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GMO Food Labels in the United States: Economic Implications of the New Law

John Bovay and Julian M. Alston

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Jill McCluskey and Justus Wesseler, Guest Editors

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John Bovay is Assistant Professor and Extension Economist, Department of Agricultural and Resource Economics, University of Connecticut, Storrs, Connecticut. Julian Alston is Distinguished Professor, Department of Agricultural and Resource Economics and Director of the Robert Mondavi Institute Center for Wine Economics, both at the University of California, Davis in Davis, California. He is also a member of the Giannini Foundation of Agricultural Economics.

1. Introduction

Genetically modified (GM) food has been controversial from the outset. Governments have responded to pressure from various non-government organizations (NGOs) by regulating the use of the technology. In many countries genetically engineered (GE) varietal technologies are effectively prohibited, and even in those countries that have most enthusiastically embraced GE varieties, such as the United States, they are subject to much more stringent regulatory oversight than the "conventional" varieties they might replace. Opposition to GE varietal technologies is also manifest in political pressures to require GM foods to be labeled as such. Unlike many other countries, in the United States the policy at the outset was one of voluntary labeling when GE crops were first released in 1996. Increasingly over time, however, we have seen political pressure building to introduce mandatory GE food labels, with formal policy proposals introduced in many states as well as federally.

Various consumer groups and NGOs have argued for mandatory labeling of GE foods in the United States, most often on the grounds of consumers' "right to know" what is in their food. However, many economists and others oppose mandatory labels on the basis of the scientific evidence demonstrating that genetic engineering poses no inherent threat or risks while bringing substantial benefits to producers, consumers, and the environment; and furthermore, because a market solution has emerged in the form of voluntary labels for non-GE food. Thus, they argue, mandatory labeling imposes a cost on the food industry, which will be passed through to consumers in the form of higher food prices and back to agricultural producers in terms of lower returns for their products, without providing tangible benefits (instead, providing a public disservice by falsely implying that GE foods are unsafe).

Nevertheless, in July 2016, the U.S. Congress passed Senate Bill 764, which requires the U.S. Department of Agriculture to establish a national disclosure standard for GE foods as a compromise between forces pressing for a much stricter labeling law versus forces that opposed mandatory labeling laws altogether. The legislation, now known as Public Law 114-216 or the National Bioengineered Food Disclosure Standard (NBFDS), also preempts states from setting their own standards for mandatory GE labels, and immediately nullified a state law to mandate GE labels in Vermont, which had entered force earlier that month.[1] Several other states had passed similar laws that had not yet come into effect; a patchwork of conflicting state requirements was expected to ensue and the new law also prevented this from happening.

In this paper, we first review the economic history of the political and policy processes that gave rise to the 2016 passage of PL 114-216, paying some attention to economic and scientific evidence and arguments, the role of NGOs and the media in promoting mandatory labeling policies, and the role of the food industry as an intermediary between consumers and farm producers. Next we discuss the implementation of the new law and its expected economic consequences. The relevant comparisons are with both a hypothetical scenario of no mandatory labeling laws as well as with the alternative future regime that the new law pre-empted, which would have entailed a patchwork of potentially more onerous state regulations.

We conclude that PL 114-216 is a clumsy and incoherent piece of legislation that will be burdensome to producers and, regardless of one's views on GE technology, will be limited in effectiveness and potential benefits. PL 114-216 is worse than a complete absence of mandatory labeling laws. However, it is likely to be much better than the likely scenario of policies that it

[1] PL 114-216 refers to the legislation; NBFDS may refer to the legislation or the pending regulations. For clarity, we use NBFDS when we refer to the pending regulations.

pre-empted, and could be reasonably inexpensive, depending on the implementation details of the new law—which are yet to be determined—and how producers and consumers choose to respond to it.

2. Background to PL 114–216: The GE Food Labeling Debate

Negative perceptions of GE technology are central to proposals for mandatory labeling requirements, whether mandatory labels are seen by the proponents as a way of enabling consumers to make better informed choices or simply as one more way to discourage a technology they dislike. Clearly, in spite of the overwhelming volume of scientific and economic evidence to the contrary, some people believe that GE technology poses significant potential risks to human health or the environment. However, even if labels on GE food are seen as providing information that is of interest to consumers for these reasons, it is hard for supporters to argue credibly that *mandatory* labels solve a market failure. First, the existence—and, indeed, proliferation—of voluntary labels on organic and other non-GE products raises the question of what value mandatory GE labels would provide to consumers seeking to avoid GE products and ingredients. Manufacturers adopt these labels voluntarily, and consumers can infer that products not carrying such labels may contain GE material.[2] So, there is evidently no information asymmetry that mandatory labeling would solve. Second, if GE foods posed a true (rather than an imagined) health threat, a more reasonable response by the government would be to ban the sale of food with more than a certain threshold of GE content, as it has done with regulated pesticides, microbial contaminants such as *Salmonella*, and will soon do with trans fats.

[2] Many products not currently certified to use Organic or Non-GE Project Verified labels under the current voluntary labeling system are likely to be subject to labeling under the NBFDS, unless the manufacturers pay for certification of their non-GE status.

Similarly, mandatory labels would be unlikely to mitigate any hypothesized environmental externalities. In sum, in reality GE foods and ingredients pose no threat to human health or the environment, and proponents of mandatory labeling have resorted to a "right to know" argument and the spread of misleading information to advance a political agenda, sometimes expressing straightforwardly a disdain for the large multinational corporations that produce GE seeds and the large-scale, high-tech commercial farms that are the main growers of GE crops. In this section, we discuss the participants in the debate over GE labeling and review the arguments for and against mandatory labeling.

2.1. Participants in the debate

Issues about regulation of GE food (or other food) are sometimes portrayed as consumers and their representatives, on one side, versus farmers and technology firms, on the other. But consumers and farmers are not really the main protagonists in the policy debate. As discussed and documented by Qaim (2016, pp. 145–163), NGOs such as Greenpeace and Friends of the Earth have been the leading protagonists of policies to ban or regulate the use of GE technologies in farming and food production around the world. These organizations cast themselves as the representatives of consumers and the environment in this and other contexts, lead campaigns about the claimed implications of GE technologies for human health and the environment, and engage in political action to block the use of the technology—including the political processes that led to the various state-level GE labelling propositions and initiatives and ultimately the introduction of PL 114-216 in the United States.

These organizations are highly effective in these roles. They have successfully demonized Monsanto and other technology companies who have been the leading and most visible (and not always politically astute) protagonists for GE technologies; they have sought to discredit other

proponents of the technology in academia and government; and they have effectively shaped public perceptions of GE technology and GE foods along with the technology companies who make them possible. Consequently, the debate about GE labels has gone much the same way as the broader debate about regulation of GE technology. The media have served as an accomplice in this process—perhaps unwittingly or naïvely—given their propensity to emphasize bad news and give it "front page" coverage (such as falsehoods about the negative impacts of GE technologies on farmer suicides or Monarch butterflies or cancer risk) and an asymmetric comparative inattention to stories that report the less dramatic good news or that counter the falsehoods (see, e.g., McCluskey and Swinnen 2004).

