Consumer Purchasing Response to Genetically Engineered Labeling

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Abstract
On January 1, 2022, mandatory genetically engineered (GE) food disclosure labeling will be required nationwide in the United States. To date, the only mandatory GE labeling law implemented in the U.S. was Act 120 in Vermont. This research examines the consumer purchasing response to the implementation of Vermont Act 120 using store-level scanner data of food purchases. We measure the effects of Vermont Act 120 on the grocery store sales of non-GMO, organic, and GE- labeled products in Vermont. Using a difference-in-difference approach, we can compare stores in Vermont to control states before and after the law was passed, implemented, and repealed. We find that during the implementation period, sales of non-GMO and organic labeled products increased, and the sales of GE-labeled products decreased. The sales trend reverted after the law was repealed but not quite to the baseline levels for organic and GE-labeled products.

The analysis, findings, and conclusions expressed in this report should not be attributed to IRI

INTRODUCTION

On January 1, 2022, mandatory genetically engineered (GE) food disclosure labeling will be fully required nationwide in the United States on foods produced with GE ingredients[1]. To date, the only mandatory GE labeling law implemented in the U.S. has been Vermont Act 120, which required foods with GE ingredients sold in Vermont be labeled with a GE disclosure statement on the package.

The law was implemented for the month of July 2016 before being preempted by the National Bioengineered Food Disclosure Standard (NBFDS). In this research we study the consumer purchasing response to the initial implementation of mandatory GE labeling in Vermont using store-level scanner data of food purchases. Using Vermont Act 120 as a natural experiment, we measure the effects of the GE labeling law on the quantities sold of Non-GMO (GMO - Genetically Modified Organism, equivalent to GE), Organic, and GE- labeled products in Vermont grocery stores compared to comparable control states using difference-in-differences for the main analysis and synthetic control method as a primary robustness check.

While the implementation of the law was unique to Vermont and rife with complications, we will attempt to control for these complications in several ways. Once Vermont Act 120 was passed in May 2014, the law met immediate opposition from the food industry, which feared a state-by-state patchwork of labeling requirements would affect their ability to distribute food nationally. This led to efforts in Congress to pass a law preempting Vermont Act 120. While

[1] The National Bioengineered Food Disclosure Standard will require foods with over 5% bioengineered (BE) ingredients to labeled. While GE and BE are different terms, to date the list of approved bioengineered crops listed by the USDA Agricultural Marketing Service are the same as the GE crops approved for production in the United States.

these efforts failed to preempt the initial July 2016 implementation of the law, there was a sense that Congress would eventually preempt the law, which they did by the end of July by passing the NBFDS. Additionally, there was a six-month grace period for foods without a GE label produced prior to July 1, 2016 and a one-year grace period before lawsuits could be brought against manufacturers for non-compliance (O'Gorman 2016). In anticipation of Vermont Act 120 being overturned and the grace periods, many food companies were apprehensive to begin labeling in Vermont, creating a fundamental empirical challenge. Therefore, we are unable to definitively conclude whether each product was or was not correctly labeled during the month the policy was in place. We account for this ambiguity by focusing on products that were most likely to be labeled: non-GMO labeled products, organic labeled products, and GE labeled Campbell's soup.

Overall, food manufactures feared consumers would decrease purchases of GE labeled products, due to mistrust and confusion over genetic engineering, and increased food costs (Van Eenennaam, Chassy, and Kalaitzandonakes 2014). Although there is no scientific evidence that GE foods are unsafe for human consumption (National Academies of Science, Engineering, and Medicine 2016), food manufacturers were concerned that GE labels could potentially signal to consumers that the product was inferior. A 2018 Pew Research Center survey found that 49% of Americans believe that foods with GE ingredients are worse for one's health than non-GE foods, an increase of 10 percentage points from the same survey question compared to 2016 (Funk and Kennedy 2016; Funk, Kennedy, and Hefferon 2018).

We find that the implementation of Vermont's GE labeling law led to increases in sales of non-GMO and organic labeled products and decreases in sales of GE labeled soups during the month it was implemented. Sales reverted back towards the baseline for all three product categories after Vermont Act 120 was preempted, but remained above the baseline for organic products, below the baseline for GE labeled soups, and fell below the baseline for non-GMO labeled products.

This research contributes to the literature in several ways. To the best of our knowledge, this is the first study to analyze the impact of mandatory GE labeling on the purchasing decisions of consumers using store-level scanner data and a multi-year framework. This is also the first study to investigate the impact of mandatory GE labeling on the sales of substitute products, i.e. non-GMO and organic labeled foods in a real-world context. While the Vermont GE labeling implementation was imperfect and differs from the NBFDS in a number of ways, this research will help inform industry groups on what to expect from consumers at the grocery store as NBFDS goes into effect and is relevant for policy makers who are curious about the impact of mandatory GE labeling on food sales.

BACKGROUND & LITERATURE REVIEW

Genetic engineering

The National Academies of Science, Engineering, and Medicine (2016) define genetic engineering as, "a process by which humans introduce or change DNA, RNA, or proteins in an organism to express a new trait or change the expression of an existing trait." Genetically Engineered foods, often referred to as Genetically Modified Organisms (GMO's) by the public, were first utilized commercially in the mid-1990's. There are ten GE crops in commercial production in the United States: corn, soybeans, cotton, potatoes, papayas, squash, canola, alfalfa, apples and sugar beets (ISAAA, 2018). Ingredients from corn, soybeans, cotton, sugar beets, and canola are particularly common in processed foods available in U.S. grocery stores[2]. In addition to the ten GE crops in commercial production in the United States, the Agricultural Marketing Service (AMS) includes eggplant, pink fleshed pineapple, and AquAdvantage Salmon on its List of Bioengineered Foods available worldwide (USDA AMS, 2018). Bioengineered foods are defined by the National Bioengineered Food Disclosure Standard as those that, "contain detectable genetic material that has been modified through certain lab techniques and cannot be created through conventional breeding or found in nature" (National Bioengineered Food Disclosure Standard, 2018). While these definitions are somewhat ambiguous, the current AMS bioengineered foods list includes all genetically engineered foods listed by ISAAA, the International Service for the Acquisition of Agri-biotech Applications.

Genetic Engineering is used to add desirable traits to crops such as herbicide-tolerance, insect-resistance (e.g., Bt Bacterium), or enhanced nutritional benefits (NASEM, 2016). Genetic

[2] Ingredients derived from these crops are wide-ranging. Examples include many forms of oils, sweeteners, thickeners, starches, and more.

Engineering has been found to increase the world supply of corn, cotton, and soybeans, reduce food prices, and reduce land conversion, preventing increases in greenhouse gas emissions (Barrows, Sexton, and Zilberman 2014; Taheripour, Mahaffey, and Tyner 2016; Lusk, Tack, and Hendricks 2017; Scheitrum, Schaefer, and Nes 2020). Switching from non-Bt to Bt crops specifically has led to decreases in synthetic insecticide use and higher insect biodiversity (NASEM, 2016).

Despite scientific consensus on the safety of GMOs, many consumers remain skeptical. A 2018 survey by the Pew Research Center found that 49% of Americans believe that foods with GE ingredients are worse for one's health than non-GE foods, 44% believe they are neither better nor worse, and 5% say GE ingredients are better for one's health than non-GE foods (Funk, Kennedy, and Hefferon 2018). This represents a 10% increase from 2016, when 39% of Americans believed that foods with GE ingredients were worse for one's health than non-GE foods (Funk and Kennedy 2016).

Arguments against GE foods tend to focus on the potential consequences on human health and the environment. The Non-GMO Project, which designates the Non-GMO Project Verified Label, cites the increased use of the herbicide glyphosate, emergence of herbicide and pesticide resistant weeds and pests, concerns over farmer sovereignty due to patented GE seeds, and lack of epidemiological studies on health impacts as reasons to avoid GE foods. Vermont Law 120 also cited concerns in the law's preamble over the effects on biodiversity, cross-pollination with native plants, and religious and moral objections as reasons people avoid GE foods.

