose the Wheat, Lose the Weight, and Find Your Path Back to Health*. Rodale Books.
- Dulleck, U., & Kerschbamer, R. (2006). On doctors, mechanics, and computer specialists: The economics of credence goods. *Journal of Economic Literature*, 5–42.
- Eknoyan, G. (2007). Adolphe Quetelet (1796 1874) the average man and indices of obesity. *Nephrology Dialysis Transplantation*, 23(1), 47–51. <http://doi.org/10.1093/ndt/gfm517>
- Elliott, S. S., Keim, N. L., Stern, J. S., Teff, K., & Havel, P. J. (2002). Fructose, weight gain, and the insulin resistance syndrome. *The American Journal of Clinical Nutrition*, 76(5), 911.
- Emons, W. (1997). Credence goods and fraudulent experts. *The RAND Journal of Economics*, 107–119.

- Foster, G. D., Wyatt, H. R., Hill, J. O., Makris, A. P., Rosenbaum, D. L., Brill, C., ... others. (2010). Weight and metabolic outcomes after 2 years on a low-carbohydrate versus low-fat diet: A randomized trial. *Annals of Internal Medicine*, 153(3), 147–157.
- Foster, G. D., Wyatt, H. R., Hill, J. O., McGuckin, B. G., Brill, C., Mohammed, B. S., ... Klein, S. (2003). A Randomized Trial of a Low-Carbohydrate Diet for Obesity. *New England Journal of Medicine*, 348(21), 2082–2090.
- Fan, M., & Jin, Y. (2014). Obesity and Self-control: Food Consumption, Physical Activity, and Weight-loss Intention. *Applied Economic Perspectives and Policy*, 36(1), 125–145.
- FDA. (2014). Food Labeling: Nutrition Labeling of Standard Menu Items in Restaurants and Similar Retail Food Establishments Final Regulatory Impact Analysis FDA–2011–F–0172 . Office of Regulations, Policy, and Social Sciences Center for Food Safety and Applied Nutrition.
- Fisher, I., & Fisk, E. L. (1917). *How to Live: Rules for Healthful Living, Based on Modern Science*. Funk & Wagnalls Company.
- Feinman, R. D., & Fine, E. J. (2004). A calorie is a calorie" violates the second law of thermodynamics. *Nutr J*, 3(9).
- Feinman, R. D., Fine, E. J., & Volek, J. S. (2008). Analysis of dietary interventions. A simple payoff matrix for display of comparative dietary trials. *Nutrition Journal*, 7(1), 24. <http://doi.org/10.1186/1475-2891-7-24>
- Fiszman, S., Varela, P., Díaz, P., Linares, M. B., & Garrido, M. D. (2014). What is satiating? Consumer perceptions of satiating foods and expected satiety of protein-based meals. *Food Research International*, 62, 551–560.
- Fogel, R. (2004). Health Nutrition and Economic Growth. *Economic Development and Cultural Change*, 52(3), 643–658.
- Fox, Maggie. (2016, June 7). “America’s Obesity Epidemic Hits a New High”. NBC News. <http://www.nbcnews.com/health/health-news/america-s-obesity-epidemic-hits-new-high-n587251>
- Frederick, Shane, Loewenstein, George, & O’Donoghue, Ted. (2002). Time Discounting and Time Preference: A Critical Review. *Journal of Economic Literature*, 40(2), 351–401.