The food industry is also a key player both in shaping policy and responding to it. In the debate over Proposition 37, for example, various elements of the food industry joined biotechnology firms in financing the "No" side, while organic food producers and retailers led in financing the "Yes" campaign (California Secretary of State, 2017). More subtly, whether consumers as such have an opportunity to exercise a choice between GE foods and non-GE foods is determined to a great extent by food manufacturers in deciding what foods to produce and retailers in deciding what foods to stock and offer to consumers.

The role of the food industry as an intermediary between consumers and farmers was analyzed by Saitone, Sexton and Sumner (2015) and their analysis is particularly pertinent to GE foods. Even when it is legal to produce and sell GE foods, with or without specific labels, the food manufacturing and retailing industry might be persuaded by the prospect of political action by anti-biotech activists that it will be against their interest to do so. Consequently, when retailers like Walmart and Safeway opt not to sell milk unless it is labeled as not having been produced from cows treated with rBST, we have no information about consumer preferences for

rBST milk; likewise, when McCain and McDonald's opt not to produce consumer products using GE potatoes (Charles, 2015; McCain Foods, 2015). Repeated protests against Monsanto and NGO campaigns promoting the misinformed view that genetic engineering poses risks have likely dissuaded food manufacturers and retailers from expanding the production and sale of GE food products.

2.2. Pro and con arguments

Van Eenenaam et al. (2014) summarize the main arguments made for mandatory labeling, on the "pro" side, and against it on the "con" side. Some important elements of differences in views expressed in the public debate can be traced to different perceptions of the scientific and economic "facts" in terms of the actual and potential value conferred by the technology, and the risks associated with its use. On these questions, the overwhelming weight of the economic and scientific evidence is favorable to the technology (e.g., Brookes and Barfoot 2013; Klümper and Qaim 2014; Qaim 2016). While some of the opposition is based on a rejection of this evidence, other elements of the debate do not turn on these "facts," which we take as given.

Proponents of mandatory GE labeling typically claim that consumers have the "right to know" whether the foods they purchase were produced using genetic engineering, and that this "right" justifies mandatory GE labels, even if we have no scientific basis or other reasonable justification for wanting to know whether GE ingredients were used to make the product (see, e.g., Caplan, 2015; Hamblin, 2015; Gostin, 2016; Just Label It Campaign, 2017). Whether mandatory GE labels would improve the information status of consumers is disputed on the grounds that a mandatory labeling requirement would arbitrarily single out a particular technology for specific attention and would signal falsely to consumers that the presence of GE

ingredients is of material importance, and could mislead them into thinking that they should be concerned about the presence of GE ingredients (e.g., see Marchant, Cardineau, and Redick, 2010; Alston and Sumner 2012; Qaim 2016; Sunstein 2016).

Proponents also typically claim that mandated labels would enhance the range of choices available to consumers. But, as argued by Alston and Sumner (2012) and Bovay and Alston (2016), at least some of them have a broader aim, to demonize and effectively ban the crops. For example, in an article posted on his business website, Joseph Mercola (2012), a prominent supporter of mandated labels, explained:

> Personally, I believe GM foods must be banned entirely, but labeling is the most efficient way to achieve this. Since 85 percent of the public will refuse to buy foods they know to be genetically modified, this will effectively eliminate them from the market just the way it was done in Europe.

Indeed, in those countries where such policies are enforced, it is difficult to find foods in retail outlets bearing GE labels; instead, as in Europe, those foods that would require labels have been effectively eliminated (see, e.g., Gruère 2006), though GE products are still nevertheless used in livestock feed since this use is generally allowed without requiring the livestock products to be labeled. In other words, typically, mandatory GE labeling acts as a de facto ban on those GE foods that would require labels (but not on all GE foods, since many would not be subject to the regulation) and significantly discourages the production of GE crops that would be used to make those foods, which would mean reducing rather than enhancing the choice available to consumers (see, e.g., Bovay and Alston 2016).

Some proponents of mandatory labeling laws (e.g., Taleb et al., 2014) may also raise arguments about the inherent uncertainty with GE technologies, and advocate the application of the "precautionary principle" in view of the potential for irreversible costs as grounds for

singling out GE technologies for regulation.[3] But if the precautionary principle or any other decision criterion like it is to be applied to regulate the use of agricultural technology it is reasonable to think it ought to be applied equally to other technologies and not exclusively to GE technologies. Moreover, even if arguments based on the precautionary principle were pertinent to the regulation of the use of GE technology, they are not really relevant to the question of whether food produced using that technology should be labeled as such.

Opponents of mandatory labeling contest whether the "right" to know exists as such (e.g., Kalaitzandonakes 2004) and point out that if consumers really do demand food to be segregated and labeled according to its GE content, the market can provide that service and will do so (appropriately) at a cost to those who demand it, through voluntary labeling (see, e.g., Marchant, Cardineau, and Redick 2010). Indeed, the market is already meeting such demand in two ways: first, by providing food explicitly labeled as having been produced in ways that avoid (or seek to avoid) the use of GE ingredients—in many cases certified as such through the third party Non-GMO Project;[4] and second, by providing organic food, which satisfies the non-GMO requirement while also meeting other demands. Voluntary labels provide consumers with information while preserving or enhancing the choices available to them. Mandatory labels would have the opposite effect.

[3] Countering that argument Wesseler (2007) coined the "Santaniello Theorem of Irreversible Benefits" in honor of Vittorio Santaniello.

[4] The Non-GMO Project was started by two cooperative grocery stores in 2005 and certifies food as "Non-GMO" (Non-GMO Project, 2014). A full list of requirements producers must meet to achieve certification can be found at the organization's website, http://www.nongmoproject.org. See Bovay et al. (2017) for a more complete discussion of the Non-GMO Project Verified label.

Other arguments against mandatory labeling include that the policy could impose significant costs on farmers, the food industry, consumers, and taxpayers that would not be offset by benefits.[5] The forms and size of these costs would depend on the details of the policies (i.e., the specific rules and regulations) and how consumers and the farm and food industry would respond. On the production side these costs would include elements related to enforcement and compliance, including segregation of GE and non-GE ingredients and foods produced with them, or reformulation of foods to avert the labeling requirement. Some of these costs would be passed on to consumers in the form of higher food costs and reduced choice, and to those concerned about the natural environment because farmers would become more reliant on chemical pesticide technologies. Ultimately, as discussed by Alston and Sumner (2014), producers, consumers, and society as a whole, worldwide, would bear ever-increasing long-run costs because investment in innovative genetic technologies would be stifled.

Mandatory disclosure of the presence of GE material is more costly than voluntary claims that the production process avoids the use of GE technology. Under a voluntary labeling regime, as existed prior to the passage of PL 114-216, the cost of labeling is borne by the firms that use labels to distinguish their product, seeking to extract a premium—i.e., firms that are selling "non-GE" foods, labeled as such.[6] Under mandatory disclosure, the burden falls on everyone—the

[5] Sunstein (2016) outlines the possible methods for interpreting the costs and benefits of mandatory GE labeling, and concludes that the benefits to consumers are based on a misunderstanding of the science, and that the "right to know" does not bring benefits that outweigh the costs to producers.

