WAITING FOR THE INVISIBLE HAND: BRAND NAMES, HABIT FORMATION AND DELAYED RESOLUTION OF UNCERTAINTY IN THE MODERN MARKET FOR FOOD

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ABSTRACT: In many ways, the modern market for food exemplifies the economist's conception of perfect competition, with many buyers, many sellers, and a robust and dynamic marketplace. But over the course of the last century, the U.S. has witnessed a dramatic shift away from traditional diets and toward a diet comprised primarily of processed brand-name foods with deleterious long-term health effects. This, in turn, has generated increasingly urgent calls for policy interventions aimed at improving the quality of the American diet. In this paper, we examine the question of whether the current state of affairs represents a market failure, and—if so—what might be done about it. We review evidence that most of the nutritional deficiencies associated with today's processed foods were unknown to nutrition science at the time these products were introduced, promoted, and adopted by American consumers. Today more is known about the nutritional implications of various processing technologies, but a number of forces—including consumer habits, costly information, and the market power associated with existing brands—are working in concert to maintain the status quo. We argue that while the current brand-based industrial food system (developed historically as a means of preventing competition from small-scale producers) may have its advantages, the time may have come to consider expanding the system of quality grading employed in commodity markets into the retail market for food.
Date revised: *December 8, 2008*[2]

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[2] Preliminary draft. Questions, comments, and suggestions are very welcome.

Introduction

Americans don't eat well. That is to say, the typical American diet is characterized by an excess of added sugars and other refined carbohydrates (blamed by a growing chorus of experts for epidemic levels of obesity and diabetes) and hydrogenated oils (similarly blamed for epidemic levels of heart disease), and by a dearth of beneficial nutrients such as dietary fiber, essential fatty acids, and various micronutrients. This hasn't always been the case, of course. Some 150 years ago, American households found sustenance in locally produced, freshly prepared, traditional meals—and the many "diseases of civilization" seen today were virtually unknown.

This modern transformation of the American diet was driven by a variety of market forces, many of which have been beneficial: improvements in transportation infrastructure, agricultural productivity, and food processing technology, have resulted in food products that—while perhaps less conducive to good health—are convenient and relatively inexpensive. Indeed, in light of the robust national market for food—with its many buyers and sellers and near-universal availability of a wide selection of products—it is tempting to view the U.S. market for food as exemplifying the virtues of a competitive market. While it may be true that the Western diet has unfortunate consequences for long-term health, why can't we presume that consumers have weighed these costs against the many benefits—price, taste, convenience, etc.—in choosing to consume it? This is an important question, given the ongoing public policy debate over what—if anything—should be done about the current epidemic of diet-related disease.

This question—in short, whether the nutritional *quality* of the modern American diet should be viewed as the natural outcome of an efficient market—is the subject of this essay. The answer we propose is somewhat novel (at least in mainstream economic analysis) in that we do not emphasize the usual sources of market failure, such as federal subsidies to agriculture or the moral hazard problem. Rather, we will argue that the market outcome we observe is the product of a costly information problem, which has been exacerbated historically by a number of key policy decisions.

This essay proceeds as follows: We begin with a brief review of the current state of knowledge in nutrition science, with special attention to the relationships between modern food processing technologies and various measures of nutritional value. We then proceed to examine the historical transformation of the American diet, with special attention to the lack of available information about the nutritional qualities of novel food products at the time they were introduced. This leads us to a consideration of the—somewhat formidable—forces that might prevent a market-based response to this new information. We conclude with a look at the historical developments that led to the modern dominance of proprietary brand-name food products, and ask how they might inform policy responses to diet-related public health problems.