However, some of these arguments have been rejected by the scientific community. In 2016, the National Academies of Science, Engineering, and Medicine (NASEM) issued

Genetically Engineered Crops: Experiences and Prospects, reviewing over 900 studies that spanned 20 years. The report found no substantiated evidence of risk to human health from consumption of GE crops nor overall did the committee find “conclusive evidence of cause-and-effect relationships between GE crops and environmental problems” (NASEM, 2016, p. 15). They qualify this environmental claim by saying, “However, the complex nature of assessing long-term environmental changes often made it difficult to reach definitive conclusions.” Additionally, the report found that GE crops have had generally positive economic outcomes for producers.

Vermont labeling law history and implementation

On May 8th, 2014, Vermont became the first state in the nation to pass a law requiring mandatory GE labeling for foods produced with genetically engineered ingredients when Vermont Act 120 was signed into law (H.122 (Act 120) - "An Act Relating to the Labeling of Food Produced with Genetic Engineering"). Specifically, the law required foods made with over 0.9% genetically engineered ingredients by weight to be labeled with a GE disclosure statement by July 1, 2016. Exceptions for restaurants, unpackaged foods intended for immediate consumption, liquor, products produced with GE processing aids or enzymes, meat, poultry, and dairy products meant that consumer packaged goods were the foods that would predominantly be affected. Although Vermont was the first state to succeed in passing mandatory labeling, many others had tried unsuccessfully.

Between 2012 and 2014, state-wide referendums were held on mandatory GMO labeling in California, Washington, Colorado, and Oregon. Each referendum failed, by 2.8%, 2.2%, 31%, and 0.06% respectively (California Secretary of State 2012; Washington Secretary of State 2013; Colorado Secretary of State 2014; Oregon Secretary of State 2014). Oregon’s Measure 92 initiative failed by only 837 votes out of 1,506,311 cast. In 2013 and early 2014, Connecticut and Maine passed mandatory GE labeling laws that would not go into effect unless multiple surrounding states passed similar law (Wilson 2014). In the 2016 legislative sessions alone, there were over 70 bills addressing GE labeling nationwide (Farquhar 2016).

Once Vermont Act 120 was passed in May 2014, the law met immediate opposition from the food industry, which feared a state-by-state patchwork of differing labeling requirements would affect their ability to distribute food nationally. They also feared consumers would decrease purchases of GE labeled products. The pushback included a lawsuit against Vermont by the Grocery Manufacturer's Association, Snack Food Association, International Dairy Foods Association, and the National Association of Manufacturers. In April of 2015, the GMA's request for a preliminary injunction preventing the implementation of the law was rejected in federal district court, but the lawsuit was allowed to proceed (Wyant 2015). The lawsuit was eventually dismissed in August of 2016 after the Vermont labeling law was nullified by the National Bioengineered Food Disclosure Standard (National Law Review 2016).

In addition to the lawsuit, the food industry lobbied the U.S. Congress to pass a law preventing the Vermont law from implementation. On March 16, 2016, the final attempt at preempting Vermont Act 120 through The Safe and Accurate Food Labeling Act of 2015 failed procedural vote (Brasher 2016). This law would have outlawed states from establishing mandatory GE labeling requirements and created voluntary national standards for non-GE and GE disclosure labels. Recognizing the U.S. Congress would not act in time to block Vermont's mandatory GE labeling from implementation, numerous food companies, including General Mills Inc., The Kellogg Co., Mars Inc., and more, announced plans to voluntarily implement GE labeling nationally the following week after The Safe and Accurate Food Labeling Act of 2015 failed. (Watrous 2016). Ahead of other companies, Campbell's was the first major American processed food and snack company to announce on January 8, 2016 its plans to label all GE products.

Mandatory GE labeling went into effect in Vermont on July 1, 2016, which was celebrated with a rally featuring Vermont Governor Peter Shumlin, then Democratic presidential candidate Senator Bernie Sanders, Senator Patrick Leahy, and other Vermont leaders on the statehouse steps (Gram 2016). The law going into effect was featured in widespread local news coverage. While the implementation of GE labeling was celebrated by Vermont political leaders and labeling activists, news reports also point to confusion from food retailers over the law (Ledbetter 2016). For food manufacturers that did not announce nation-wide labeling schemes, some chose to stop shipping to Vermont altogether or gave distributors stickers of GE disclosure information to add to products individually (Tron 2016). Several articles noted that Price Chopper, a major grocery chain in Vermont, had 3,000-3,500 products that would not be shipped to Vermont as they were not labeling GE foods (Tron 2016; Chandler 2016). Other anecdotal evidence suggests that some food items including Kosher food were becoming scarce (D'Ambrosio 2016). Some argued that smaller, local stores were being more affected, as they had less ability to pre-stock items no longer being shipped to Vermont ("GMO Labeling Takes Effect in Vermont" 2016).

Though it appears that stores started to act during July, they were not forced to due to a grace period. As part of the law, there was a six-month grace period for retailers to sell unlabeled foods that had been previously packaged and distributed to retailers prior to July 1st, 2016, and a one-year grace period before lawsuits could be brought against manufacturers for non-compliance (O'Gorman 2016). Liability for enforcement of this law resided with manufacturers, who faced a fine of up to $1,000 per day, per product if unlabeled GE products are offered for retail sale in Vermont. To not label their products, manufacturers were required to obtain sworn statements from suppliers verifying that the ingredients were non-GE or have the food products verified as non-GE or organic through qualifying organizations.

Part of the hesitation of national manufacturers to comply, was their belief that the Vermont labeling law would still eventually be preempted by a federal law. Their estimate was correct, as the bill that created the National Bioengineered (BE) Food Disclosure Standard (NBFDS) was passed by the Senate on July 7th, the House of Representatives on July 14th, and was signed by President Barack Obama on July 29th (S. 764). The NBFDS law nullified the Vermont mandatory GE labeling law, putting labeling solely within federal jurisdiction. It also mandated a nation-wide BE labeling program to be implemented, which will begin full enforcement on January 1, 2022.

Although the roll-out of mandatory labeling in Vermont was arguably incomplete, and amid a backdrop of probable federal interference, Vermonters were still aware of GMO labeling. In addition to extensive local media coverage cited above, Google Trends Information evidence suggests Vermonters were learning more about GMOs. Figure 1 compares the search interest for the term "GMO" of people in Vermont and the entire United States, including Vermont, from 2013 – 2017[3]. Google search interest is scored on a range of 0 – 100, with 100 being the highest level of search interest for a word/phrase in each place during a given time. The graph shows that Vermont consistently had higher interest in GMOs than the country as a whole and that

[3] Google Search Trend data showed near identical results for the overall topic of "Genetically Modified Organisms", which accounts for other related searches, misspellings, and abbreviations. The terms "Genetically Engineered" and "Bioengineered" did not have enough consistent search interest at the state level. The abbreviations "GE" and "BE" are too general and are most associated with off-topic searches including "General Electric" and "How to be…" to provide meaningful insight.

Vermonter's interest peaked when Vermont Act 120 was passed and when mandatory labeling was implemented. Figure 2 compares Vermont to this study's main control states of Washington and Oregon. It shows that while Vermont had a higher level of interest over the course of the time period, Oregon and Washington did have periods of high interest corresponding to each state's respective GMO labeling ballot initiatives election date.