[6] As shorthand, throughout this paper, we use the term "non-GE" to refer to products that have verification requirements related to inspection of premises and procedures and testing, with some allowance for adventitious presence of GE material at low rates (say < 1%). The NBFDS regulation is very likely to allow for such an approach to defining "non-GE" products such that producers of foods with small amounts of GE material can avoid having to making disclosure statements.

marketers of GE products as a cost of adding the required labels, and the marketers of non-GE products to verify that their products do not need labels.

3. The Genesis of PL 114–216

The United States has been the global leader in the development and adoption of GE crop technology, and has been comparatively slow to adopt mandated GE labels, consistent with the broader international patterns and the political economy rationale offered by Bovay and Alston (2016), drawing on Gruère, Carter and Farzin (2009); see, also Zilberman (this issue). However, in recent years many proposals for mandated GE labels have been made. This movement parallels the worldwide trend as the number of countries with mandatory GE food labels has increased from none before the European Union first introduced its labeling policies in 1997, to more than 40 having some kind of GE food labeling requirement by 2006, and now at least 65 countries including the United States (see, e.g., Gruère and Rao, 2006; Qaim 2016).

In the European Union, mandatory labeling of some foods containing GE ingredients has been in place since 1997 (Regulation EC No 258/97). Regulations EC No 1829/2003 and EC No 1830/2003 expanded the regulation of GE labeling and use in the EU. Regulation EC No 1829/2003 requires authorizations for use of GE products as food or feed. Labels are not required for products from animals that have been fed GE feed or food produced using a GE processing aid, but they do cover products that are not intended for food or feed, such as corn intended for use as a biofuel or products designed to be used ornamentally, such as flowers. Processed products with at least 0.9% GE content are covered by the labeling requirement. Farmers, processors, and buyers are required to maintain written records to trace the presence of GE material and ensure that products containing GE material can be appropriately labeled.

3.1. Policy timeline

As discussed by Bovay and Alston (2016) and documented in detail by Van Eenennaam et al. (2014), at least 25 U.S. states have considered proposed legislation to require GE labeling. Five statewide initiatives requiring labeling were not supported by a majority of the voters, specifically: in Oregon in 2002 (Measure 27), in California in 2012 (Proposition 37), in Washington in 2013 (Initiative 522), in Colorado in 2014 (Proposition 105) and in Oregon in 2014 (Measure 92).[7] Four other states have passed legislation mandating GE labels, which in three of the four never took meaningful effect for various reasons. An Alaskan law (passed in 2005) requires labeling of GE fish sold in the state, and federal legislation passed in 2015 required the U.S. Food and Drug Administration (FDA) to develop labeling guidelines for GE fish before such fish can be sold in the United States. In 2013, Connecticut and Maine passed bills with limitations (e.g., one bordering state and four other states with a total population collectively exceeding 20 million people would have had to enact similar labeling rules).

The first unconditional GE labeling law was passed by the Vermont legislature and signed into law in May 2014. Act 120 came into effect on July 1, 2016, but allowed a grace period of six months for products distributed before that date, and was overturned by federal legislation within a month. This was a broad GE labeling law, with general coverage of food containing GE ingredients sold for consumption at home, similar in scope and form to California's Proposition 37 and the other state-specific initiatives. We discuss the detailed

[7] In November 2016, in the same election that legalized the recreational use of marijuana in California, Sonoma County, California, voted to join its contiguous neighbors, Marin County and Mendocino County, in banning the cultivation of GE crops. County-level restrictions on the cultivation GE crops are also in place in Humboldt County, Trinity County, and Santa Cruz County, California, and were in place in Maui County, Hawaii County and Kauai County, Hawaii before a federal judge overturned the Hawaii restrictions in November 2016 (Law Library of Congress, 2015; Associated Press, 2016; McClurg, 2016).

requirements for labeling under Act 120 below.

Beginning in 2015, various bills were introduced in the Senate and the House related to labeling of foods produced using GE. One of these, the Safe and Accurate Food Labeling Act of 2015, passed the House of Representatives by a vote of 275–150 on July 23, 2015. A related bill was rejected by the Senate, 48–49, in a cloture vote on March 16, 2016. The Safe and Accurate Food Labeling Act of 2015 would have preempted states from developing mandatory GE labeling requirements, and at the same time would have established national standards for both voluntary non-GE and voluntary GE label claims. In both the House and the Senate, the bill was supported mostly by Republicans, with a few Democrats voting for passage and a few Republicans voting against.

A few months later, under pressure as a result of the ongoing implementation of Vermont's Act 120, lawmakers reintroduced the Senate bill with extensive revisions; a compromise was necessary to gain the requisite 60 votes in the Senate. This compromise bill retained the preemption of state regulations but did not establish a voluntary national standard for non-GE claims, instead implementing a mandatory disclosure standard for certain foods containing GE ingredients. S.B. 764 passed the Senate by a vote of 63–30 on July 7, 2016 and passed the House by 306–117 a week later, and was signed into law as PL 114-216 by President Obama on July 29, 2016.

3.2. Elements of proposed policies

Among the various statewide initiatives, California's Proposition 37 was seen by many as significant because of California's economic importance within the nation and the potential domino effect on other states if California were to lead the way. Even though it failed in 2012,

Proposition 37 has served as a model for other states in many ways, and subsequent initiatives in other states have contained similar provisions, which along with those in Vermont's Act 120 are indicative of both what might be expected under federal regulations to come, and what might have developed state-by-state, albeit piecemeal, in the absence of federal regulations.

Proposition 37 would have required labels for food and beverages purchased for home consumption if they were "or may have been entirely or partially produced" with genetic engineering. Foods and beverages containing any amount (after a phase-in period) of a genetically modified ingredient would have required a label indicating that the product was "Partially Produced with Genetic Engineering" or "May be Partially Produced with Genetic Engineering." Raw agricultural commodities (e.g., those that are not frozen or canned) would have had to be sold with the words "Genetically Engineered" displayed on the package or, if not packaged, on the shelves or bins on which those foods are stored.

Importantly, more than two-thirds of food products consumed in California would have been exempted, arbitrarily, from the labeling requirement, regardless of whether they contained GE ingredients or were made from ingredients produced using GE technologies. These exempted products including food consumed away from home (i.e., in a restaurant or other "food facility");[8] foods consisting of or derived entirely from animals;[9] beverages containing 0.5% or

[8] Food away from home accounted for 49.1% of the total value of food consumption (not including alcohol) in the United States in 2012 (Elitzak and Okrent, 2017).

[9] Meat, poultry, fish, eggs, and dairy products accounted for 32.4% of food-at-home expenditures (not including alcohol) in the United States in 2012 (BLS, 2015).

higher alcohol content;[10] foods certified as organic.[11] Similar exemptions apply in places that already have mandatory GE labels, albeit with some variation among them. For instance, in the EU, labels are not required for foods produced with the use of GE processing aids, nor for foods derived from animals that were raised with GE feed (European Parliament, 2003a). Likewise, Vermont's Act 120 exempted from the labeling requirement alcohol and food served in restaurants as well as any other unpackaged, ready-to-eat foods, foods derived from animals that were raised with GE feed, and foods manufactured using GE processing aids such as enzymes (taken together, these last two provisions exempted cheese, which is important to Vermont).