Effects of Food Processing on Nutritional Quality

The effects of particular dietary constituents on human health are both more complicated—and less well-understood—than the popular conception of nutrition would suggest. Consider, for instance, the ongoing debate over dietary causes of weight gain. While some researchers point to the consumption of sugars and/or starches as a key consideration (Ludwig 2002), others blame dietary fat, and still others dismiss such measures of dietary *quality* and instead argue that weight management can be reduced to a simple accounting of *quantity*: calories in versus calories out.[3] To illustrate the complexity—and subtlety—of these positions and some of the evidence underlying them, consider first the so-called "glycemic hypothesis."[4]

Refined Carbohydrates and the Endogeneity of Caloric Intake

Proponents of the glycemic hypothesis suggest that rather than fats or sugars or calories, the most important dietary determinant of a number of chronic diseases (including obesity and diabetes) is *carbohydrate quality*, where quality is measured by blood sugar response in the minutes and hours following ingestion. Experimental studies have demonstrated that following consumption of refined carbohydrates[5], human subjects experience a predictable sequence of physiological events: first, blood sugar levels rise dramatically; followed by a proportional increase in circulating levels of insulin, which in turn induces a number of physiological changes that have the collective effect of bringing blood sugar back into the normal range (Figure 1). In extreme cases, this sequence of events can lead paradoxically to a period of *low* blood sugar many minutes or hours after the meal, during which the subject typically reports feelings of hunger or cravings for sweets. The strength of the glycemic response can vary from person to person, and no simple formula predicts the glycemic effect of a particular food, though it is known to vary with fiber content, particle size, preparation method, chewing speed, and even the combination of foods included in the meal (Ludwig 2002). Nevertheless, chronic consumption of low-quality (i.e., high-glycemic) carbohydrates has been shown in large epidemiological studies to be associated with insulin resistance (diabetes) and obesity.

This phenomenon, which has been documented repeatedly in both animal and human studies, is remarkable in part because it represents a clear example of the

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[3] This last perspective has been a favorite in economic studies of obesity, which have tended to focus on the influence of changes in (various measures of) the implicit "price of a calorie" on body weight (e.g., Cutler *et al*. 2003, Chou *et al*. 2004).

[4] We choose this example in part because it is, indeed, emerging as perhaps the leading candidate among competing dietary causes of obesity and diabetes (Taubes 2007).

[5] *Refined carbohydrates* are generally understood to include sugar- or starch-containing foods such as sugar, flour, and white rice that have been machine-processed to make them more easily digestible (Taubes 2007).

endogeneity of dietary intake with respect to dietary quality (i.e., the consumption of high-glycemic foods appears to cause people to eat more, *ceteris paribus*), and because a consumer who lacks schooling in the endocrinology of digestion might not correctly attribute his feelings of hunger to the carbohydrate meal ingested hours earlier. It also represents an instance in which food processing technologies appear to degrade nutritional quality: refined white flour, for instance, with its small particle size and lack of fiber (Table 1), tends to induce a stronger glycemic response than simple stone ground whole grain flour (Ludwig 2002).

Hydrogenated Oils, Omega-3 Fatty Acids, and Blood Lipids

Dietary fat, as you might expect, is also considerably more complicated than popularly understood. Although dietary fat (and perhaps, in particular, cholesterol and saturated fats) has long been blamed and as a leading cause of obesity and heart disease, there is now a growing consensus that total dietary fat intake has little demonstrable effect on health outcomes.[6] Rather, the strongest evidence from both clinical and epidemiological studies now points to *trans*-fatty acids—found in many margarines and vegetable shortenings—as the most important dietary cause of heart disease.[7] And again, *trans*-fats are primarily a product of industrial food processing: nearly all trans-fats in the American diet are the product of the partial hydrogenation of vegetable oils, a process that generates a chemically stable, low-cost substitute for lard and butter.

While there is widespread scientific agreement that human health is harmed by current levels of *trans*-fats in the U.S. food supply, there is also a growing body of evidence suggesting that health outcomes would be improved if another type of dietary fat—omega-3 fatty acids—were *more* widely consumed. Omega-3 fatty acids are one of two types of polyunsaturated essential fatty acids (the other being omega-6), distinguished by their chemical structures. Both are essential components of the diet (i.e., they are necessary to sustain human life, and neither can be synthesized by the human body from other compounds), and are thought to affect blood lipids in a way that decreases the risk of heart disease (Mensink *et al*. 2003). But omega-3 fatty acids are thought to be uniquely effective in preventing cardiac deaths (GISSI 1999, Leaf 2007, Yokoyama *et al*. 2007), which makes it

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[6] Taubes (2007) provides an excellent review of the scientific debate over the dietary causes of obesity, diabetes, and heart disease, which has been conducted historically on the basis of surprisingly weak evidence. Nevertheless, a consensus emerged—and was for a time incorporated into official U.S. dietary guidelines encouraging consumers to "eat sparingly" of fats and oils—because of a desire to convey a simple message to consumers, and perhaps also for reasons of political economy (Nestle 2007).