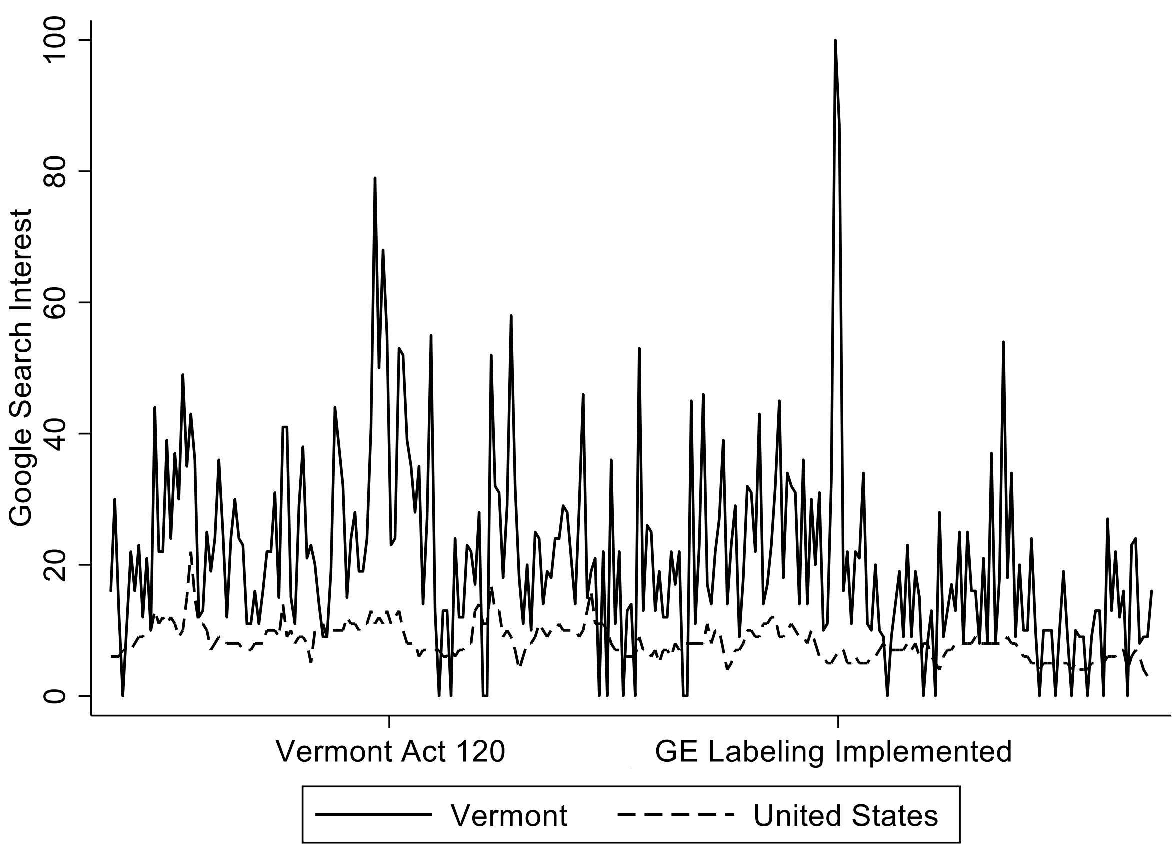

Figure 1 Google searches for "GMO" in Vermont and the United States

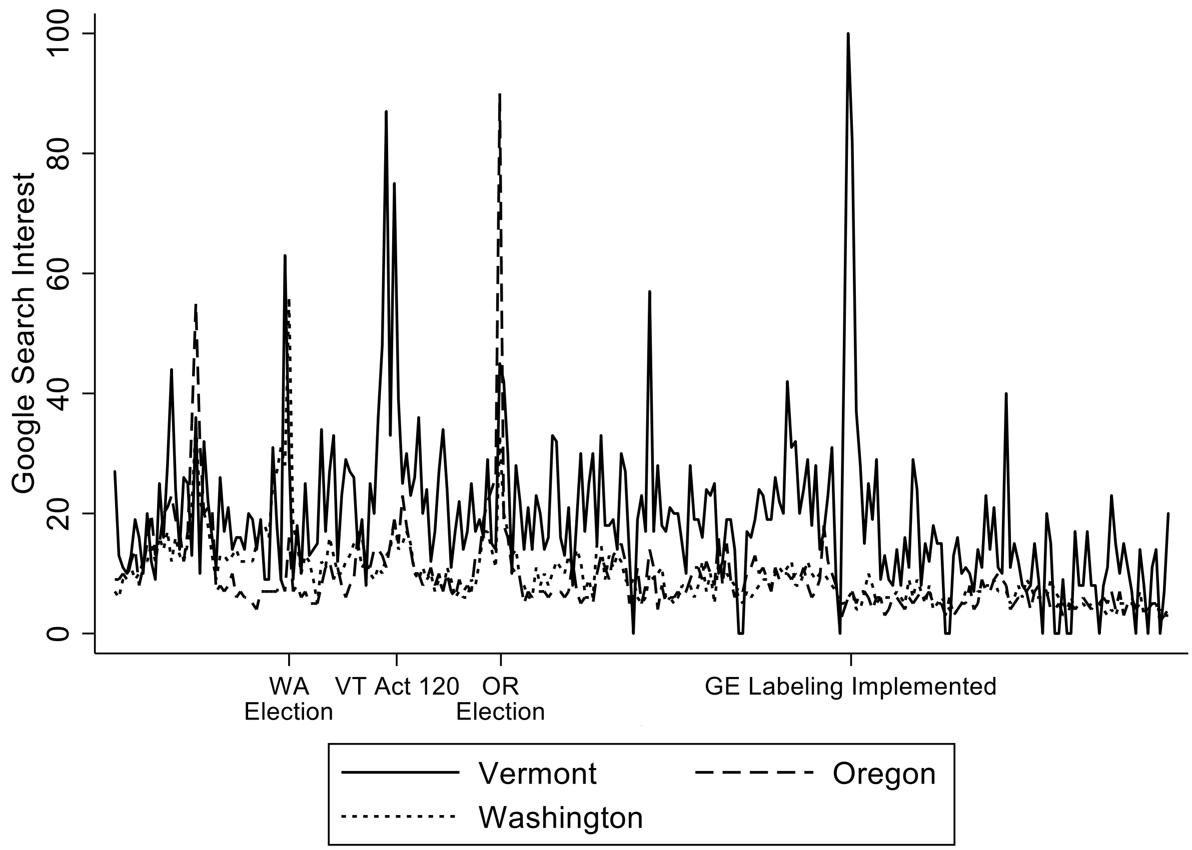

Figure 2 Google searches for “GMO” in Vermont, Oregon, and Washington

National Bioengineered Food Disclosure Standard

As discussed in the previous section, the National Bioengineered Food Disclosure Law was signed on July 29th, 2016. The law requires the USDA to create a national mandatory bioengineered food disclosure standard. Foods from very small food manufacturers, restaurants, or derived from animals that eat GE feed are excluded from the mandatory disclosure requirement.

On December 20, 2018, the USDA announced the details of the National Bioengineered Food Disclosure Standard as required by the National Bioengineered Food Disclosure Law. The new standard calls for all foods intended for human consumption with 5% or higher amounts of traceable modified genetic material to be labeled. The food manufacturer can choose between an on-package text disclosure statement (similar to the Vermont law's GE disclosure statements), USDA approved BE symbols, a QR code combined with a provided phone number for more information, or a text message disclosure prompt for more information. The USDA approved BE symbols are shown in Figure 3.