- Fung, T. T., Rimm, E. B., Spiegelman, D., Rifai, N., Tofler, G. H., Willett, W. C., & Hu, F. B. (2001). Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. *The American Journal of Clinical Nutrition*, 73(1), 61–67.
- Galizzi, M. M. (2014). What Is Really Behavioral in Behavioral Health Policy? And Does It Work? *Applied Economic Perspectives and Policy*, 36(1), 25–60.  
<http://doi.org/10.1093/aepp/ppt036>
- Gardner, C. D., Kiazand, A., Alhassan, S., Kim, S., Stafford, R. S., Balise, R. R., ... King, A. C. (2007). Comparison of the Atkins, Zone, Ornish, and LEARN diets for change in weight and related risk factors among overweight premenopausal women. *JAMA: The Journal of the American Medical Association*, 297(9), 969–977.
- Geanakoplos, J. (1992). Common Knowledge. *Journal of Economic Perspectives*, 6(4): 53-82.
- Gerstein, D. E., Woodward-Lopez, G., Evans, A. E., Kelsey, K., & Drewnowski, A. (2004). Clarifying concepts about macronutrients' effects on satiation and satiety. *Journal of the American Dietetic Association*, 104(7), 1151–1153.  
<http://doi.org/10.1016/j.jada.2004.04.027>
- Gregory, C., Rahkovsky, I., & Anekwe, T. D. (2014). USDA Economic Research Service- Calorie Labeling on Restaurant Menus—Who Is Likely to Use It?. Retrieved from <http://www.ers.usda.gov/amber-waves/2014-september/calorie-labeling-on-restaurant-menus%97who-is-likely-to-use-it.aspx>
- Grossman, M. (1972). On the concept of health capital and the demand for health. *The Journal of Political Economy*, 223–255.
- Grolleau, G. & BenAbid, S. (2001). Fair Trading in Markets for Credence Goods. *Intereconomics*, 36(4), 208–214.
- Guldbrand, H., Lindström, T., Dizdar, B., Bunjaku, B., Östgren, C. J., Nystrom, F. H., & Bachrach-Lindström, M. (2014). Randomization to a low-carbohydrate diet advice improves health related quality of life compared with a low-fat diet at similar weight-loss in Type 2 diabetes mellitus. *Diabetes Research and Clinical Practice*, 106(2), 221–227.  
<http://doi.org/10.1016/j.diabres.2014.08.032>
- Harcombe, Z. (2010). *The Obesity Epidemic: What caused it? How can we stop it?* Columbus Publishing Limited.

- Hefti, Elise Zugl. (2009) Economic Aspects and Implications of Obesity. Hamburg, Univ., Diss.
- Hirshleifer, J., & Riley, J. G. (1992). *The Analytics of Uncertainty and Information*. Cambridge University Press.
- Hite, A. H., Feinman, R. D., Guzman, G. E., Satin, M., Schoenfeld, P. A., & Wood, R. J. (2010). In the face of contradictory evidence: Report of the Dietary Guidelines for Americans Committee. *Nutrition*, 26(10), 915–924.
- Hite, A. H., & Schoenfeld, P. (2015). Open Letter to the Secretaries of the U.S. Departments of Agriculture and Health and Human Services on the creation of the 2015 Dietary Guidelines for Americans. *Nutrition*, 31(5), 776–779.  
<http://doi.org/10.1016/j.nut.2014.12.019>
- Hodgson, Geoffrey M. (2003). The hidden persuaders: Institutions and Individuals in Economic Theory. *Cambridge Journal of Economics*, 27(2), 159–175.
- Hodgson, G. M. (2004). Reclaiming habit for institutional economics. *Journal of Economic Psychology*, 25(5), 651–660. <https://doi.org/10.1016/j.joep.2003.03.001>
- Hodgson, J. M., Burke, V., Beilin, L. J., & Puddey, I. B. (2006). Partial substitution of carbohydrate intake with protein intake from lean red meat lowers blood pressure in hypertensive persons. *The American Journal of Clinical Nutrition*, 83(4), 780.
- Horner, J. (2002). Reputation and Competition. *The American Economic Review*, 92(3), 644–66.
- Hsieh, H.F. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, 15(9), 1277–1288. <http://doi.org/10.1177/1049732305276687>
- "Irving Fisher". (2008). The Concise Encyclopedia of Economics. Library of Economics and Liberty. Retrieved October 3, 2016 from the World Wide Web:  
<http://www.econlib.org/library/Enc/bios/Fisher.html>
- Jack, J. (2009). Lydia J. Roberts's Nutrition Research and the Thetoric of "Democratic" Science. *College Composition and Communication*, 61(1), 109–129.
- Jin, L., Kenkel, D., Liu, F., & Wang, H. (2015). Retrospective and prospective benefit-cost analyses of US anti-smoking policies. *Journal of Benefit-Cost Analysis*, 6(01), 154-186.