[7] *Trans*-fats have the singular ability to increase low density lipoproteins (the "bad cholesterol") while decreasing high density lipoproteins (the "good cholesterol") in the bloodstream. Epidemiological estimates suggest that eliminating *trans*-fats from the U.S. food supply could prevent between 6 and 19 percent of heart attacks and related deaths (Mozaffarian *et al*. 2006).

particularly unfortunate that they are in such short supply in the modern diet. While the pre-industrial ratio of omega-6 to omega-3 in the diet is thought to be on the order of 1:1, the modern ratio is around 11:1 (Eaton *et al*. 1997).[8] The reasons for this are related to the nature of omega-3s: found primarily in fish and green plants but also some nuts and seeds, omega-3 fatty acids are more susceptible to oxidation and spoilage than their omega-6 counterparts. For this reason, vegetable oils (such as soybean oil) containing significant amounts of omega-3s are not well-suited for use in mass-marketed processed foods (which often require long-term storage without refrigeration), and are typically hydrogenated (a process that preferentially destroys omega-3s, in addition to generating *trans*-fats) and used as shortening (Allport 2006). In other words, the shortage of omega-3s in the American diet appears to be yet another unfortunate—and apparently deadly—side effect of modern food processing technology.

Food Processing and the Consumer

It is worth noting that the examples we have outlined appear to have some generality: industrial food processing often has (perhaps unintended) negative effects on the nutritional properties of food. Heat treatment, to cite yet another example, is widely used to eliminate food-borne pathogens, and can dramatically reduce levels of valuable micronutrients in canned foods (Table 1), and (along with homogenization) negatively affects the flavor and other nutritional properties of fresh milk (Schmid 2003). The milling of grains, similarly, results in the isolation and removal of the (vitamin- and essential-fatty-acid-rich) germ and (fiber-rich) bran so that the (carbohydrate-rich) endosperm can be ground into white flour. The observation that findings in nutrition science continue to point to the role of food processing in virtually every diet-related illness has led some public health advocates to call broadly for a return to minimally processed, traditionally prepared foods (Willet 2005, Pollan 2008).[9]

It is also worth noting, however, the many real benefits of food processing technologies. By altering food in ways that improves its longevity and uniformity and—at least in the case of food-borne pathogens—safety, retail products can be marketed on a national or international scale, allowing producers to take advantage of economies of scale and the efficiencies (because more consumers have access to the wares of low-cost producers) of comparative advantage. Indeed, it might be

[8] Some researchers argue that the *ratio* of these two types of fats is more important than absolute intakes, implying that a reduction in omega-6 might be beneficial under current circumstances (see Allport 2006 for an extended discussion). Others, however, have failed to detect such an effect in epidemiological studies (Mozaffarian *et al*. 2005, Willett 2007).

[9] Pollan (2008) takes this logic one step further, declaring that nutrition science (or, more particularly, "nutritionism," the idea that nutritional value of foods can be reduced to a list of one or more individual nutrients) causes more damage to human health than it prevents, by focusing the attention of the consumer on nutrients or health claims when it might be more prudent to simply steer him to traditional foods.

argued that consumers see these benefits, in the form of lower prices and convenience and (perhaps) taste, and—having weighed them against the possibility of negative health effects—decided that the benefits exceed the costs.[10] It is to this question—i.e., whether current American dietary practice can be viewed as the efficient outcome of a free market—to which we turn our attention now.

Long-Term Health Effects and the Delayed Resolution of Uncertainty

It has long been known that when information (about price, availability, quality, etc.) is *costly* from the perspective of individual market participants, multiple equilibria can exist (e.g., Stiglitz and Weiss 1983). We suspect that readers of this essay already schooled in the particulars of nutrition science (and especially those with experience in the communication of this knowledge to the general public) will be unsurprised at our assertion that this is an appropriate way to model the typical American food consumer; and we hope that our discussion in the previous section will have convinced the rest. In other words, the complexities of nutrition science (a problem compounded by the dearth of information on food labels) make it difficult for the typical consumer to make informed judgments about the long-term health consequences of eating a particular diet. The implications of the resulting equilibrium selection problem are best illustrated by a closer examination of the history of the development and introduction of processed foods.