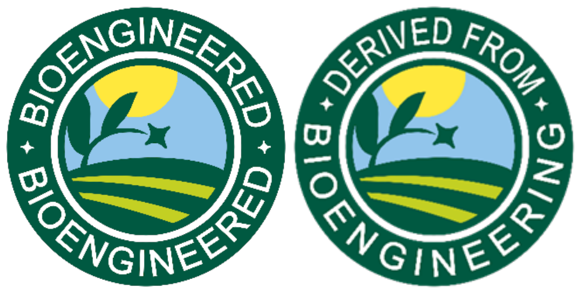

Figure 3 USDA approved National Bioengineered Food Disclosure Standard symbols

This mandatory labeling standard differs from Vermont's mandatory labeling regulations in three main ways. First, the federal law uses the term "Bioengineered" while Vermont's law used the term "Genetically Engineered" or "Genetically Modified" on its disclosures. Second, they differ in ingredient levels requiring labeling. Vermont's standard required a disclosure for foods containing 0.9% or greater GE ingredients, while the federal standard is 5% or greater. Lastly, the NBFDS allows for a variety of disclosure choices, including a QR code.

GE labeling debate

There is a wide gap between consumer and producer acceptance of GE technologies. Between 1995 and 2016, roughly the first 20 years of GE commercial crops, nearly one thousand academic articles were published exploring consumer's attitudes towards GE foods (Lusk, McFadden, and Wilson 2018). Mandatory GE labeling proponents argued that it is a consumer's right to know if GE ingredients were present in food (Just Label It). The Just Label It campaign listed over 700 partner organizations, primarily consisting of natural food brands and businesses. It also included partners from consumer advocate, environmental, health, and select farm organizations (Just Label it).

Opponents of GE labeling consisted primarily of biotechnology and food companies who argued that mandatory labels would act as a warning sign for consumers, further confusing them on the safety of GE products, and lead to potential increases in price of both GE and non-GE foods. They argued that as there is scientific consensus on the safety of GE food, the benefits to consumers "right-to-know" is based on scientific misunderstanding, and thus the benefits to consumers do not outweigh the costs to producers (Sunstein 2017).

For those who believed GE labels would act as a warning, they hypothesized that the labels disclosing the inclusion of GE ingredients would cause a signaling effect, potentially influencing individual preferences away from GE products. A new emerging view finds that implementation of mandatory GE labels may actually have the opposite signaling effect by bolstering consumer trust and lowering perceived risk (Costa-Font and Mossialos 2005; Kolodinsky, Morris, and Pazuniak 2018; Kolodinsky and Lusk 2018).

Empirical evidence for GE labels as information tools include Costanigro and Lusk (2014), who use controlled experiments to find that the willingness-to-pay (WTP) to avoid GE foods was higher in the presence of mandatory "contains" labels than with voluntary "does not contain" labels. In a Canadian mock grocery store lab experiment using eye tracking technology, Baynham (2018) finds that while the presence of non-GE labels increases purchases for non-GE products, the presence of GE labels does not affect the likelihood of purchases of granola bars including GE ingredients.

Lusk and Rozan (2008) use a mail survey and find that respondents who believe a mandatory labelling law is already in place by the U.S. federal government are more likely to believe GE food is unsafe. Studying another form of biotechnology that faces a significant backlash when introduced into the marketplace, Kanter, Messer, and Kaiser (2009) provide experimental evidence that the presence of non-rBST and organic milk choices lead to lower WTP for conventional milk. In a meta-analysis of WTP for GE foods, Lusk et al. (2005) found that overall WTP for non-GE foods was approximately 26% higher than GE foods.

Arguments around pricing centered on what would occur to food prices if companies switched to more expensive, non-GMO ingredients. On the retailer and producer side, mandatory GE labels have been demonstrated to change the products available in the marketplace. In response to the 2016 Vermont law implementation, Carter and Schaefer (2019) find food manufacturers substitute GE beet sugar for non-GE cane sugar. The substitution and reformulation results in a 13% price discount for GE beet sugar and a 1% price premium for non-GE cane sugar. Gruère, Carter, and Farzin (2008) compare mandatory and voluntary labeling systems in the EU and Canada. They find that in countries with high distrust of genetic engineering, mandatory labeling leads to a reduction of consumer choice as food manufacturers chose to reformulate to non-GE ingredients. An empirical analysis of the food prices of non-GE, organic, and conventional (GE) foods finds that between 2009-2016, price premiums for select processed food categories for non-GE foods ranged from 9.8% - 61.8% and between 13.8% - 91% for organic (Kalaitzandonakes, Lusk, and Magnier 2018). Thus, if food manufacturers switched from producing GE to more non-GE and organic products, food prices would likely rise.

Response to Vermont law

The most pertinent studies to our research examine the effects of Vermont's brief implementation of mandatory GE labels on consumers. Kolodinsky and Lusk (2018) find that the labeling policy leads to a 19% reduction in opposition to GE foods. They used nationally representative survey data and a difference-in-difference (DiD) method (Vermonters as treatment and respondents in the rest of the U.S. as control) for their analysis. The authors did not distinguish whether the improved attitudes towards GE products are the result of labels improving a sense of control, trust, or operating by some other mechanisms.

Also using surveys, Kolodinsky, Morris and Pazuniak (2018) analyze what type of consumers notice the mandatory GE labels in Vermont and how the labels affect self-reported consumer behavior. They find that approximately one-third of respondents report seeing a "produced with genetic engineering" or "partially produced with genetic engineering" label. Of those who do notice the label, slightly over one-half use the label as an informational cue to make a decision on previously held beliefs. In contrast, 12.8% of those who see the label, or 4% of total respondents, indicated the labels act as a signal that affect preferences and purchases.

A recent master's thesis examined the short term effect of mandatory labeling in Vermont using IRI scanner data at the week-product-state level and a triple difference approach comparing non-GE and GE breakfast foods in Vermont and Oregon (Pazuniak 2018). Pazuniak found that there were no significant short-term effects on the prices or quantity sold of GE or non-GE products in Vermont after labeling was implemented. Importantly, this study's non-GE category consisted of completely unlabeled products, without non-GMO or organic labels. Additionally, as Vermont Act 120 was not fully enforced due to grace periods, it is unclear if Pazuniak' s GE product sample definitively had a GE disclosure label. Overall, our study differs from Pazuniak's work in three aspects: (1) we focus on products we know with more certainty were labeled during the implementation period, i.e. Campbell soups, to obtain the impact of Vermont Act 120 on the sales of GE labeled products, (2) because Non-GMO and Organic labeled foods are substitutes of GE versions of the foods, we study the impact of Vermont Act 120 on a wider variety of *non-GMO* and *organic* labeled products (3) we use a longer time frame to analyze separately the impact of Vermont Act 120's passage, initial implementation, and repeal on the sales of GE, non-GMO, and organic labeled food items

DATA AND METHODS

For this study, we use IRI InfoScan which provides weekly sales records with Universal Product Code (UPC) or barcode level product information at major regional and national chain stores. A UPC is a unique product identifier. One product such as GE Campbell Soup has around 200 UPC IDs because there are different flavors or sizes of Campbell soup and each flavor-size combination (for example) has a unique UPC ID. The final dataset we use in the main analysis is restricted to stores in Vermont, Washington, and Oregon and includes 54,234 store-weeks, 1,301 unique non-GMO labeled UPCs, 4,858 unique organic labeled UPCs and 283 unique GE-labeled Campbell's soup UPCs. An observation consists of the units sold of a specific item (UPC) over one week at one store. We also use IRI HomeScan, which includes barcode-level weekly food purchases for sample households and household characteristics. HomeScan is used to analyze who purchases GE Campbell's soup in Vermont and the nation and to shed light on the generalizability of the results to customers outside Vermont and non-soup buyers. To mitigate the complexities associated with entries and exits of stores, this analysis only includes those that remain open every year. Furthermore, only mass merchandisers and grocery stores are incorporated in the study because those stores take up the vast majority of grocery sales in the respective states.