Another crucial dimension of the policy is tolerance for adventitious presence of GE products. Many countries that have mandatory labeling laws have some reasonable tolerance—say, 0.9% by weight, as in the EU, or 5% as in Japan (European Parliament, 2003b; Umeda, 2014). Under California's Proposition 37, after a phase-in period, the tolerance was to be reduced from 0.5% to zero, although food certified as organic could contain GE material and still be exempt from the GE labeling requirement. As discussed by Alston and Sumner (2012), compliance with a zero-tolerance rule could be very difficult and costly, even if GE and non-GE production systems were entirely segregated, which is in itself costly.

The Vermont law, Act 120, required that products sold in Vermont be labeled if they were entirely or partially produced with the use of GE technologies. Manufacturers would have been fined $1,000 per day, per product, if improperly labeled items were offered for sale, regardless of

[10] Alcoholic beverages accounted for 12.2% of the value of all food and alcohol consumption in the United States in 2012 (Elitzak and Okrent, 2017).

[11] Organic products accounted for over 4% of all food sales in 2012 (Greene, 2016). To have their products certified as organic, producers must not intentionally use GE inputs. However, organic certification does not require testing for GE content (see, e.g., Alston and Sumner 2012, USDA−Agricultural Marketing Service, 2011).

whether the manufacturer had intended for the products to be distributed in Vermont. Like the EU standard and the Non-GMO Project standard, the threshold for labeling would have been 0.9% GE ingredients, by weight. To prove that their products did not require labels, producers would have had to either obtain sworn statements from suppliers about the non-GE status of ingredients, or have a third-party organization verify the status of finished products. Although some producers introduced GE disclosure statements in 2016, apparently in anticipation of the Vermont law, other producers announced (at least privately) that they planned to cease distributing products to Vermont, which contains about 0.5% of the U.S. population.

The mechanism for enforcement of the NBFDS is yet to be determined, but the legislation (PL 214-116) prohibits USDA from recalling food on the basis of NBFDS violations. Proposition 37 explicitly authorized consumers to sue for violations of the labeling requirements, "without needing to demonstrate that any specific damage occurred as the result of the alleged violation." As discussed by Alston and Sumner (2012), this clause would have opened the door to a new cottage industry for lawyers suing manufacturers and marketers and settling out of court. Vermont Act 120, Vermont Consumer Protection Rule 121, and the state's consumer protection statute (9 V.S.A., Chapter 63, Sec. 2461) appear to permit similar activities, although the language is less explicit. If federal regulations permit consumers to sue for violations of the NBFDS, this will add tremendous costs for industry; in any event, state-level regulations mirroring the NBFDS are likely to emerge under which, as in California, consumers can sue marketers even without alleging damages.

4. Implementation of PL 114–216

In this section we discuss the implementation of the new law, including the likely timing and the form the policy will take, and the nature of the change in policy in practice. The first step is to define likely future GE labeling rules and regulations under PL 114-216 compared with those that would be likely to apply otherwise.

4.1. Regulatory requirements

PL 114-216 requires that some food products bear a disclosure statement if they contain "genetic material that has been modified through in vitro recombinant deoxyribonucleic acid (DNA) techniques; and for which the modification could not otherwise be obtained through conventional breeding or found in nature."[12] This disclosure statement need not be explicit on a label; the legislation allows manufacturers to use a text statement, a symbol (presumably, a uniform symbol to be developed by USDA), or a QR code readable by smartphones, accompanied by text simply stating: "Scan here for more food information." This QR code will direct users to a website where information about the food's GE content will be available. Some alternative compliance options will be available for small manufacturers.

Similar to California's Proposition 37 and Vermont's Act 120, PL 114-216 exempts food served in restaurants and similar retail food establishments; organic food is automatically considered non-GE; and animals may be raised on GE feed without their products having to be labeled as GE. Beyond these broad (and conventional) exemptions, the definition of products for which GE labels will be required is convoluted. In the United States, food labels are regulated by the Food and Drug Administration (part of the Department of Health and Human Services) and

[12] This is a specific and somewhat limited definition of bioengineering that excludes new technologies such as CRISPR and TALEN.

the Food Safety and Inspection Service (part of the Department of Agriculture). Generally speaking, FSIS oversees meat, poultry, meat and poultry products, egg products, and catfish, while FDA oversees everything else.[13] Keeping these definitions in mind, PL 114-216 applies only to foods for which the predominant or second-leading ingredient is regulated by FDA, and to products for which the predominant ingredient is broth, stock, water, or a similar solution. So, for example, a package of beef kebabs marinated with a solution including GE high-fructose corn syrup would require a GE disclosure statement; whereas a package of mixed beef and lamb kebabs marinated with the same solution would not.[14]

The Congressional legislation, PL 114-216, leaves several aspects of the NBFDS to be determined by USDA before July 2018:

The threshold for labeling of GE content. 0.9% GE content, by weight, has emerged as the leading standard as the threshold for labeling requirements or non-GE claims, used by the EU and the Non-GMO Project. Establishing the federal standard at 0.9% would ensure that products could be marketed using the same label claims in both the United States and Europe.[15] A lower threshold than 0.9% could create the awkward situation where a product qualifies for the Non-GMO Project Verified standard but also must be labeled with a GE content disclosure statement—unless the Non-GMO Project changes its rules. For these various reasons, it seems likely that USDA will select 0.9% as the threshold for mandatory disclosure of GE content.

[13] The details are even more complicated. See FDA (2016), page 106.

[14] At this point in time, it remains unclear what roles FDA and USDA will play in enforcing the NBFDS standards. Presumably, each agency will retain authority over the foods it generally regulates. Consistency of enforcement and penalties for noncompliance may differ across agencies.

[15] Although the packages may differ between the United States and Europe, for other regulatory reasons as well as because of language, a standardized threshold tolerance would improve the ease of traceability.

The process for verifying that disclosure statements are not required. Who will enforce the label requirements? Will that agency randomly test products to verify compliance, or randomly audit manufacturers' records? Or will they only respond to complaints from consumers or consumer-advocacy groups or competitors? What records will manufacturers be obliged to keep to document that they do not have to label products as containing GE ingredients?

Consequences for non-compliance. The legislation (Sec. 293(g)(4)) states that the USDA "shall have no authority to recall any food… on the basis of whether the food bears a disclosure that the food is bioengineered." The USDA also may not fine manufacturers or retailers for non-compliance. States will be able to adopt the language of the federal disclosure requirement as part of their state laws. If they do so, will they choose to force recalls of improperly labeled products or levy fines as enforcement strategies?

Exemptions from verification or testing. Will products that do not use ingredients for which GE varieties exist have to undergo testing, on grounds that they might be contaminated with the residue of GE ingredients used elsewhere in a processing facility? If such products are exempt from testing, would the exemption apply only to single-ingredient foods, such as oatmeal or pears? Or would it apply to all processed foods that did not list among the ingredients species with GE varieties in use?