Consider, for instance, the history of canning. Invented by Nicolas Appert in 1802 to facilitate export and greatly expanded in the 1870s when new methods of packing under steam pressure large-scale canning and pickling feasible[11], it was the 1920s before the effects of canning on vitamin content began to become clear (Levenstein 1988).[12] Similarly, Gail Borden was awarded a U.S. patent for unsweetened condensed milk in 1856, a development historians now blame for the outbreak of "infantile scurvy" (now known to be caused by Vitamin C deficiency) in the last decades of the 19th century, a period during which the use of evaporated and condensed milk (in which most Vitamin C is destroyed by heat during

[10] This point is often made more or less explicitly in economic analysis of obesity (e.g., Cutler *et al*. 2003, Chou *et al*. 2004).

[11] The H.J. Heinz Company was among the first to take advantage of the new technology, soon claiming to produce "57 Varieties" of preserved foods. Heinz invested aggressively in advertising and promotion of its brands, including a popular display at the 1893 Chicago World's Fair (where more than one million attendees receive free samples and a green metallic Heinz pickle charm), a six-story-tall electrically illuminated sign (the first of its kind) in New York, and the opening of the Heinz Pier in Atlantic City in 1899). Another large player entered the scene in 1898, when J.T. Torrance developed a new method of condensing soups (making canned soups less bulky) and founded the Joseph P. Campbell Company, maker of Campbell's Soups (Levenstein 1988).

[12] Indeed, the very existence of vitamins was unknown prior to 1900.

processing) as food for infants increased dramatically (Jay *et al*. 2005, Kiple and Ornelas 2000).

Another processing technology that removes valuable micronutrients from food is the milling of grains to produce white flour, the industrial efficiency of which facilitated introduction of the Uneeda Cracker by the National Biscuit Company (known today as Nabisco) in 1899, and the aggressive campaigns by the Post and Kellogg's companies a few years later to convince Americans to give up the traditional egg- and meat-based breakfast in favor of cereals made from highly processed grains. That the consequences of these new products for human health were unknown at the time is underscored by the fact that the accompanying ad campaigns aggressively promoted them as *more healthy* and—the existence of microorganisms having been recently discovered—hygienic than traditional foods.[13,14]

Fortunately, once the source of the "diseases of malnutrition" caused by micronutrient deficiency was identified, the problem was resolved by replacing key nutrients after processing (though even this has been a slow process: while the first federal standard for the sale of "enriched" white flour was issued in 1941, it was amended as recently as 1998 to include folate—a dearth of which can cause birth defects). In other cases, health effects have taken longer to discern, and industrial adjustment may not be so easy. The hydrogenation of vegetable oils for use in shortening and margarine, for instance, was developed in Germany in 1903, leading to a 1910 U.S. patent for (and 1911 introduction of) Crisco, but the first studies demonstrating the effect of *trans*-fat on blood chemistry (and thus, presumably, heart disease) were not published until the early 1990s (Mensink and Katan 1990, Zock and Katan 1992, Judd *et al*. 1994), and the scientific consensus was not strong enough to warrant a new product labeling requirement until 2006. While the label law has spurred industry movement toward fully hydrogenated (and thus *trans*-fat-free) oils and saturated vegetable fats such as palm oil, public health advocates warn that these products may generate adverse health effects of their own.

Omega-3 fatty acids present an even more difficult problem. Though the shift away from omega-3s probably began with the advent of agrarian societies, it has almost certainly been accelerated (as noted above) by the switch to industrially

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A similar message was disseminated by the American Sugar Refining Company (the "sugar trust") in the 1880s, which successfully convinced the public that brown sugar was unsafe to eat. Between 1880 and 1915, per capita consumption of white granulated sugar doubled (Levenstein 1988). The conversion of brown sugar to white, of course, requires the removal of molasses and thus virtually all nutritionally valuable vitamins and minerals.