Product category selection

We study three main product categories: non-GMO labeled products, organic labeled products, and GE-labeled Campbell's Soup. Non-GMO and organic labeled products were chosen as categories of interest because they are natural substitutes to GE products. Organic products as certified by the USDA cannot include GE ingredients. As there was a lot of confusion over the rollout of GE labeling in Vermont, if consumers sought to definitively avoid GE ingredients, non-GMO and organic labeled foods offered a clear option.

The organic_claim and gmo_claim variables provide information on which UPCs are labeled as organic and non-GMO. Of the 32,002 total observations (upc-year combinations) with some sort of organic labels, 96.6% have the "USDA/CERTIFIED ORGANIC" and 3.4% have the "100% ORGANIC" claim. Of the 2,429 total observations with some kind of non-GMO labels, 48.6% were claimed "NO GMO", 48.3% claimed "NON GMO PROJECT VERIFIED", and 3.0% claimed "NOT TREATED WITH GMOS". The non-GMO and organic products represent a wide range of packaged food items including frozen meals, baby food, juices, dairy products, snack foods, and more. Random weight products, those that you must weigh at check out and primarily consist of fresh fruits and vegetables, are not included in this study.

As it is impossible to know definitively what products were labeled with a GE disclosure statement, when they were labeled, and where they were available, it is a much more difficult decision to select which GE labeled product to study. On January 7, 2016, Campbell Soup became the first major food company to announce intentions of labeling all products with a GE disclosure statement nationwide (Strom 2016). They had previously disclosed GE ingredients starting in 2015 on their website, *whatsinmyfood.com.* In their press statement, Campbell declared their support for federal regulation of GE labeling, citing a consumer-first mindset and that 92% of consumers supported mandatory labeling. While supporting federal regulation, they still opposed a state-by-state approach, which may boost manufacturing costs and increase confusion among consumers. There are no data about whether the rest of the country, or our control states, i.e. Washington and Oregon, had GE labeled products after Vermont Act 120 was initially implemented. The implementation of mandatory GE labeling in Vermont was not fully enforced on July 1, 2016 and the state granted grace periods to retailers and manufacturers. However, we choose to study Campbell Soup because we know with more certainty that this product was labeled during the implementation period. In addition, our estimated impact of Vermont Act 120 on the sales of GE labeled Campbell's soup also captures the increase in Vermont's consumer awareness of mandatory GE labeling during the implementation period. In other words, we assume that Vermonters are more aware of the mandatory GE labeling law/Act 120 compared to consumers in Washington and Oregon. This assumption is consistent with Figure 1 and 2 which show google searches for "GMO" in Vermont are much higher than those in Washington, Oregon, and nationally during the study period.

Other major food companies including General Mills, Mars, ConAgra, and Kellogg's did not announce their decisions to start labeling their products with GE disclosure statements until the second half of the March of 2016, after the Senate's attempts at a national labeling law failed. Store visits suggest that despite the announcement in March, ConAgra and Kellogg's did not label products with GE ingredients as of November 2018. General Mill's, which has a broad variety of product categories, does not seem to consistently label all their products with GE ingredients.

The main identifying assumption for the DiD model is the parallel trends assumption. This assumption implies that absent any treatment, the sales for the treated and control states must have similar trajectories before and after the treatment/policy change took place. we graphically test for parallel trends in the sales of Mars candies, Mars M&Ms, and Campbell owned Pepperidge Farm cookies before Vermont Act 120. They do not exhibit reliable parallel pre-existing trends or parallel trends even after controlling for various store characteristics and fixed effects and thus do not serve as good candidates for a different-in-difference framework. In contrast, Campbell's soup shows relatively stable parallel pre-existing trends which indicates that Vermonters were likely to show similar trends of purchase behaviors as consumers in Washington and Oregon absent mandatory GE labeling. We specifically chose Campbell's soup as it is the most iconic of the Campbell's products. Campbell's is an American processed food company that includes brands like Campbell's, V8, Goldfish, Pepperidge Farm. Although media coverage of Campbell's decision to label all their brands containing GE ingredients was prevalent in Vermont, consumers may not be aware that brands such as V8 and Goldfish also belong to Campbell's. Therefore, we choose Campbell's soup to diminish the uncertainties around brand recognition and increase the probability that Vermonters know Campbell's soup with GE ingredients is labeled after Act 120.

The panel for non-GMO and organic categories begins December 31, 2012 and ends December 31, 2017, which includes the dates of the signing of Vermont Act 120 (May 8, 2014), implementation of Vermont Act 120 (July 1, 2016), and signing of NBFDS which preempted Vermont Act 120 (July 29, 2016). As shown in Figure 4, the analysis for the non-GMO and organic panel uses four periods: a pre-period (from Dec. 31, 2012 to April 27, 2014), an Act 120 passage period (from May 5, 2014 to June 26, 2016), a labeling period (from July 4 to July 31, 2016) and a post-labeling period (from August 1, 2016 – Dec. 31, 2017). We limit the panel for Campbell's soup to the timeframe that has more certainty regarding the GE labeling of the product. The timeframe of the analysis over GE soup is restricted to the period from May 23, 2016 to September 11th, 2016. As shown in Figure 5, the analysis for the GE Campbell Soup panel uses three periods: a pre-period (from May 23 to June 26, 2016), a labeling period (from July 4 to July 31, 2016) and a post-labeling period (from August 1 to September 11, 2016).

Control state selection

For our main analysis, Vermont stores are compared to stores from Washington and Oregon. These two states were selected for several reasons. First, Washington and Oregon both had extremely close state-wide GE labeling ballot initiatives in 2013 and 2014, respectively. GE labeling was defeated in Washington by 2.18% of the vote and in Oregon by 0.06%, showing that a large portion of the population supported mandatory GE labeling. Second, both states are like Vermont in political ideology. In a 2014 Pew Research Center survey, each state had 30% of respondents identify as conservative, 32-34% identify as moderate, 30-35% identify as liberal, and 5-7% identify as not knowing (2014 Religious Landscape Study). Each state was also represented by exclusively Democratic or Democratic-leaning independent U.S. Senators and Governors throughout the timeframe of this study. Third, they all share a somewhat similar geography. Each is a northern, coastal, and mountainous state. Finally, while neighboring states may have been a better demographic and cultural fit, they are in the same labeling and media markets as Vermont. In addition, as Vermont is a small state, it is feasible that Vermont residents could cross state lines to grocery shop. We also check the robustness of the results using Northeastern states in the synthetic control method, and the results are consistent.

As an identification test for the difference-in-difference method, we look at sales data graphically to confirm parallel trends between the treated and control states. Figures 4 and 5 show that the quantity sold by week throughout the respective time frames for each product category. These figures show that there are no major differences in trends between Vermont and the control states. Based on this graphical analysis, we use WA and OR as control states. Additionally, store-fixed effects will control for all possible time-invariant determinants of demand for the different locations.