- Kenkel, D. (1991). What You Don't Know Really Won't Hurt You. *Journal of Policy Analysis and Management*, 10 (2): 304-309.
- Krauss, R. M., Deckelbaum, R. J., Ernst, N., Fisher, E., Howard, B. V., Knopp, R. H., ... Weinberg, R. (1996). Dietary Guidelines for Healthy American Adults. *Circulation*, 94(7), 1795. <https://doi.org/10.1161/01.CIR.94.7.1795>
- Laibson, D. (1997). Golden eggs and hyperbolic discounting. *The Quarterly Journal of Economics*, 443–477.
- Lake A & Townshend T. (2006). Obesogenic environments: exploring the built and food environments. *J R Soc Promot Health*, 126:262–7. <http://dx.doi.org/10.1177/1466424006070487>
- Lancaster, K. J. (1966). A new approach to consumer theory. *The Journal of Political Economy*, 132–157.
- Lancaster, K.J. (1991). Operationally Relevant Characteristics In *Modern Consumer Theory* (pp. 53-68). Brookfield, VT: Edward Elgar.
- Legg, C., Puri, A., & Thomas, N. (2000). Dietary restraint and self-reported meal sizes: diary studies with differentially informed consent. *Appetite*. 34(3), 235–243.
- Liebowitz, S.; Margolis, S. (September 2000). Bouckaert, Boudewijn; De Geest, Gerrit, eds. Encyclopedia of Law and Economics, Volume I. The History and Methodology of Law and Economics.
- Lindeberg, S., Jönsson, T., Granfeldt, Y., Borgstrand, E., Soffman, J., Sjöström, K., & Åhrén, B. (2007). A Palaeolithic diet improves glucose tolerance more than a Mediterranean-like diet in individuals with ischaemic heart disease. *Diabetologia*, 50, 1795–1807.
- Liu, P. J., Wisdom, J., Roberto, C. A., Liu, L. J., & Ubel, P. A. (2014). Using Behavioral Economics to Design More Effective Food Policies to Address Obesity. *Applied Economic Perspectives and Policy*, 36(1), 6–24.
- Luedicke, J. (2011). FMMLC: Stata module for postestimation with finite mixture models. *Statistical Software Components*.
- Lusk, J. (2013). *The Food Police: A Well-Fed Manifesto About the Politics of Your Plate*. Danvers, MA: Crown Forum.
- Lynch, Diahanna, and David Vogel. "The Regulation of GMOs in Europe and the United States: A Case-Study of Contemporary European Regulatory Politics." Apr 2001.

- Mailath, G.J. & Samuelson, L. (2001). Who Wants a Good Reputation? *Review of Economic Studies*, 68, 415–441.
- Marteau, T., Ogilvie, D., Roland, M., Suhrcke, M., Kelly M. (2011). Judging nudging: can nudging improve population health? *Bmj*, 342, 263-265.
- Mead, M. and others. (1964). Food Habits Research: Problems of the 1960's. *National Academy of Sciences, National Research Council. Publication 1225*. Washington, DC.
- NRC (1943). *Bulletin of the National Research Council*. National Research Council of the National Academy of Sciences. Retrieved from <https://books.google.com/books?id=8SUrAAAAYAAJ>
- Nelson, Phillip. (1970). Information and Consumer Behavior. *Journal of Political Economy*, 78(2), 311–329.
- Nevill, A. M., Stewart, A. D., Olds, T., & Holder, R. (2006). Relationship between adiposity and body size reveals limitations of BMI. *American Journal of Physical Anthropology*, 129(1), 151–156. <http://doi.org/10.1002/ajpa.20262>
- North, D. (1991). Institutions. *The Journal of Economic Perspectives*. 5(1), 97-112.
- Ogden, C. L., & Carroll, M. D. (2010). Prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1960–1962 through 2007–2008. *National Center for Health Statistics*, 6, 1–6.
- Ottaviani, M., & Sørensen, P. N. (2006). Professional advice. *Journal of Economic Theory*, 126(1), 120–142.
- Ozdenoren, E., Salant, S. W., & Silverman, D. (2012). Willpower and the Optimal Control of Visceral Urges. *Journal of the European Economic Association*, 10(2), 342–368.
- Palacios-Huerta, I., & Santos, T. J. (2004). A theory of markets, institutions, and endogenous preferences. *Journal of Public Economics*, 88(3-4), 601–627.
- Perlmutter, D., & Loberg, K. (2013). *Grain brain: The surprising truth about wheat, carbs, and sugar--your brain's silent killers*. Boston, MA: Little, Brown.
- Raftery, A. (1995). Bayesian Model Selection in Social Research. *Sociological Methodology*, 25, 111-163. doi:10.2307/271063
- R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

