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Consumer Acceptance of Biotechnology
Lessons from the rbST Experience

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Abstract

The controversial introduction of rbST, a laboratory version of bST, a growth hormone that stimulates milk production in cows, may provide hopeful lessons for other foods produced by biotechnology. Milk sales remained steady after rbST became available to dairy farmers, even though a multitude of public opinion surveys documented widespread concern about food safety and biotechnology, and some analysts predicted a drop in milk consumption of up to 20 percent. The undiminished consumer demand for milk may indicate that consumers will also accept other animal food products from biotechnology. The rbST experience suggests that, while scientific evidence of food safety will not prevent controversy over biotech foods, controversy will not necessarily inhibit consumer demand for the food.

Introduction

Potential consumer resistance to animal food products produced using biotechnology continues to raise uncertainty among analysts of the food system (Kinsey and Senaeur; Caswell et al.). Animal food products in particular raise concerns because consumer surveys seem to document less acceptance of genetic modification of animals than of plants. Examination of the widely publicized and analyzed introduction of recombinant bovine somatotropin (rbST) reduces the uncertainty over consumer demand for animal food products produced by biotechnology.

BST is a bovine growth hormone that occurs naturally in cows; rbst is bst produced by genetically altered bacteria in the laboratory. Laboratory-produced rbST, when injected into cows, increases their milk production.

Despite the uncertainty, research continues on genetic modifications of animals. In the not-too-distant future, commercially produced swine, sheep, and chickens may mature more quickly thanks to the addition of other species' growth genes. Cows may produce milk palatable to lactose-intolerant people (Krimsky and Wrubel, p. 195).

Clues to the future of animal food products from biotechnology may be found in the fervor surrounding the announcement of rbST contrasted with the ultimate stability in the milk market. Comparing survey evidence available before the commercial introduction of rbST with an econometric analysis of milk demand afterwards indicates that the survey evidence did not accurately predict the effects of rbST on milk demand.

The Road to rbST Approval

The technique used to develop bacteria that grow rbST was bioengineering, the transfer of genetic material from one species into another or the modification of the genetic material in a species in order to change the characteristics of the receiving or modified species. The resulting plant or animal is referred to as transgenic, if material was transferred, or bioengineered, for both modified and transferred material. One procedure used to transfer genetic material is also called recombinant DNA. The basic technology dates from the 1970's (Krimsky and Wrubel, p. 1).

The first report on the use of rbST to increase milk production appeared in 1982. In 1984-85, the Food and Drug Administration (FDA) ruled that milk and meat from rbST-treated cows in experimental herds were safe for human consumption and could be marketed. Some milk and meat from rbST-treated cows were then introduced into the food supply and were consumed throughout the controversy over rbST's final approval.

In the decade following, rbST was studied extensively. By 1993, more than 1,500 studies, books, professional papers, and surveys examined rbST and its implications. Virtually all scientific studies determined that rbST posed no danger to human consumption (Executive Branch).

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Backed by overwhelming scientific opinion that rbST was safe for human consumption, FDA approved general use of rbST in November 1993. Controversy continued. Consumer representatives at a May 1993 hearing sponsored by FDA described negative consumer reaction arising from a number of concerns, including fear of new technology, animal welfare, milk's link with children, and support of small-scale agriculture (Executive Branch).

During the decade before rbST's commercial availability, estimates of adoption rates varied widely, depending on the methodology of the study and assumptions about costs. The estimates ranged between 8 and 40 percent of U.S. producers using rbST on 6 to 90 percent of cows (Caswell et al.), because producers' decision to use rbST is complicated. Use of rbST can increase producer income from milk in excess of the cost of rbST applications. To increase production, however, producers must properly time rbST applications and adjust feed supplies to meet the cow's increasing nutrition requirements for added milk production. U.S. Department of Agriculture (USDA) expectations before FDA approval were for treatment of approximately 30 percent of cows by 1998. (Although estimates of rbST adoption as of early 1998 vary widely, probably 12 to 18 percent of cows are actually now treated with rbST.)