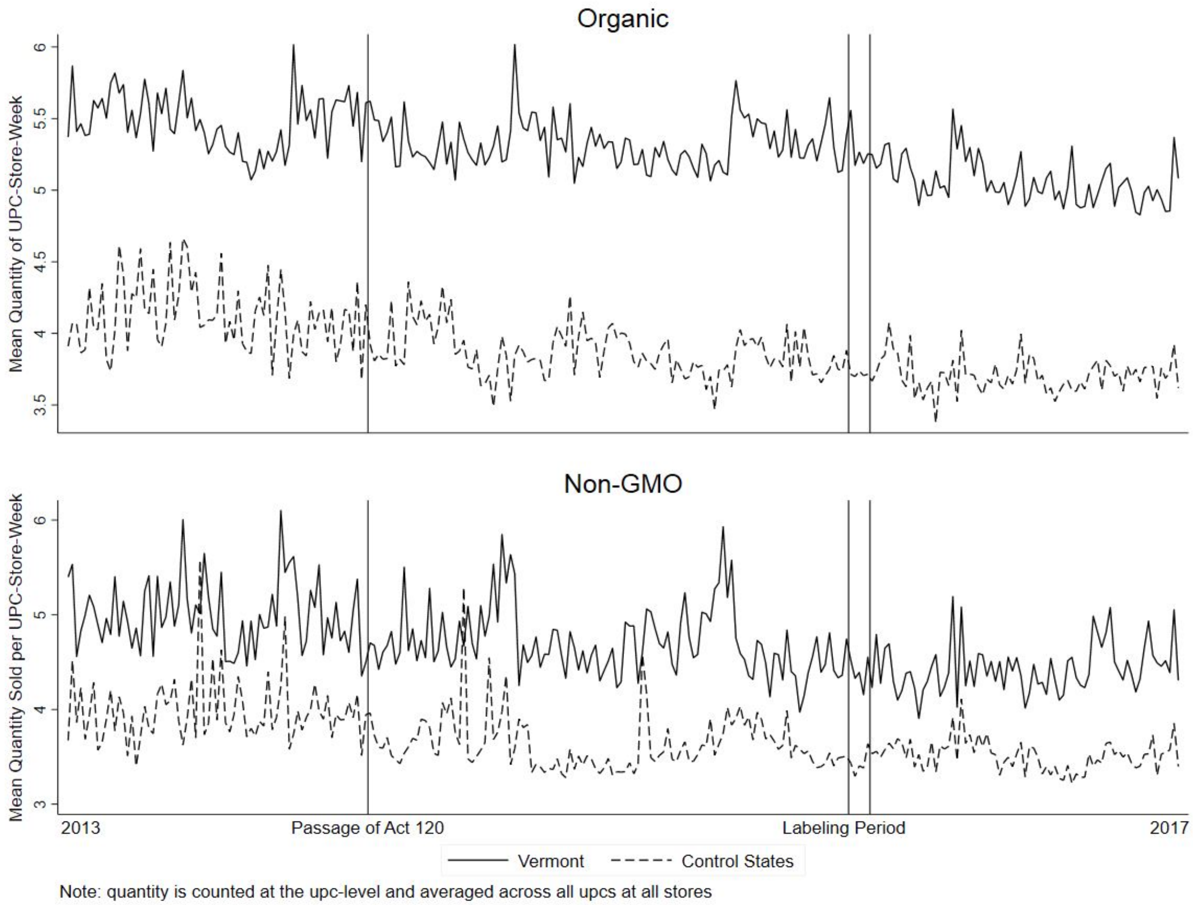

Figure 4 Average quantity of organic and non-GMO labeled products sold by week and state

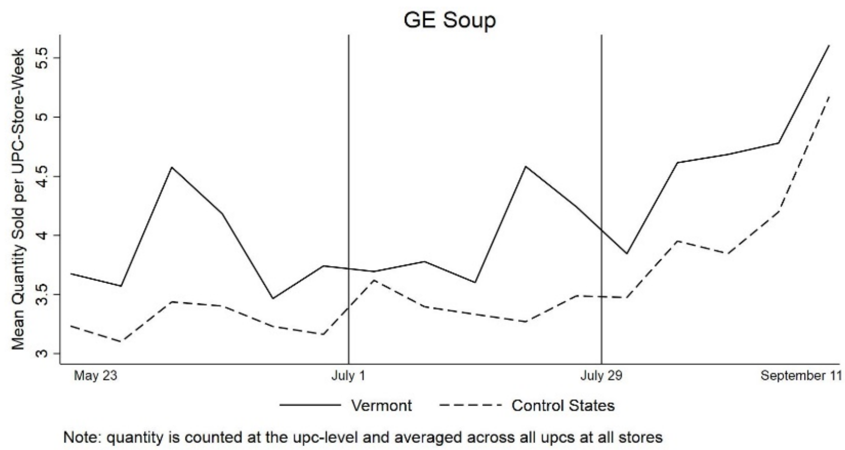

Figure 5 Average quantity of GE Campbell's Soup products sold by week and state

Summary Statistics

Table 1 consists of summary statistics for the three product categories divided between the control stores from Washington and Oregon, and the treated stores from Vermont, and by time period. As the GE Soup analysis is done on a shorter time frame that does not span the date when Vermont Act 120 was passed, time periods for the GE Campbell Soup products only include the pre-period, the mandatory labeling period, and the post-labeling period. However, in the GE Campbell Soup analysis the pre-period corresponds to roughly a month before the labeling period begins. Included in the table are the means for logged quantity of units sold per UPC-store-week, unit price, total number of stores, and unique UPCs per group.

Table 1 Means of treated and control product categories

Period	Variable	Organic		Non-GMO		GE *Campbell's*® Soup	
		Control Stores	Treated Stores	Control Stores	Treated Stores	Control Stores	Treated Stores
Pre-Period	Log(Q)	0.98	1.14	0.95	1.10	0.81	0.97
		(0.89)	(0.98)	(0.87)	(0.93)	(0.80)	(0.83)
	Unit Price	3.39	3.71	4.87	4.55	2.25	2.04
		(2.31)	(2.15)	(4.09)	(2.70)	(0.67)	(0.68)
	Number of Stores	152	55	152	55	152	56
	Number of UPC IDS	1,807	2,510	216	292	210	204
Act 120	Log(Q)	0.94	1.11	0.89	1.06		
		(0.86)	(0.97)	(0.83)	(0.91)		
	Unit Price	3.70	3.88	5.02	4.33		
		(2.82)	(2.25)	(4.98)	(2.73)		
	Number of Stores	151	55	151	55		
	Number of UPC IDS	2,427	2,833	547	579		
Labeling	Log(Q)	0.91	1.11	0.85	1.02	0.83	0.93
		(0.85)	(0.97)	(0.80)	(0.88)	(0.81)	(0.83)
	Unit Price	3.77	4.02	4.90	4.05	2.22	2.06
		(2.98)	(2.35)	(5.07)	(2.83)	(0.65)	(0.65)
	Number of Stores	144	54	143	54	154	56
	Number of UPC IDS	1,995	2,056	474	531	213	205
Postlabel	Log(Q)	0.91	1.09	0.89	1.00	1.01	1.04
		(0.84)	(0.95)	(0.81)	(0.90)	(0.80)	(0.87)
	Unit Price	3.75	4.03	4.91	4.08	2.12	2.07
		(2.91)	(2.28)	(5.40)	(2.94)	(0.68)	(0.66)
	Number of Stores	143	54	143	54	152	56
	Number of UPC IDS	2,720	2,517	871	916	233	206

Table 1 (continued)

Note: Standard deviations appear in parentheses. The pre-period, Act 120, labeling and postlabel period correspond to Jan. 2013 – April 27, 2014, May 5, 2014 – June 26, 2016, July 4 – July 31, 2016 and August 1, 2016 – Dec. 31, 2017 for the non-GMO and organic categories, respectively. For GE Campbell's Soup, the pre-period, labeling and postlabel periods are May 23 – June 26, 2016, July 4 – July 31, 2016 and August 1 – Sept. 11, 2016. Weeks split by policy implementation are dropped.

Treatment effect without controls

Table 1 includes the means of average quantities sold per upc-store-week as well as average unit price, total number of stores, and total number of unique UPCs sold during each period.

Notably, Table 1 allows one to calculate preliminary estimates of the treatment effects of GE labeling policies on an outcome variable of interest (e.g., quantity sold, price) based on a DiD approach. This can be done by subtracting the difference in an outcome variable between the post- and the pre-treatment period for the stores in the control states (WA, OR) from the difference in an outcome variable between the post- and the pre-treatment period for the stores in the treated states (VT). Compared to their immediate previous period, the sales of both organic and non-GMO products rose or stayed the same when the law was passed (Act 120) and implemented (labeling). When the law was repealed (postlabel), the sales of both organic and non-GMO foods declined when compared to the labeling period. Specifically, the sales of organic products rose by 1%, 3% and declined by 2% when the law was passed, implemented, and repealed compared to the immediate previous periods. Similarly, the sales of non-GMO increased by 2% and 0% and declined by 6% compared to the same periods. The implementation of labeling led to a 6% decrease in the sales of GE Campbell's soup while the repeal of the law did not reverse the decline in sales. While here we are reporting the sequential impacts of policy changes (i.e., relative to the immediate previous period) without adding controls, we also report all impacts relative to the pre-period and sequential impacts adding controls in the results section.