- Rolls, B.J., Hetherington, M., & Burley, V.J. (1988). The Specificity of Satiety: The Influence of Foods of Different Macronutrient Content on the Development of Satiety. *Psychology and Behavior*, 43, 145–153.
- Samaha, F. F., Iqbal, N., Seshadri, P., Chicano, K. L., Daily, D. A., McGrory, J., ... Stern, L. (2003). A low-carbohydrate as compared with a low-fat diet in severe obesity. *New England Journal of Medicine*, 348(21), 2074–2081.
- Sandford, J. A. (2010). Experts and quacks. *The RAND Journal of Economics*, 41(1), 199–214.
- Select Committee on Nutrition and Human Needs. (1977). *Dietary Goals for the United States*.
- Shea, M. K., Nicklas, B. J., Houston, D. K., Miller, M. E., Davis, C. C., Kitzman, D. W., ... Kritchevsky, S. B. (2011). The effect of intentional weight loss on all-cause mortality in older adults: results of a randomized controlled weight-loss trial. *American Journal of Clinical Nutrition*, 94(3), 839–846. <http://doi.org/10.3945/ajcn.110.006379>
- Shocker, A. D., Ben-Akiva, M., Boccara, B., & Nedungadi, P. (1991). Consideration set influences on consumer decision-making and choice: Issues, models, and suggestions. *Marketing Letters*, 2(3), 181–197.
- Simon, H. A. (1959a). Theories of decision-making in economics and behavioral science. *The American Economic Review*, 253–283.
- Shai, I., Schwarzfuchs, D., Henkin, Y., Shahar, D. R., Witkow, S., Greenberg, I., ... others. (2008). Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *N Engl J Med*. 2008 Jul 17;359(3):229-41.
- Siri-Tarino, P. W., Sun, Q., Hu, F. B., & Krauss, R. M. (2010). Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. *American Journal of Clinical Nutrition*, 91(3), 535–546. <http://doi.org/10.3945/ajcn.2009.27725>
- Skov, A. R., Toubro, S., Rønn, B., Holm, L., & Astrup, A. (1999). Randomized trial on protein vs carbohydrate in ad libitum fat reduced diet for the treatment of obesity. *International Journal of Obesity*, 23(5), 528–536.

- Sollid, Kris. (2015) "New Dietary Guidelines: What Changed & What Stayed the Same". Food Insight. Retrieved from: <http://www.foodinsight.org/new-dietary-guidelines-americans-2015-changes>
- Stern, L., Iqbal, N., Seshadri, P., Chicano, K. L., Daily, D. A., McGrory, J., ... Samaha, F. F. (2004). The effects of low-carbohydrate versus conventional weight loss diets in severely obese adults: one-year follow-up of a randomized trial. *Annals of Internal Medicine*, 140(10), 778–785.
- Stigler, G. (1945). The Cost of Subsistence. *Journal of Farm Economics*, 27(2), 303.
- Stigler, G. (1961). The Economics of Information. *Journal of Political Economy*, 69(3), 213–225.
- Stigler, G. J., & Becker, G. S. (1977). De gustibus non est disputandum. *The American Economic Review*, 67(2), 76–90.
- Strotz, R.H. (1955). Myopia and Inconsistency in Dynamic Utility Maximization. *The Review of Economic Studies*, 23(3), 165–180.
- Taubes, G. (2007). *Good Calories, Bad Calories*. Knopf Doubleday Publishing Group.
- Teicholz, N. (2014). *The Big Fat Surprise: Why Butter, Meat and Cheese Belong in a Healthy Diet*. Simon & Schuster.
- Thaler, R. H. & Shefrin, H. M. (1981). An economic theory of self-control. *The Journal of Political Economy*, 392–406.
- Thaler, R.H. & Sunstein, C. 2003. "Libertarian Paternalism". *The American Economic Review* 93: 175–179.
- Tirole, J. (1996). A Theory of Collective Reputations (with Applications to Corruption and to Firm Quality). *The Review of Economic Studies*, 63(1), 1–22.
- The Problem of Changing Food Habits Report of the Committee on Food Habits 1941-1943*. (1943). Washington, DC: The National Academies Press.
- Todd, J., & Morrison, R. M. (2014). USDA Economic Research Service-Less Eating Out, Improved Diets, and More Family Meals in the Wake of the Great Recession. Retrieved from <http://www.ers.usda.gov/amber-waves/2014-march/less-eating-out,-improved-diets,-and-more-family-meals-in-the-wake-of-the-great-recession.aspx?utm>
- Tullock, G. (1971). Public Decisions as Public Goods. *Journal of Political Economy*, 79(4), 913-918. Retrieved from <http://www.jstor.org/stable/1830840>