In response to consumer concern, Congress voted for a moratorium on rbST until February 1994. Public concern over rbST was strong despite a library of scientific evidence of its safety. Clearly, a conclusive body of scientific study confirming safety is insufficient to counter consumer concerns and prevent public controversy over future animal food products from biotechnology.

Surveys Attempted To Gauge Consumer Response

Consumer surveys taken in the years just before rbST approval documented consumer concern about the use of rbST as well as consumers' expressed intentions to reduce milk consumption if the product were approved. A widely cited study is Hoban and Kendall, a national telephone survey of 1,200 consumers conducted in early 1992.

The survey included questions about traditional cross-breeding, described as a way of moving genes between the same kind of plants or animals, and biotechnology, described as a way of moving genes between different kinds of plants or animals. A little more than half of the respondents were aware of cross-breeding; fewer were aware of biotechnology. Questions followed about the acceptability of cross-breeding and biotechnology. Fewer than half accepted biotechnology for leaner meat, increased milk production, food flavorings, or larger sport fish. Yet, more accepted biotechnology to increase milk production (rbST) than accepted traditional animal breeding.

Respondents were also questioned about specific types of genetic transfer between species. While 66 percent judged plant-to-plant transfers acceptable, only 39 percent found animal-to-animal transfers acceptable. Only 10 percent rated human-to-animal transfers acceptable. These results could forewarn of controversy over food products from transgenic animals based on moral issues.

Finally, a question rated confidence in government agencies' ability to regulate biotechnology effectively. USDA received the highest marks: over 80 percent had some or a lot of confidence in its ability. Slightly smaller proportions had the same confidence in the Environmental Production Agency (EPA) and FDA.

Others besides Hoban and Kendall have found consumer disapproval of traditional cross-breeding. In a survey of New Jersey consumers, Hallman found that two-thirds of respondents disapproved of hybrid animals and half found them "morally wrong." He also cited similar responses from an Office of Technology Assessment survey.

Clearly, the finding that consumers disapprove of traditional cross-breeding does not translate into refusal to purchase milk and meat from common farm animals, such as cows and pigs, which have been cross-bred for many years. More likely, it indicates a separation of consumer attitudes about plants and animals from attitudes about food due to a blurring of the link between production agriculture and food purchased by consumers.

In 1992, Smith and Warland summarized 11 consumer studies, including the Hoban and Kendall study. Averaging over all the studies, Smith and Warland concluded that 57 percent of respondents viewed rbST negatively. Smith and Warland noted an important caveat to all the survey results—the largely negative response was consistent with research findings that respondents with limited understanding of a situation in which they perceive some risk are more likely to focus on negative characteristics and information.

Based on the responses to multiple consumer surveys, analysts expected that farmers' use of rbST would trigger a 4- to 20-percent decline in consumption of fluid milk (Executive Branch).

Consumer Demand After rbST: Almost No Effect

When rbST was approved, survey evidence had created expectations of at least a temporary reduction in milk consumption. To determine whether the surveys had accurately predicted the future, tests on the effect of rbST on milk consumption were conducted using a model of fluid milk consumption originally developed to estimate the effect of generic fluid milk advertising (Blisard, Blaylock, and Smallwood). This model could gauge whether rbST had a negative effect that was offset by positive effects from other factors. The model, a single equation, uses average per capita consumption of fluid milk as the dependent variable and independent variables including advertising, time, season, price per half gallon of milk and average per capita income (both adjusted for inflation), and a series of demographic variables. The model is estimated using pooled time series and regional data: monthly data from December 1978 to September 1996 for 12 selected milk marketing orders, representing about 43 percent of milk sales in the United States.

Econometric tests found no effect of the introduction of rbST on aggregate fluid milk consumption.