[14] Processing was not, strictly speaking, the only means by which nutritional quality was (inadvertently) diminished for the sake of industrial efficiency. Iceberg lettuce (a new variety introduced in 1903, the virtues of which included being "virtually indestructible" and thus suitable for long-distance shipment by train; see Levenstein 1988), for example, is—we now know—nutritionally inferior to heritage varieties such as Romaine by virtually any measure (Table 1).

processed foods in the early 1900s. The first reports suggesting any nutritional significance of the omega-3 family of fatty acids were not published until the 1970s (indeed the "omega" nomenclature for distinguishing omega-3 from omega-6 fatty acids was not even proposed until 1964), and though their putative role in the prevention of cardiac deaths was first reported in 1999, these findings were not replicated until 2007 (see above). Because of the inherent instability of omega-3s, it is not clear that these nutrients can easily be incorporated into processed foods (Allport 2006).

The lag between the introduction of new processing technologies and discovery of the nutritional changes may have been slow in the cases of heat treatment, hydrogenation, and fatty acid composition, but nothing compares with the problem posed by refined carbohydrates. Though millers have been creating ever-whiter flour (and rice growers ever-whiter rice) for thousands of years, the effects of refined carbohydrate on heart disease and body weight remain controversial even today. Indeed, while many researchers and practitioners have pointed to dietary carbohydrates (or more precisely, the *quality* of dietary carbohydrates) as a likely cause of heart disease and obesity over the past century, in recent decades they have been more or less relegated to the fringes of scientific discourse, at least until Ludwig's influential review article appeared in the *Journal of the American Medical Association* in 2002 (Taubes 2007). And even if this debate is resolved in favor of the glycemic hypothesis, it will remain true that glycemic effects are difficult to measure (they vary, for instance, from person to person, and upon such factors as the composition of other foods eaten in the same meal, chewing speed, and cooking time), making it difficult to see how the consumer could easily gauge the tradeoffs between particular products in the grocery store.

Current food processing technologies were originally adopted in part because they improved the cost-effectiveness of delivering food to consumers. But if the large food processors introduced (and consumers adopted) novel foods in the absence of information about long-term health effects, we might expect that new information about these health effects would induce, at the margin, a "market correction" of sorts, with consumer demand shifting toward a more traditional diet comprised of less highly processed foods.[15] The next section considers some of the forces that appear to be working against such a correction.

Waiting for the Invisible Hand

The current situation in the U.S. retail market for food can be summarized as follows:

[15] Pollan (2008) has argued this point most directly, advocating that consumers avoid processed foods altogether. Such appeals typically fail, however, to acknowledge the market forces underlying the problem, and tend to ignore the advantages of productive efficiency.

- It has become apparent that the typical diet has significantly deleterious effects on long-term health.
- These effects can, in large part, be traced to historical innovations in food processing technology.
- These effects were unknown to both producers and consumers at the time today's typical diet was adopted.
- It seems likely that if full information about health effects had been available at the time these foods had been adopted, then adoption would not have been so widespread.
- Uncertainty about the impact of particular diets or foods on human health remains; however, the picture emerging from modern nutrition science can be reduced to a relatively simple rule: a diet comprised primarily of traditionally prepared (i.e., minimally processed) foods is more likely to promote long-term health than a diet comprised primarily of highly processed foods.

As noted in the previous section, an equilibrium selection problem arises whenever search is costly. If we take as given that consumer search for information about the links between diet and health are costly—because time and literacy are required to understand the scientific evidence, because in many cases there remains disagreement between experts, or because information about nutrients or extent of processing are not found on food labels in an accessible form—then there will be an implicit bias toward the *status quo* diet, even when new information becomes available.[16] That this diet was originally adopted when it was generally thought to be *healthier* than traditional dietary practice suggests strongly that consumers, given the chance to start anew make the choice all over again, would give less weight to cost and convenience, and more weight to long-term health effects, than is reflected in current dietary practice.