4.2. Verification of non-GE status and enforcement

Bovay et al. (2017) discuss the drawbacks of third-party verification of label claims, and argue that government intervention in setting standards, verifying claims, and enforcing penalties can improve understandability, credibility, and truthfulness of label claims. The role of government in enforcing standards under the NBFDS is still to be determined. Will the federal

government allow private, third-party certifiers to take primary responsibility for verifying that GE disclosure statements are not required? If so, will these third parties be accredited, and how will the accreditation process work? How will USDA formally exempt foods that meet those standards and allow for the possibility of competition within the non-GE certification and labeling space?

Related to verification, the mechanism for enforcement of the NBFDS is yet to be determined, and many issues may arise as USDA develops the regulations that are to be enforced. If products are found to have incorrect or missing labels or disclosure statements or QR codes that link to broken or outdated websites, will the producers be obliged to withdraw those products from the market? Will FDA have the authority to police QR codes and websites, and will it exert that authority? The legislation precludes USDA from ordering recalls of improperly labeled foods. Will states be able to order recalls, or will FDA? What will be the penalties for noncompliance? How will they be set and enforced, and by whom?

Will states have the authority to enforce the NBFDS? If so, and if some states choose not to invest resources to investigate whether products have been properly labeled and to enforce the law, the effective result is that a patchwork of standards will emerge. Although the resulting patchwork of standards will be more uniform than the patchwork that would have been likely to emerge absent PL 114-216, it does seem likely that products marketed only in regions without strong enforcement will be able to avoid the mandatory disclosure requirement.

All of these unresolved issues raise serious questions about the enforcement of the NBFDS and, indeed, whether the law will effectively incentivize producers and marketers to comply. If federal regulators do not have any authority to enforce the law or cannot impose

penalties for noncompliance, all pressure on manufacturers will come from state governments—who are authorized by USDA to pass state-level standards for mandatory GE labeling identical to the NBFDS—and possibly from private entities bringing complaints against manufacturers for non-compliance. In this case, the market effects could be similar to those anticipated under the regulatory patchwork that would have resulted without the new national law, albeit with harmonization of standards for GE labeling across states, and increased costs for federal bureaucracy.

4.3. Issues regarding understandability, credibility, truthfulness

GE labels do not refer to the product itself, but rather to the production process by which the product is made. This is a credence attribute that cannot be verified by the consumer. Bovay et al. (2017) suggest that, in order to be effective, labels related to credence attributes must be understandable, credible, and truthful. Credibility and truthfulness of the mandatory disclosure statements are not substantial issues, chiefly because many (or most) consumers are unlikely to prefer to buy GE foods; marketers will not falsely use "made with GE" claims in an effort to increase market share. However, the requirements laid out in the legislation do not ensure that the mandatory disclosure statements will be broadly understandable.

If it transpires that the dominant response by food manufacturers to the NBFDS is to add smartphone-readable codes to product labels, directing users to websites, the information status of consumers may not change materially. First, the legislation does not specify whether manufacturers and food marketers will be required to maintain individual websites for each product. Perhaps they will not, and most products will be labeled with a code directing users to a generic website stating, for instance: "This product may contain genetically engineered

ingredients."[16] If, in an abundance of caution, all manufacturers were to apply the claim "may contain GE material" to all their products, the quality of information provided to consumers might actually be lower than in the prior regulatory environment—i.e., absent mandatory disclosure or state-mandated labels. Alternatively, if in practice the NBFDS does not allow manufacturers to direct consumers to generic websites or does not allow them to hedge their bets by issuing vague statements like "may contain" for all products, then who will enforce the NBFDS and ensure that claims are truthful? This relates to credibility, also. Will consumers realize that "may contain GE" is an empty albeit possibly negative statement?

The response of consumers to "may contain GE" labels and "Non-GMO Project Verified" labels or other labels such as "GMO Free" and "made using genetic engineering" is likely to be asymmetric, and dependent on the details of the wording and other information provided, and the shopping context, as discussed by Bovay et al. (2017), drawing on Liaukonyte et al. (2013) and Liaukonyte, Streletskaya, and Kaiser (2015). These findings suggest an important role for USDA to ensure that mandatory disclosure statements under the NBFDS do not needlessly frighten consumers. As the FDA has done for milk packaged with the claim "made from cows not treated with rBST," the USDA could recommend standard language indicating the scientific evidence on the safety of genetic engineering technology and products made using GE.[17] In addition, unlike a package label, a website has no corresponding space limitations. Hence, in conjunction with other information about the appropriate interpretation of the labels, the government could also provide language that would inform consumers about the basic definition of genetic engineering

[16] "May contain" is a blanket statement that can be applied to any product, whether it contains GE material or not.

[17] Even with such language included, milk processors and retailers have shied away from milk that does not include the label claim "made from cows not treated with rBST," so milk without that label is no longer widely available to consumers—a cautionary tale for those who think such labels are innocuous if accompanied by advice about the relevant scientific evidence (An and Butler, 2012).

and the advantages of GE technology. This would improve the provision of information to consumers and limit confusion and misinformation resulting from mandatory disclosure statements.

5. The Likely Economic Consequences of PL 114–216

In this section we discuss the likely economic consequences of the new law, compared with other possible realities. The relevant comparisons might be with both (1) the previous regime, prior to the passage of PL 114-216, and the alternative future regime that the new law pre-empted, including a patchwork of potentially more onerous state regulations, as well as (2) the hypothetical scenario of an absence of any such mandatory labeling requirements but permitting voluntary labeling in some form. We outline a range of consumer and producer responses, discuss how costs of the regulation could be determined, and compare the costs with both alternative realities.

As outlined in the preceding section, many of the details of the policy and government's role in enforcing that policy remain to be determined. At this point, therefore, attempting to quantify precisely industry and consumer responses to the NBFDS is a fruitless exercise involving many unknown unknowns. We now outline a range of possible industry and consumer responses and identify the most likely responses based on the available evidence.

5.1. Industry response to consumer and marketer demands

The responses of firms to the NBFDS are likely to depend on consumers' demands for information about GE content, whether the mandatory disclosure statements draw consumers toward non-GE products, and the anticipated response of competitors to the NBFDS and any induced changes in consumer demand. If consumers are indifferent toward information about GE

content or the disclosure statements (there is a subtle distinction here), then firms may find that the best strategic response to the NBFDS is to disclose GE content, according to the legal requirement, but not to change anything else about operations or marketing. A range of other responses by firms is possible, including reformulation of products to avoid having to label them as containing GE ingredients, by replacing those ingredients with non-GE ingredients produced using conventional technology or with organic ingredients—noting that to be eligible to be labeled as organic, and thus exempt, all the ingredients would have to be organic not just those that were GE.

Consumers may differ in their preferences among these different alternative products (i.e., GE labeled as such; conventional non-GE, with no label; conventional non-GE, labeled as such; and organic, labeled as such), and might even disagree about the ranking of them from their perspective as prospective buyers. While some might be willing to pay a premium for GE products with a smaller environmental footprint (in that GE products are typically grown with less use of toxic pesticides) or because, globally, they reduce world hunger and allow for the use of less land for agriculture, it seems likely that a majority of Americans would have a lower willingness-to-pay for GE-labeled products than the others in the current context.[18] Consequently, producers and sellers are likely to prefer not to have to label products as containing GE ingredients.