Several hypotheses were tested (table 1). These tests found no effect of the introduction of rbST on aggregate fluid milk consumption.[1]

Before the introduction of rbST, some large supermarket chains announced that they would not sell milk from rbST-treated cows. Milk cooperatives (the wholesalers between producers and supermarkets) serving these chains allowed producers to self-certify that they did not use rbST. Some suppliers did label milk products, but the labeled products' share of the market was small. One Northeast chain of about 50 stores reported the market share of labeled rbST-free milk in its stores at 1.5 percent in the first year after FDA approval. However, most fluid milk was unlabeled so there were few (if any) visual reminders about rbST at the point of purchase.

[1] In all cases, F tests of the regressions described below, compared with the original model, were insignificant.

To examine changes in the market after the introduction of rbST, test 4, a test for a possible change in market structure, is the most meaningful because it simultaneously compared the intercept, slope, and coefficients on price, income, and other variables before and after the introduction of rbST. That none of these coefficients changed is consistent with little change in consumer purchases due to the presence of rbST in the market. Significant shifts within the market among grocery chains or between labeled and unlabeled milk most likely would not have left demographic, price, and income coefficients unchanged, particularly because labeled rbST-free milk generally cost more.

Other econometric results show no or minimal effects of rbST on milk demand. Kaiser found significant but very small negative effects on retail demand for fluid milk and cheese but positive, and large, effects on butter and frozen desserts. The positive effects on butter and frozen desserts raise the possibility that his rbST dummies might reflect some other interactions among variables. ERS runs of a modified version of Kaiser's model have not found significant effects of rbST on fluid milk demand.

Whether this apparent absence of rbST impact in the retail milk market occurred because consumers essentially trusted government regulation, were unaware of the introduction of rbST, or were not

Table 1. Hypotheses and tests of consumer reaction to rbST

Variable changes in model runs	Hypothesis tested
1. rbST dummies for intercept, price, and income variables from February 1994 to September 1996.	The actual sale of rbST caused consumers to reduce fluid milk consumption.
2. rbST dummies from November 1993 to October 1994.	The announced approval caused a temporary, 1-year reduction in consumption that disappeared over time due to experience of no negative effects.
3. rbST dummies from November 1993 through February 1994.	An "announcement" effect of the approval and Congressional action temporarily reduced consumption.
4. Sample divided in two parts before and after February 1994—no explicit rbST dummies.	The introduction of rbST changed the structure of the fluid milk market.

willing to incur the cost of making adjustments is uncertain. Habit and convenience (low transaction costs) are important determinants of food buying.

Why Little or No Effect? Theories of Consumer Behavior

In modern economic theory, information is costly to both the consumer and the producer; benefits must outweigh costs for its use or production. Beginning in 1961 with Stigler, who focused on price information, economists have been incorporating information into consumer demand theory.

Kevin Lancaster and Sherwin Rosen pioneered the consideration of goods as bundles of characteristics that could change with technology and innovation (Ratchford; Agarwal and Ratchford). Soon this characteristics approach was combined with Stigler's cost-of-information approach (Lynch and Schuler; Nelson; Darby and Karni) to form the economics of information theory (EOI).

The EOI literature distinguishes among search, experience, and credence characteristics. The consumer acquires information in each category differently, incurring different costs. Search characteristics include product cost, size of package, color, measurements of the product, and locations of sale. These characteristics can be determined prior to making the purchase, with some time costs of search. Experience characteristics, such as taste and durability, can be determined by consumption, or possibly through the testimony of friends and other sources, also at a time cost. Credence characteristics cover those that can never be determined directly by the consumer, even after consumption, such as nutrition of a food, expertise of a professional, and honesty of a repairman. Consumers may seek information on all three characteristics; sellers will try to provide such information through advertising, reputation, and other means. Third parties such as governments, professional associations, and consumer reporting services will also provide information, again with costs.