It is impossible, however, to fully characterize the reluctance (or inability) of consumers to adjust to new findings in nutrition science without considering the producer side of the retail market. Consumer habits, after all, are presumably associated with particular foods, and more precisely—when it comes to the industrially processed foods that dominate the modern American diet—to proprietary brand names. Brand names convey market power (and hence, presumably, higher prices and greater profit) on the seller, providing an incentive to invest in process (and product) improvements, the infrastructure of the

[16] As an alternative our "costly search" nomenclature, this reluctance of the consumer to change his diet can be captured more concisely with a single word: *habit*. While this descriptor may be more consistent with the subjective reports of consumers, we emphasize the search framework because it suggests environmental parameters—such as the opportunity cost of time, education, and ease of access to information—upon which the strength of habits might be expected to depend. Our use of the term "habit" in the remainder of this essay should be viewed in this light. For more extended discussions of the notion that habits might be an optimal response to costly search, see, e.g., Becker 1996, Smith 2004, or Smith and Tasnádi 2007.

marketing system, and—most importantly—*promotion*. Advertising has played a critical role in the marketing of newly developed brand-name food products since the earliest days (i.e., around the turn of the 19th century) of the expansion of the U.S. retail foods market to a national scale (see, e.g., footnote 11), and it continues to do so today (Elitzak 2001). This is an important observation because it underscores a key asymmetry in the market for food that parallels the findings of nutrition science summarized in the previous section: while firms have a private incentive to invest in the promotion of processed (brand-name) foods, minimally processed (and thus, evidently, healthier) traditional foods are necessarily non-proprietary, so that no individual seller (of carrots, or lettuce, or tomatoes…) can fully recover benefits that might accrue from their promotion (including, but not limited to, campaigns to educate consumers about the health benefits of consuming such a diet). While there have been efforts to address this asymmetry with federal nutrition education campaigns and mandatory grower participation in marketing programs, these have been dwarfed by private investments in brand name advertising. Consumers Union (2005), for instance, estimates that total expenditures on the widely touted California and federal "5-a-day" program (advising consumers to eat a minimum of five servings of fruits and vegetables each day) in 2004 were less than 1/1000th of comparable expenditures on advertising by commercial sellers of foods and beverages over the same time period. Gallo (1999) uses a broader measure of public expenditures—all U.S. Department of Agriculture expenditures on nutrition education, evaluation, and demonstrations in 1997—still added up to less than 1/20th of advertising expenditures by food manufacturers.

Today's popular brand-name foods represent valuable profit streams for their producers, and it should not be surprising that these firms would be reluctant to alter product formulations in response to emerging scientific evidence on health outcomes, especially when such changes will almost certainly increase production costs, and might even be harmful with respect to consumer demand (if flavor or appearance are noticeably affected). This reluctance to change on the part of food manufacturers, together with engrained consumer habits, make it hard to argue that the market has reached—or will reach anytime soon—something approaching a "full information" equilibrium, reflecting optimal trade-offs between cost, convenience, and health outcomes. In the next section we consider the history of America's dominant brand-based model for marketing foods and beverages, consider implications for possible alternatives to the persistent information-based market failure evident in the current food system.

Is Branding Efficient?

At the supermarket, the consumer is faced with an interesting decision problem. Constraints of time and availability necessarily require that foods are chosen without detailed information about nutritional attributes or the potential for contamination with dangerous pathogens, not to mention the particulars of how products are grown, handled, and processed en route to the retail market.

Producers, of course, might have much of this information, but conveying it to the consumer is costly, and the resultant effects on demand (and hence profits) are not unambiguous.[17] One market-based solution to this problem is to rely on proprietary brand names. A firm's investment in the development and promotion of a branded good can serve as a credible signal of high quality, resulting in higher equilibrium prices for branded goods (Wolinsky *et al*. 1980, Klein and Leffler 1981, Nichols 1998, Milgrom and Roberts 1986).

There are inefficiencies associated with an unfettered brand-based system, of course. Prices are distorted upward by market power; money spent on advertising (around $26 billion in 2000, or 4% of the $660 billion consumers spent on food—up from $7.3 billion or 2.7% of consumer expenditures in 1980 (Elitzak 2001)) may be excessive from the perspective of social welfare, especially if it represents an "arms race" of costly signaling among producers; selection may be limited by the scale of the market; and in the absence clearly established labeling standards, producer-provided product information is likely to be of little use to consumers. This is in addition to the imbalance caused by the fact that non-proprietary (but nutritionally superior) traditional foods lack an equivalent source of funding for promotion.