Table 1 also shows the impact of Vermont the Act 120 on product prices. Following a DiD approach to compare the means in prices in treatment against control states, we find that the passage, implementation, and repeal of Act 120 lead to \$0.14 decrease, \$0.07 increase, and \$0.03 increase in the prices of organic products compared to the immediate previous periods. Non-GMO products see a price drop of \$0.37 and \$0.16 along with an increase of \$0.02 in the same time frame. The prices of GE soup jump by \$0.05 and \$0.11 following the implementation and repeal of Vermont Act 120 compared to the immediate previous periods. Given that the prices fluctuate over the study period; it is important to control for prices when analyzing the impact of Vermont Act 120.

We also observe that the number of unique organic and non-GMO products decreases in the labeling periods compared to other times while the number of products in GE Campbell's soup stay fairly consistent. When conducting robustness tests, we control for the number of unique UPCs sold in the store to isolate the effect of availability of products on sales.

Similarity of treated and untreated stores

For a formal DiD strategy to be appropriate, the control and treatment groups must demonstrate similar parallel trends in the pre-period.[4] In Table 2, we display a few variables that are possible determinants of demand. As mentioned above, Washington and Oregon were

[4] Although we analyze the sequential impacts as well as impacts relative to the pre-period, our parallel trends assumption only need to be satisfied in the pre-period because pre-period is the baseline without any policy interventions; sequential impacts are presented only to illustrate the changes in sales over time for better comparison reasons.

selected as control states due to their demographic and cultural similarities to Vermont while not being located close by or in the same media markets. When there are systematic differences in consumer demand between food treated and untreated stores, it is important to control for those variables that affect consumer demand and exploit the panel structure of the data. Through utilizing the panel data, we control for time fixed effects, i.e. including week of year and year-quarter fixed effects to control for seasonality and national temporal shocks to sales. In addition, we include product-store fixed effects to control for unobserved time-invariant product-store characteristics.

Table 2 contains summary data for all three product categories between control and treated stores during the pre-period. As the GE soup study time frame is shorter, its pre-period is from when it would be reasonable that Campbell's GE labels appeared on shelves to mandatory labeling began, or from May 23 – June 26, 2016. As suggested by the statistically significant p-values reported in Table 2, average log of quantities sold for organic, non-GMO and GE soup in treated stores are significantly higher in treatment stores than control stores. The average price of organic products in treated stores is significantly higher than that in control stores while non-GMO and GE-soup are on average cheaper in treated stores than control stores. The median income in the zip code where an average treatment store is located is higher than that in control stores. Treatment stores have higher shares of population with college degrees in their zip codes than control stores.

As mentioned earlier, unit prices are included as a control variable in the difference-in-difference (DiD) regression. To the extent that these differences are constant over time, store fixed effects will control for all possible time-invariant determinants of demand for organic, non-GMO labeled products and GE Campbell's soup, such as the possible observable differences.

Table 2 Testing similiarities in treated and control stores in the "pre" period

Variables	Control Stores			Treated Stores			P-Value of Difference		
	Organic	Non-GMO	GE Soup	Organic	Non-GMO	GE Soup	Organic	Non-GMO	GE Soup
Avg. (log(Q))	0.98	0.95	0.81	1.14	1.10	0.97	0.000	0.000	0.000
	(0.89)	(0.86)	(0.80)	(0.98)	(0.93)	(0.83)			
Avg. Unit Price ($)	3.39	4.87	2.25	3.71	4.55	2.04	0.000	0.000	0.000
	(2.31)	(4.09)	(0.67)	(2.51)	(2.70)	(0.68)			
Median Income ($)	59105		59687	54172		54394	0.0581		0.0393
	(17933)		(18107)	(11334)		(11200)			
Population with a College Degree (%)	30.6		31.3	36.6		36.6	0.0041		0.0107
	(13.44)		(13.85)	(11.81)		(11.96)			

Source: Income and education data from U.S. Census Bureau, 2012-2016 American Community Survey, 5-year estimates. Income and education variables are based on the zip code where the store is located. The organic and non-GMO categories have the exact same store mix.

Empirical Specifications

For the main analysis, we use an OLS regression to estimate a DiD model to find the effects of various stages of mandatory labeling on the quantity of non-GMO, organic, and GE labeled products sold. Individual products are identified by their universal product code (UPC), also referred to as a barcode. The impact of mandatory labeling can be estimated using the following regression model:

$$lnQ_{isw} = \alpha_{y-q} + \alpha_w + \alpha_{is}\beta_0 + \beta_1 a_{iw} + \beta_2 G_{is} a_{iw} + \beta_3 t_{iw} + \beta_4 G_{is} t_{iw} + \beta_5 r_{iw} + \beta_6 G_{is} r_{iw} + \beta_7 p_{iw} + \varepsilon_{isw}$$

where lnQ_{isw} is the log of the product *i*'s quantity sold at store *s* in week *w*. The dummy variables α_{y-q} denote year-by-quarter fixed effects, α_w for week of year fixed effects, and α_{is} for product-store fixed effects. As the study time frame is shorter for GE soup than for organic and non-GMO foods, time fixed effects are not used in the analysis of GE soup. There are three time dummy variables (a_{iw}, t_{iw}, r_{iw}) that represent the passage, implementation, and removal of Vermont Act 120. We refer to the four periods that are separated by the three dummy variables as "Pre-Period", "Act 120", "Labeling", and "Post-Label", respectively. The dummy variable G_{is} is equal to one for products in Vermont. In regressions where product-store fixed effects are included, Vermont as an individual variable drops out due to collinearity, as stores' locations are constant across time. The coefficient for $G_{is}a_{iw}$ is the estimated ATE of passing mandatory GE labeling legislation, the coefficient for $G_{is}r_{iw}$ is the estimated ATE of implementing mandatory GE labeling, and the coefficient for $G_{is}t_{iw}$ is the estimated ATE of mandatory labeling removal. Lastly p_{iw} denotes unit price and ε_{isw} is the error term.

For all product groups under study, we use several distinct DiD specifications. By adding in fixed effects individually, it shows the model's sensitivity to different underlying assumptions.

Our preferred specification has the most controls, including product-store fixed effects, time fixed effects, and unit price. Importantly, store-product fixed effects allow the demand for individual products to vary by store based on unseen factors. Week of year fixed effects account for seasonality and year-by-quarter fixed account for long-term trends in the regressions.

In addition to the main analysis' specification presented above, we estimate models allowing the treatment to have a different effect based on the demographics in stores' locations. We explore heterogeneity in income and education by modifying the specification demonstrated in the equation above. Specifically, we use the median income (divided by 1,000) and the percentage of the population with at least a bachelor's degree in a store's zip code. We then create a linear estimate of how income and educational attainment affect the results by interacting a store's income and education levels with the treatment-time interaction terms.

RESULTS

We first discuss the results from the main analysis; where we use the difference-in-differences method to measure the average change in the quantity of each non-GMO and organic product purchased, in response to when Act 120 passed in May of 2014, the mandatory labeling period in July of 2016, and after labeling was overturned by the National Bioengineered Food Disclosure Law. For GE Campbell's Soup products, the same analysis is done focusing only on the response to mandatory labeling and the post labeling periods. Next, we explore the heterogeneity of these effects based on income and levels of education. We also use HomeScan data to analyze the characteristics of Campbell's soup buyers and compare their characteristics with consumers from the rest of country to shed light on the generalizability of the results. We test the robustness of our model specifications and rule out some alternative explanations for the findings. Finally, we use a different empirical strategy, the synthetic control method, to check the veracity of our results.