[18] The newest generation of GE crops promise differences in terms of finished products with regard to diminished browning and carcinogen content, and future GE crops may have improved nutritional benefits. However, we suspect that few consumers are willing to pay more for the vast majority of GE products available today. It is worth noting that in an unpublished paper describing the results of economic experiments in several grocery stores, James et al. (2005) found that labeling sweet corn as biotech had little effect (in either direction) on consumers' purchasing decisions.

In the current regulatory environment, consumers who wish to avoid GE foods can obtain information about GE content of foods for which there is any ambiguity by searching for the Organic label, the Non-GMO Project label, or other non-GE label claims.[19] If the NBFDS increases consumer awareness of GE and changes the share of consumers who prefer non-GE food, or changes the way consumers judge whether foods are GE-free, then manufacturers and retailers may have some incentive to change the formulation of products and substitute away from GE ingredients, or to undertake segregation and verification or auditing to ensure that their products do not have to carry the NBFDS disclosure.[20]

It is of special importance to note that producers may undertake additional costs because retailers and other marketers are demanding products without the NBFDS disclosure label, even if consumers do not change their valuation of products in response to the NBFDS requirements. Retailers might make decisions to avoid marketing products carrying the NBFDS label so as to improve public relations and brand image, or because they have misjudged the markets. If manufacturers incur significant costs to reformulate products or have their processes verified, and consumers are not willing to pay for those changes, significant losses will result (see Saitone, Sexton, and Sumner, 2015 for a discussion of this phenomenon in a different context).

5.2. Possible consumer demand responses

[19] At present, well-informed consumers can "unravel" information about GE content by noting whether food products have Non-GE or organic claims and whether they have ingredients that can be made using GE varieties. Consumers are heterogeneous in their ability to unravel and their knowledge about GE and their interpretation of ambiguous information about GE. Many consumers may assume that all food products are non-GE unless told otherwise. After the NBFDS is implemented, these consumers might begin categorizing many more food products as having some GE content.

[20] Some have suggested that a proliferation of "may contain GE" labels could induce consumers to accept GE foods (see, e.g., Carter, 2015; Sexton and Sexton 2016), but this has not been the experience in Europe.

If consumers react to the implementation of the NBFDS disclosure standard at all, a variety of different responses are possible. Will a group of consumers avoid all QR codes? Will a group of consumers gravitate toward food products that do not specify "contains GE" but remain ambivalent about all products that do not carry the NBFDS disclosure statement for whatever reason? Will a group become interested in the Non-GMO Project Verified label or other non-GE claims because the NBFDS disclosure statements have piqued their interests in non-GE foods? All of these responses are possible—or indeed, likely, for at least some groups of consumers—and all have different implications for marketers and manufacturers.

5.3. Possible food industry responses

The response of food manufacturers to the NBFDS will depend in part on whether consumers respond to the law by avoiding foods produced using GE ingredients, but ultimately it will depend on whether retailers and other intermediaries begin to demand food not carrying the disclosure statements. Saitone, Sexton, and Sumner (2015) and Bovay (2017) discussed the important roles of intermediaries in demanding process-based product attributes in other contexts. It is easy to imagine that some retailers would want to avoid carrying products labeled with the federal disclosure statements or QR codes, even if these statements are vague or placed in an abundance of precaution on products that have little chance of containing any GE material. If this were the case, any manufacturer intending to make sales to such retailers would have to replace all GE ingredients with non-GE ingredients; and, in addition to paying a premium for non-GE inputs, they would have to incur segregation costs and, if required under the final NBFDS regulation, costs to have the segregation verified by Non-GMO Project or a similar accreditation body.

Some retailers, including Whole Foods Market, are already making a push toward disclosure of GE content.[21] We expect that a federal standard would push more retailers toward avoiding products that carry a GE disclosure statement. Some large retailers will be quick to move in this direction and even proclaim it to achieve some marketing advantages, if prior experience is any guide; other retailers may eventually be driven to follow these leaders either by competition in the market or by the consequences of political activists. Such an outcome would mirror the experience in the European Union following the introduction of mandatory GE labels there, and could occur even if consumers do not demand non-GE food or if all consumers who demand non-GE food already are able to meet their demands by using existing voluntary non-GE labels and knowing which foods do not have GE varieties in commercial production.

Claims that food is "Non-GMO" or "Not made with genetic engineering" are not currently regulated by the federal government or any state government, so manufacturers may make these claims without being held accountable if the claims are incorrect. Organic food must be made without the use of genetic engineering, so consumers interested in avoiding GE already had the option of purchasing organic products to that end. However, there was evidently a market opportunity for a third-party certification agency, the Non-GMO Project, to set standards for the use of its label (Non-GMO Project Verified) and charge firms for the right to use that label, subject to meeting the technical requirements of limited GE content, without having to meet the more stringent additional requirements to be labeled "Organic." Under the NBFDS, manufacturers may make claims such as "non-GMO" for foods certified as organic through the

[21] See http://www.wholefoodsmarket.com/our-commitment-gmo-transparency.

National Organic Program; however, food may not be labeled as "non-GMO" merely because it is not required to carry a disclosure statement.

It is of interest to consider the role of the Non-GMO Project and whether it will continue to operate—and whether the label will continue to grow—in the context of a mandatory GE standard. We suggest that, because many producers are likely to respond to the disclosure requirement by placing QR codes on product labels, there will continue to be some demand for Non-GMO Project Verified items, at least among retailers.[22] If consumers demand information about GE content, the various categories of exemptions from the disclosure requirement could necessitate the continued use of non-GE label claims.

If a patchwork of state regulations were to have emerged, in the absence of PL 114-216, a failure of coordination among covered products and even among states' definitions of genetic engineering would likely have meant that ever-more products needed to carry labels as additional states developed their own labeling requirements. Hence, the NBFDS may dampen the responses of both consumers and manufacturers, compared with a patchwork. This dampening compared with a patchwork may be reinforced because PL 114-216 allows the use of QR codes instead of explicit on-package statements. For these reasons, the NBFDS is likely to be less costly to both consumers and industry than a patchwork of standards would have been; all costs discussed below are relative to a baseline in which no state is enforcing mandatory GE disclosure or labeling regulations.

5.4. Benefits from a National Bioengineered Food Disclosure Standard

[22] In an unpublished paper, Adalja (2016) reports results suggesting that consumers are not paying a premium for the Non-GMO Project Verified label. Nevertheless, as Adalja documents, that segment of the market continues to grow indicating that sellers see some advantage in the label even if consumers apparently do not!

Insofar as mandatory disclosure of GE content provides zero benefits (see Sunstein, 2016), the primary benefit of the NBFDS is that it preempts the patchwork of state-level mandatory labels that was inevitably going to emerge. Although the NBFDS does not eliminate all possible sources of confusion surrounding non-GE label claims, it at least ensures consistency in the use of GE disclosure statements.