Today's brand-based food economy has not always been seen as an inevitable outcome. In the early 1930s, when concerns about inconsistent quality in canned foods (including the notorious case of a druggist whose patent medicine killed seventy-three people in seven states; his only punishment under the existing law was a two-hundred-dollar fine), Congress considered updating the 1906 Food and Drug Act to include a quality grading system. Such a system would have established standards with respect to process and content for canned foods, resulting in federal "grades" (A, B, C, etc.) that could be placed on food labels by manufacturers who meet the standards. Though the large food processors of the time had initially supported a weaker measure that would have labeled substandard fare "Below U.S. Standard, Low Quality but Not Illegal" they came out strongly against more specific grading of high-quality foods, reportedly both because the proposed penalties for false and misleading advertising would preclude the use of extravagant health claims in marketing new products, and because proposed federal quality grading would diminish the importance of large advertising budgets and brand names (thus making it easier for smaller producers to gain market share). Another important voice speaking in opposition to these regulations was that of the mass circulation magazines (by the mid-1930s, the food industries had become their largest advertisers). The editorial boards of both *Good Housekeeping* magazine and *Ladies Home Journal* were forced into embarrassing reversals after initially expressing support for the bill. A weakened version of the bill (the *Food, Drug, and Cosmetic Act* of 1938) that did not include a strong grading system was eventually passed (Levenstein 1993).

[17] Akerlof's classic (1970) study was the first to examine market failure induced by adverse selection, noting that under some circumstances, a "lemons equilibrium" results, in which only low quality goods are sold.

A similar debate played out (mostly at the state and local levels) over the pasteurization of milk. Pasteurization ensures that fresh milk can be stored under refrigeration for extended periods of time without spoilage, and can prevent food-borne disease. But pasteurization is not the only option: milk can also be made safe by a combination of careful attention to hygiene during production and rapid distribution to the consumer. Shortly after the advent of commercial pasteurization in 1890, the Certified Milk movement was founded by H.I. Coit, who advocated against pasteurization because of its impact on both taste and nutritional value (though the latter claim was relatively unfounded at the time) (Jay *et al*. 2005). Nevertheless, local laws requiring pasteurization were enacted in many localities, beginning (with New York City) in 1910 (Levenstein 1988). The debate over whether to require pasteurization (as opposed to certification) to ensure the safety of fresh milk continued into the late 1930s, when a public relations campaign sponsored by large milk producers succeeded in establishing a widespread belief that raw milk is never safe to drink. Many states subsequently banned the sale of unpasteurized milk completely, making pasteurization the norm for interstate commerce (Schmid 2003).

Another important development in the history of American food came in 1973, when the Food and Drug Administration issued a regulation repealing the 1938 "imitation" rule prohibiting substantial changes to traditional foods without explicit notice (via the printing of the word "IMITATION" on the label). The move was endorsed by a coalition of large food processors, who presumably hoped to benefit from the sale of reformulated versions of traditional foods. This seemingly minor regulatory change has been blamed by some as leading to the dramatic subsequent rise in diet-related illness (Pollan 2008).[18]

Despite the ultimate predominance of branding as the primary means of communicating product quality to the American consumer, it seems reasonable—especially in light of the historical role evidently played by industry in the decision to rely on brands—to reconsider whether an expanded system of certification (including, perhaps, quality grading of processed foods—branded or not) could well generate a net gain in market efficiency. That certification might generate a Pareto improvement over the absence thereof is easy establish in theory, and depends on such factors as the costs and accuracy of monitoring, the extent to which standards are relevant to the concerns (including health outcomes) of consumers, and the impact of implementation on producer market power (Caswell and Padberg 1992, Crespi and Marette 2001, Masters and Sanogo 2002, Raynaud *et al*. 2005). Moreover, certification is already widely employed in the U.S. for organic production, and quality standards exist for seventy vegetables, and twenty-two fruits, and grading is used for red meats, fowl, and eggs (Dimitri *et al*. 1996).

[18] Ironically, the change was also supported by the American Heart Association, on the grounds that it would facilitate the reformulation of many foods to reduce levels of saturated fat.

Conclusion

In light of the historical development of processed foods in the absence of reliable information about their various adverse effects on human health, and the apparent role of industry in preserving the original brand-based system, certain aspects of the composition of the modern American diet can be characterized as representing a market failure induced by costly information. Policy mechanisms for correcting problems of this type include certification and grading, but the success of such policies in promoting consumer welfare will depend very much on the details of implementation. In light of the historical lag between the advent of various food processing technologies and confirmation of the resulting impacts on human health, a conservative approach to quality grading would emphasize process rather than nutrient content, with traditional methods receiving "higher" quality grades.