- U.S. Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group (Beltsville, MD). Continuing Survey of Food Intakes by Individuals 1994-96, 1998 and Diet and Health Knowledge Survey 1994-96. Documentation:  
[http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/csfii9498\\_documentationupdated.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/csfii9498_documentationupdated.pdf)
- U.S. Department of Agriculture, Economic Research Service, Food and Rural Economics Division. May 1999. *America's Eating Habits: Changes and Consequences* (Agriculture Information Bulletin (AIB) No. 750). Retrieved from:  
[http://www.ers.usda.gov/media/92736/aib750\\_1\\_.pdf](http://www.ers.usda.gov/media/92736/aib750_1_.pdf)
- Viscusi, W. K., Magat, W. A., & Huber, J. (1986). Informational Regulation of Consumer Health Risks: An Empirical Evaluation of Hazard Warnings. *The RAND Journal of Economics*, 17(3), 351. <http://doi.org/10.2307/2555716>
- Volckart, O. (2012). Institutional competition: a new theoretical concept for economic history. *Essays in Economic & Business History*, 17.
- Volek, J., Sharman, M., Gómez, A., Judelson, D., Rubin, M., Watson, G., ... Kraemer, W. (2004). Comparison of energy-restricted very low-carbohydrate and low-fat diets on weight loss and body composition in overweight men and women. *Nutrition & Metabolism*, 1, 13. <http://doi.org/10.1186/1743-7075-1-13>
- Wang, Y. et al. (2010). "Trends and Correlates in Meat Consumption Patterns in the US Adult Population." *Public health nutrition* 13.9: 1333–1345. PMC.
- Wang, Y. C., Pamplin, J., Long, M. W., Ward, Z. J., Gortmaker, S. L., & Andreyeva, T. (2015). Severe obesity in adults cost state Medicaid programs nearly \$8 billion in 2013. *Health Affairs*, 34(11), 1923-1931.
- Wansink, B. (2004). Environmental Factors that Increase the Food Intake and Consumption Volume of Unknowing Consumers. *Annual Review of Nutrition*, 24(1), 455–479.
- Witt, U. (2010). *Escaping Satiation: The Demand Side of Economic Growth*. Springer Berlin Heidelberg.
- Wolinsky, A. (1993). Competition in a Market for Informed Experts' Services. *The RAND Journal of Economics*, 24(3), 380. <http://doi.org/10.2307/2555964>

- Wright, L.T., Nancarrow, C, Kwok, P.M.H. (2001). Case study: Food taste preferences and cultural influences on consumption. *British Food Journal*, 103(5), 348–357.
- Young, D.S. (1993). "Occupational Licensing." The Concise Encyclopedia of Economics. Library of Economics and Liberty. Retrieved from <http://econlib.org/library/Enc1/OccupationalLicensing.html>
- Yancy Jr, W. S., Olsen, M. K., Guyton, J. R., Bakst, R. P., & Westman, E. C. (2004). A low-carbohydrate, ketogenic diet versus a low-fat diet to treat obesity and hyperlipidemia. *Annals of Internal Medicine*, 140(10), 769–777.
- Zajonc, R. B., & Markus, H. (1982). Affective and cognitive factors in preferences. *Journal of Consumer Research*, 123–131.

## JAMES WOODWARD

### EDUCATION

- University of Kentucky, Lexington, KY  
**Ph.D. in Public Policy and Administration** 2016 (expected)  
Dissertation: “American Obesity: Rooted in Uncertainty, Institutions and Public Policy”
- University of Kentucky, Lexington, KY  
**Master of public policy** 2012  
Capstone: “Nutrition Policy, Nonmarket Failure, and the Obesity Epidemic”
- Ohio University, Athens, Ohio  
**B.A. Economics** 2009

### RELATED EXPERIENCE

- Martin School of Public Policy and Administration, Lexington, KY  
**Research Assistant** 2013 – 2015
- Hazard Mitigation Grant Program, Lexington, KY  
**Research Assistant** 2011 – 2012

### PUBLICATIONS AND PAPERS

- The Role of Institutions and Rationality in the Emergence of an Obesity Epidemic*  
Presentation to the Ancestral Health Society, San Francisco, CA 2014
- A Report on Cannabis Legalization*  
Prepared for the Kentucky Commonwealth Council on  
Developmental Disabilities, with Seungjin Choi and Ed Jennings 2014
- Training for Health Personnel to Prepare to Deal Effectively with Individuals with Disabilities*  
Prepared for the Kentucky Commonwealth Council on  
Developmental Disabilities, with Elle Hull and Ed Jennings 2013

### LANGUAGES

- [English – native language]