5.5. Anticipating costs of compliance and costs to consumers and taxpayers

Alston and Sumner (2012) and Lesser (2014) outlined the nature of costs that may be incurred by farmers, food manufacturers and processors, and other participants in the food supply chain upon the implementation of mandatory GE labeling laws. In this section, we draw upon these studies and others to describe the likely costs of compliance with the NBFDS, borne initially by producers, and the likely ultimate costs to consumers and taxpayers. The basic categories of costs can be described as follows: labeling foods with disclosure statements or barcodes that allow consumers to access websites that provide disclosure statements; switching some production from GE to non-GE, including organic; segregating GE seeds and ingredients from non-GE seeds and ingredients and documenting this segregation through third-party verification and recordkeeping; storing, shipping, and marketing parallel GE and non-GE product lines; and enforcement and litigation.

As a baseline, all food producers will incur some costs to learn about the regulatory status of the products they produce and all requirements with which they may have to comply. In addition, at a minimum, the producers of products for which labels are required will incur costs to develop the new packages or labels that comply with the NBFDS and (optionally) to maintain websites with disclosure information. Estimates of the costs of creating and printing new labels—expressed in terms of consumer price increases—have ranged from $1.27 per household

per year in California (Shepherd-Bailey, 2012; equivalent to $160 million per year for the nation) to a one-time cost of $2.3 billion (Dunham, 2016)—an annualized cost of $230 million per year using the standard 10-year horizon for government cost-benefit analyses. Although the requirements for labeling under the NBFDS vary slightly from the requirements of the proposed state laws in California and Vermont, the costs of disclosure are likely to be a relatively trivial component of the overall costs of the NBFDS, although there is some possibility that the other costs discussed below will not be incurred by the majority of producers.[23]

If producers undertake any actions besides developing new labels in response to new consumer or marketer demands that result from the NBFDS, these actions are likely to involve segregation of non-GE inputs from GE inputs, certification or verification of non-GE status, and keeping records about these aspects of the production process. Although Organic certification automatically qualifies products to be sold without the NBFDS disclosure statement, it also requires that the substantial majority of inputs are organic, so adjusting a product's formulation so that it can attain the Organic certification would require that the producer incur additional costs for all ingredients.[24] However, manufacturers may find that purchasing organic ingredients to replace GE ingredients is the most cost-effective way of ensuring that the end products are not required to carry NBFDS disclosure statements.[25]

[23] Of particular importance may be the costs of developing and maintaining a website with disclosure information.

[24] The 100% Organic label, of course, requires that all ingredients are organic; the Organic label allows up to 5% of ingredients to be non-organic, excluding salt and water (see https://www.ams.usda.gov/sites/default/files/media/Labeling%20Organic%20Products.pdf).

[25] Note that the limited availability of organic farm products and land for organic agriculture would make an immediate and complete shift from GE to organic production impossible.

Lesser (2014) cited various analyses that used data from 2008–13 to show that the farm price differential between GE and non-GE, non-organic corn and soybeans ranged from 7 to 24 percent. As noted by Alston and Sumner (2012), the price differential between GE and non-GE inputs may rise as demand for non-GE inputs increases. Lesser (2014) suggests that the cost of replacing all GE production with non-GE production to serve the New York market would be $11 to $103 per capita, or $3.6 to $33 billion per year for the United States as a whole, based on the farmgate price differentials of 7 to 24 percent; similarly, he suggests that replacing all GE production with organic would increase costs by $29 to $126 billion for the United States. Manufacturers may also elect, as an alternative to producing the same products with non-GE versions of the same ingredients, to reformulate products so that they use, for example, butter (which is exempt from the NBDFS) instead of GE soybean oil.

Having switched from GE to non-GE inputs for at least part of their line of production, farmers, processors, and manufacturers will incur costs to certify that they have done so and keep records of all segregation activities, if they intend to market the product as non-GE, or, if they are final processors, to avoid using the NBFDS disclosure statement. As noted by Bovay et al. (2017), as of November 14, 2016, the standard annual fees paid to a third party licensed to verify products for the Non-GMO Project ranged from $650 to $3,490 for a single high-risk product or ingredient—i.e., a product or ingredient for which GE varieties are available. To verify ten high-risk products and ingredients, the standard fees ranged from $2,000 to $3,490. These costs are merely the fees paid to third parties for verification and do not include the (potentially much higher) costs of physically segregating products.

Alston and Sumner (2012) estimated the costs for segregation, certification, and monitoring or recordkeeping under California's proposed Proposition 37, for producers serving

the California market. They suggested that these costs could amount to 3 percent of the value of output for the affected industries, somewhat lower than earlier estimates of comparable costs for the purpose of country-of-origin labeling.[26] If applied to the food manufacturing industries covered by the NBFDS across the United States, a 3 percent cost of compliance would amount to perhaps $11.6 billion annually.[27]

Lesser (2014) estimated that costs of identity preservation for non-GE ingredients—the same, in essence, as segregation and certification—were about 10 percent of the farm-gate price of corn and soybeans, which translates to up to $9 per capita in New York, or about $2.9 billion annually for the United States. The costs under the NFBDS could be considerably lower, however, because manufacturers can segregate some products that will be sold at grocery stores and regulated by the NBFDS from those to be used in downstream manufacturing or foodservice.

Although it is by no means a legislative or regulatory requirement, the NBFDS may induce retailers to stock both non-GE and GE varieties of similar or even nearly identical products, much as they have done with organic and non-organic, and with low-fat or low sodium

[26] Alston and Sumner (2012) used as the value of output for affected industries in California $40 billion, which they calculated as follows. The total value of agricultural processing output was $98 billion. This $98 billion included several industries that would not have been covered by Proposition 37: livestock feed and pet foods, seafood processing, and animal slaughter. After eliminating these industries from the total and also eliminating one-half of dairy processing and one-half of beverage processing to reflect partial coverage for these industries, the estimated total value of agricultural processing covered by Proposition 37 in California was $60 billion. Finally, Alston and Sumner (2012) applied the 3 percent cost of segregation, certification, and monitoring to only two-thirds of $60 billion, to reflect the likely share of California food processing output dedicated to markets outside California or to food-service, neither of which would have required labeling under Proposition 37.

[27] Based on the U.S. Census 2015 Annual Survey of Manufactures, the value of products shipped by food and beverage industries not including pet and animal food, meat, poultry, and seafood, and alcohol—i.e., a rough approximation of the product categories that would be subject to mandatory disclosure under the NBFDS—was $515 billion in 2015. We take this number to be equivalent to the $60 billion value of covered agricultural processing referenced by Alston and Sumner (2012) for California. If we assume roughly that three-quarters of U.S. agricultural processing is not dedicated to export markets or to food-service, then the cost of segregation, certification, and monitoring under the NBFDS may be approximately 3 percent of 75 percent of $515 billion, or $11.6 billion.

product varieties.[28] If retailers pursue such a marketing strategy, this will introduce additional costs in the form of warehousing space and retailer storage and shelf space, as well as adding complexities in supply-chain management. Lesser (2014) suggests the additional costs of warehousing in New York alone may be $39 to $45 million per year; scaled to the nation, this would be $650 to $750 million per year, substantially smaller than the other categories of compliance cost.