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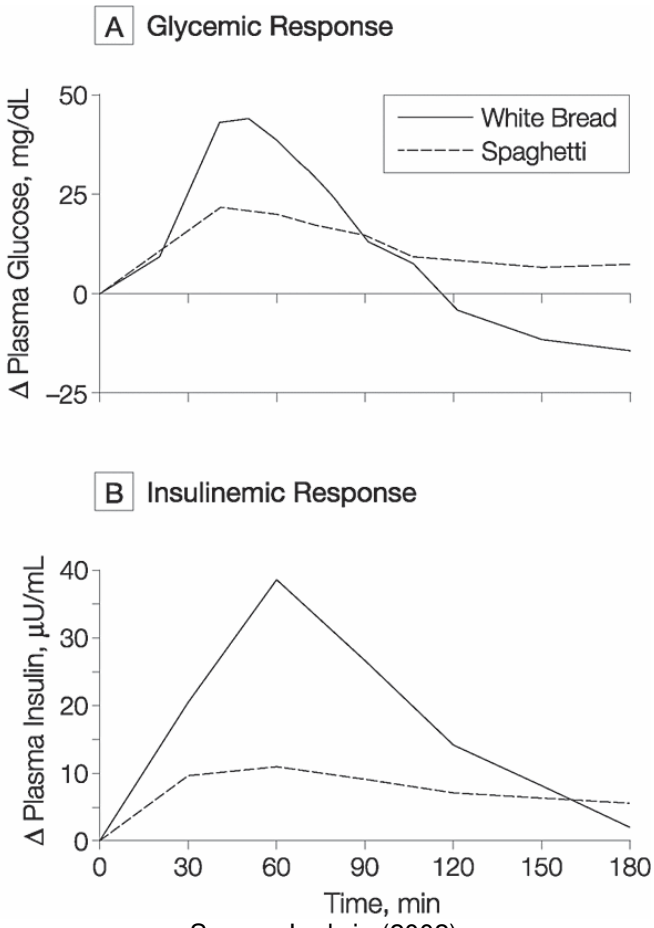
Tables and Figures

Figure 1: Carbohydrate Quality and Glycemic Response



Source: Ludwig (2002)

Table 1: Food Processing and Nutrition

Processed Food	Changes in nutritional quality induced by processing
Canned Tomatoes (relative to fresh)	27% decrease in vitamin C
	84% decrease in beta-carotene
	2760% increase in sodium
Dried Tomatoes (relative to fresh) (dry wt.)	27% decrease in vitamin C
	71% decrease in folate
White Flour (unenriched, relative to whole wheat flour)	78% decrease in fiber
	70% decrease in iron
	73% decrease in thiamine
	81% decrease in riboflavin
	80% decrease in niacin
	87% decrease in vitamin B-6
	41% decrease in folate
	63% decrease in monounsaturated fatty acids
	47% decrease in polyunsaturated fatty acids
White Flour (enriched, relative to whole wheat flour)	78% decrease in fiber
	63% decrease in monounsaturated fatty acids
	47% decrease in polyunsaturated fatty acids
White Rice (unenriched, relative to brown rice)	56% decrease in iron
	83% decrease in thiamine
	63% decrease in niacin
	72% decrease in vitamin B-6
	55% decrease in folate
	81% decrease in monounsaturated fatty acids
	84% decrease in polyunsaturated fatty acids
Canned Apples (sweetened, drained, relative to fresh)	29% decrease in fiber
	91% decrease in vitamin C
	47% decrease in thiamine
	62% decrease in riboflavin
	20% decrease in niacin
	19% decrease in beta-carotene
	200% increase in sodium
	44% increase in sugar
Iceberg Lettuce (relative to Romaine)	43% decrease in fiber
	58% decrease in iron
	35% decrease in zinc
	88% decrease in vitamin C
	43% decrease in thiamine
	63% decrease in riboflavin
	61% decrease in niacin
	43% decrease in vitamin B-6
	79% decrease in folate
	94% decrease in beta-carotene

Source: USDA and authors' calculations