The most relevant question, based on EOI, is what milk characteristics consumers are actively considering in the decision to buy milk from rbST-treated cows. Surveys on consumer response to labels revealed that both possibilities for labeling—milk labeled either as from cows treated with rbST or not treated with rbST—created a perception of "difference" between the labeled milk and other milk. Most respondents who perceived a difference mentioned safety and contamination as potential differences (Westgate Research, Inc., 1993a, 1993b, 1994a, 1994b), indicating food safety concerns.

The guiding principle of Federal regulation of biotechnology is that the product, not the process of production, is regulated.

EOI offers an interesting interpretation of the consumer reaction to rbST. If the consumer concern over rbST involved mainly a food safety issue, it was a credence characteristic at the individual level. To evaluate the credence claim of safety, the consumer could either trust government regulation, at no cost, or research the rbST issue, at considerable cost in time. From this perspective, charging government agencies with the responsibility saves the costs of determining safety for the rest of society (Kuchler et al.).

Society as a whole experiences food safety issues differently than individuals do. If the whole milk supply, or food supply in general, is unacceptably risky, the incidence of disease will increase and become publicly known. Media reports on foodborne illness outbreaks, and their absence, are an important source of information to the consumer. Thus, EOI provides an explanation of the uninterrupted consumption of fluid milk after commercial availability of rbST. As a whole, consumers did not hear of negative experiences from milk consumption, and may have been comfortable relying on government regulation for unobservable food safety.

Federal Regulation of Biotechnology

RbST is an animal drug and was regulated as such by the FDA. Even though the regulatory process for animal drugs is different from that for foods, the result—unlabeled milk from rbST-treated cows—offers insight into consumer acceptance of future animal food products from biotechnology. Because milk from rbST-treated cows was determined to be safe and was not different from other milk, no special handling or labeling was required. (Milk from untreated cows could be so labeled.) In practice, most milk from treated cows cannot be identified by consumers. Unfamiliar terms on labels could have caused uncertainty and concerns over risk, as the Westgate surveys revealed.

The guiding principle of Federal regulation of food products from biotechnology is that the product, not the process of production, is regulated (Caswell et al.). Thus, products produced by biotechnology are judged by the same standards of protection of public health and safety as are other products. In 1998, continued use of the product principle may be smoothing the transition of a number of bioengineered plants into the food supply. Whether or not the principle will ease adoption of bioengineered animals into the food supply remains to be seen.

FDA regulates most food products (meat and poultry are regulated by USDA) and animal feed and drugs. FDA description of its approach to bioengineered plant food products reads in part:

> Based on our present knowledge of developments in agricultural research, we believe that most of the substances being introduced into food by genetic modification have been safely consumed as food or are substantially similar to such substances. There-

> fore, we do not anticipate that most foods developed by recombinant DNA methods will contain substances that require premarket approval as new food additives (FDA, 1995).

FDA has issued guidelines to the food industry on the circumstances in which consultation with FDA is recommended before marketing a bioengineered food product (Kessler et al.).

FDA does not require special labeling of a biotechnology-produced food solely on the basis of the process. FDA requires labeling of plant foods from biotechnology only when the food has been significantly altered from the traditional food. An example would be soybean oil with higher than naturally occurring levels of oleic acid that must be labeled "high oleic soybean oil" rather than simply "soybean oil."

When genetically modified meat and poultry enter commercial channels, they will be regulated by the Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture, whose policy on labeling of products from biotechnology is consistent with FDA's.

Conclusion

Four major lessons from the rbST experience offer future insight for animal food products produced with biotechnology:

1. Scientific evidence about food safety will not prevent controversy. As long as some consumers doubt the scientific evidence, biotechnological advances may create controversy.

2. Even intense controversy may have minimal or no effect on total consumer demand. Consumer demand for milk was unaffected, which suggests that other products could be similarly unaffected.

3. The absence of reports of harm from consumption contributes to continued consumption. Survey evidence indicates that consumers perceive biotechnology as a food safety issue and sometimes a moral issue. In the absence of reported harm, consumers continue purchasing the affected product.

4. The Federal Government's regulation contributes to continuing consumption.

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