Regardless of the exact cost incurred by farmers, processors, and manufacturers to document segregation of non-GE inputs from GE inputs and to label GE products as such, these costs will be passed through to consumers. The nature of assumptions about marketing margins greatly affects estimates of the effects of mandatory GE labeling laws on consumers. For example, under the assumption of proportional marketing margins, a 10 percent cost increase for manufacturers would lead to a 10 percent increase in prices facing consumers. Alternative assumptions might suggest that a 10 percent increase in the farm costs of breakfast cereal result in an 0.4 percent increase in the retail price of breakfast cereal.[29]

Finally, costs of enforcing the NBFDS should also be considered. The more action government undertakes to enforce the NBFDS, the greater will be the public costs of enforcement. What actions or effort are justified to enforce a law that brings no public benefit? Perhaps the USDA and the FDA will see the NBFDS as a tool for preventing the development of a patchwork of state-level regulations, and will not devote any resources to enforcing the law. To

[28] General Mills currently markets non-GE Original Cheerios in the United States and markets all Cheerios as non-GE in Europe, but other flavors of Cheerios currently marketed in the United States use GE ingredients. See http://www.cheerios.com/en/Articles/cheerios-and-gmos (accessed March 29, 2017).

[29] The USDA-ERS Food Dollar data series indicates that 4% of the retail price of breakfast cereal accrued to farm production in 2007 (https://data.ers.usda.gov/reports.aspx?ID=17885).

audit food products for compliance with the NBFDS could be extraordinarily costly unless the federal government is able to levy fines for noncompliance that exceed the cost of enforcement. Depending on the enforcement mechanism and whether private citizens will be able to initiate complaints, litigation over violations of the NBFDS could also be costly; as discussed by Alston and Sumner (2012), the industry that has formed around lawsuits over California's Proposition 65 (which relates to disclosure about chemicals) illustrates an outcome that regulators should strive to avoid.

In summary, the costs to producers and food sellers of compliance with the NBFDS can be organized into several categories, as seen in Table 1. The cost of disclosing that foods are (or may be) made using genetic engineering—which is estimated to cost around $200 million per year in various analyses—is likely to be a fraction of the cost to manufacturers and consumers of adjusting product formulations so that the disclosure statements do not have to be made. If GE inputs were avoided entirely, the total of the price premium paid to farmers for non-GE or organic inputs and the cost of documenting segregation or identity preservation could together be at least $7 billion and possibly over $100 billion. This range of estimates is too wide to be very useful, but highlights the high degree of uncertainty about the costs of the NBFDS, which contrasts with our considerable confidence that the law will not bring benefits to justify the costs. Other categories of costs to producers, consumers, and taxpayers include the requirements for additional warehouse space, and the costs of enforcement, including, possibly lawsuits over noncompliance.

[Table 1 about here]

5.6. Long-term cost considerations

In addition to the costs incurred immediately by producers, consumers, and government, if the NBFDS results in a shift away from the use of GE technology, this will mean a shift in derived demand for other agricultural inputs. Because non-GE production requires more land than production using many types of GE traits, a shift away from GE production will increase the demand for land for agriculture. That shift would also change demand for chemicals—less for Roundup in particular and more for other chemicals (which typically present greater risk than Roundup based on both acute and chronic toxicity; see Kniss, 2017). Changes in demand for both land and chemicals have difficult-to-quantify environmental implications, and the use of chemicals has implications for the health of farm workers and local residents.

In the long run, the NBFDS may also result in changes to the way seed companies create profits and may reduce the returns to agricultural R&D. These pressures could ultimately reduce the incentives for technology firms to invest in a host of innovative genetic technologies, including drought-, insect-, and disease-resistant varieties that promise to contribute to reducing world hunger, especially if consumers and governments in the developing world continue to view the attitudes of developed-country consumers toward GE foods as an example to emulate.

Many aspects of these questions are quite uncertain given the recent development of gene-editing tools such as CRISPR and TALEN, which might offer many of the same technological opportunities without having to face the burdens associated with the GE rubric and its baggage. In particular it is uncertain whether the opponents of GE food will be successful in their current efforts to characterize these new technologies as part of the GE covered by existing discriminatory technology regulatory policies, including the NBDFS.

6. Conclusion

This paper has reviewed the economic history of the political and policy processes that gave rise to the 2016 passage of PL 114-216, the National Bioengineered Food Disclosure Standard. We discuss the various participants in the debate over GE technology and mandatory labeling of GE foods, and give an overview of the requirements of the NBFDS legislation and the elements of the standard that remain to be determined by federal regulators. Among the most important of these outstanding issues is whether federal agencies will have the power to enforce the NBFDS, and what penalties will be levied for violations. We highlight some problematic features of the legislation, discuss some potentially problematic features of the NBFDS regulations, and suggest options for regulators to consider as they develop the regulations. We then contemplate how consumers, food marketers, and producers may respond to the NBFDS requirements. Finally, we review various estimates of the cost of implementing state-level GE labeling regulations and discuss the implications of those estimates for nationwide implementation of GE labeling requirements.

We conclude that PL 114-216 is a clumsy and incoherent piece of legislation that will be burdensome initially to producers and ultimately to consumers—potentially, to the tune of billions of dollars in annual expenses. Regardless of one's views on GE technology, the NBFDS will be limited in effectiveness and potential benefits, primarily because the option to disclose information on GE content through a barcode linking consumers to a website does not seem to be a promising method of disclosing information to consumers. However, it is much better than the likely scenario, which PL 114-216 preempted, of a patchwork of state-level policies that differed in key details from one another; and it could be reasonably inexpensive, depending on the details of the NBFDS yet to be developed and how consumers and producers choose to respond to it.

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Table 1: Some Estimates of the Cost of Compliance with the National Bioengineered Food Disclosure Standard

Type of cost	Estimated annual cost	Source	Context of estimate	Scaled to nation, under NBFDS
Labeling	$1.27/household	Shepherd-Bailey (2012)	California Prop. 37	$160m/year
Labeling	$2.3b (one-time cost)	Dunham (2016)	Nationwide producer response to Act 120	$2.3b (one time); $230m/year over 10 years
Complete replacement of GE with non-GE ingredients	$11–103/capita	Lesser (2014)	New York's proposed labeling law	$3.6b–33b/year
Complete replacement of GE with organic ingredients	$90–$388/capita	Lesser (2014)	New York's proposed labeling law	$29b–125b/year
Segregation, certification, and monitoring	$1.2b	Alston & Sumner (2012)	California Prop. 37	$11.6b/year
Segregation, certification, and monitoring	$9/capita	Lesser (2014)	New York's proposed labeling law	$2.9b/year
Warehousing and retail space	$39m–$45m	Lesser (2014)	New York's proposed labeling law	$640–740m/year
Total		Minimum cost of labeling alone	$160m to $230m per year	
		All cost categories listed above	$7.3b to $138b per year	

Notes: Scaled estimates based on U.S. Census Bureau 2016 estimates of number of households in United States (https://www2.census.gov/programs-surveys/demo/tables/families/time-series/households/hh1.xls); U.S. Census Bureau 2016 estimates of population of United States and New York State (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2016_PEPANNRES&prodType=table); and as described in footnote 27.