Main analysis

Tables 3, 4, and 5 present the results from the difference-in-differences specification for the non-GMO, organic, and GE Campbell Soup categories, respectively. The dependent variable for each regression is the logged quantity of units sold per upc-store-week. In all regressions, the coefficients on the interaction terms represent the estimated average treatment effect on sales of Vermont Act 120 being passed (Act 120), implemented (Labeling), and preempted (postlabel). The coefficients indicate the effect of each policy change relative to each category's pre-period, i.e. before Vermont Act 120 is passed in organic and non-GMO regressions and roughly one month before the labeling period begins in GE Campbell's soup regressions. For all three categories, Column (1) has the least number of controls. In this regression, the independent variables are a constant, time dummy variables representing the different time periods, a dummy variable denoting treated stores (Vermont), and interactions of the time and treated store variables (Act 120 * VT, Labeling * VT, and Postlabel * VT).

Columns (2) adds product-store fixed effects, controlling for time invariant demand determinants of different products at each store. In regressions where product-store fixed effects are included, Vermont as an individual variable drops out due to collinearity, as stores' location are constant across time. Column (3) for the non-GMO and organic categories adds two different time fixed effects: week of year dummies and a rolling quarterly dummy to account for seasonality and demand changes over time. As the study timeframe is much shorter for GE soup, time fixed effects are not used in this category. The last column for all three product categories adds a unit price variable and is the preferred specification because it has the most controls that could account for unobserved differences in demand. Standard errors are robust to heteroscedasticity and clustered at the product-store level.

Table 3 show the results for non-GMO products. When product-store and time fixed effects are added gradually to the regression model, the signs of the results do not change considerably. As mentioned above, model (4) in the last column with all fixed effects included and unit prices added is our preferred specification. Unit price is negatively correlated with sales of non-GMO products, supporting an inverse relationship between demand and prices. In sum, the estimation results of model (4) show that the passage, implementation, and repeal of the Vermont Act 120 lead to a 3.5% decrease, 1.7% increase, and 2.7% decrease in the sales of non-GMO foods compared to before Vermont Act 120 was passed (pre-period).

We estimate the results for organic products in Table 4. It shows that the passage of Vermont Act 120 leads to 0.8% increase in the sales of organic products, while the mandatory labeling increases the sales of organic products further by 3.0%. Lastly, when Vermont Act 120 was preempted, the sales of organic products increase by 1.7% compared to before the law was passed.

Lastly, the results for GE Campbell's soup are shown in Table 5. We find that mandatory labeling and removal of Vermont Act 120 leads to 5.4% and 4.5% decrease in sales of GE Campbell's soup compared to before the law takes effect (pre-period). Thus, mandatory GE labeling seems to dampen consumers' interests to buy GE Campbell's soup. Although the demand rises slightly after the law is repealed, it does not recover to the pre-period levels.

Table 3 Difference-in-differences regression for log of quantity sold of non-GMO labeled products

variables	(1)	(2)	(3)	(4)
Act 120 * VT	0.0110	-0.0272***	-0.0270***	-0.0354***
	(0.00810)	(0.00569)	(0.00569)	(0.00548)
Labeling * VT	0.0222	0.0361***	0.0367***	0.0166*
	(0.0119)	(0.00861)	(0.00861)	(0.00829)
Postlabel * VT	-0.0369**	-0.0164*	-0.0156*	-0.0268***
	(0.0113)	(0.00739)	(0.00740)	(0.00721)
Act 120	-0.0556***	0.00301	0.0444***	0.0407***
	(0.00482)	(0.00349)	(0.00562)	(0.00545)
Labeling	-0.105***	-0.0360***	0.0193**	0.0247***
	(0.00721)	(0.00514)	(0.00746)	(0.00726)
Postlabel	-0.0635***	-0.000410	0.0693***	0.0712***
	(0.00665)	(0.00437)	(0.00823)	(0.00801)
Vermont	0.152***			
	(0.0135)			
Unit Price				-0.202***
				(0.00245)
Constant	0.950***	0.957***	0.855***	1.803***
	(0.00764)	(0.00255)	(0.00868)	(0.0144)
Product-Store FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Observations	3,789,234	3,789,234	3,789,234	3,789,234
R^2	0.007	0.000	0.002	0.045
Number of upc_store	65,149	65,149	65,149	65,149

Note: Standard deviations appear in parentheses. The pre-period is Dec. 31, 2012 - April 27, 2014, the Act 120 period is May 5, 2014 – June 26, 2016, the labeling period is July 4 – July 31, 2016, and the postlabel period is August 1, 2016 – Dec. 31, 2017. Weeks split by policy implementation are dropped. Asterisks indicate: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4 Difference-in-differences regression for log of quantity sold of organic labeled products

variables	(1)	(2)	(3)	(4)
Act 120 * VT	0.0176^{***}	0.00440	0.00456	0.00770^{**}
	(0.00414)	(0.00283)	(0.00283)	(0.00280)
Labeling * VT	0.0366^{***}	0.0213^{***}	0.0214^{***}	0.0301^{***}
	(0.00659)	(0.00458)	(0.00458)	(0.00452)
Post Label * VT	0.00941	0.00551	0.00590	0.0169^{***}
	(0.00577)	(0.00379)	(0.00379)	(0.00378)
Act 120	-0.0463^{***}	-0.0294^{***}	0.0163^{***}	0.0143^{***}
	(0.00260)	(0.00197)	(0.00267)	(0.00263)
Labeling	-0.0774^{***}	-0.0538^{***}	0.00679	0.00417
	(0.00400)	(0.00285)	(0.00382)	(0.00376)
Post Label	-0.0652^{***}	-0.0252^{***}	0.0419^{***}	0.0342^{***}
	(0.00353)	(0.00247)	(0.00422)	(0.00417)
Vermont	0.163^{***}			
	(0.00611)			
Unit Price				-0.221^{***}
				(0.00169)
Constant	0.980^{***}	1.027^{***}	0.933^{***}	1.769^{***}
	(0.00349)	(0.00118)	(0.00483)	(0.00796)
Product-Store FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Observations	13,291,820	13,291,820	13,291,820	13,291,820
R^2	0.010	0.000	0.001	0.030
Number of upc_store	215,277	215,277	215,277	215,277

Note: Standard deviations appear in parentheses. The pre-period is Dec. 31, 2012 - April 27, 2014, the Act 120 period is May 5, 2014 – June 26, 2016, the labeling period is July 4 – July 31, 2016, and the postlabel period is August 1, 2016 – Dec. 31, 2017. Weeks split by policy implementation are dropped. Asterisks indicate: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5 Difference-in-differences regression of log of quantity sold of GE Campbell's Soup

variables	(1)	(2)	(3)
Labeling * VT	-0.0677***	-0.0874***	-0.0538***
	(0.00840)	(0.00780)	(0.00776)
Post Label * VT	-0.136***	-0.131***	-0.0449***
	(0.00804)	(0.00750)	(0.00737)
Labeling	0.0262***	0.0183***	-0.000184
	(0.00504)	(0.00455)	(0.00451)
Post Label	0.206***	0.221***	0.142***
	(0.00492)	(0.00438)	(0.00427)
Vermont	0.165***		
	(0.0112)		
Unit Price			-0.515***
			(0.00784)
Constant	0.809***	0.873***	2.030***
	(0.00673)	(0.00259)	(0.0172)
Product-Store FE	No	Yes	Yes
Observations	196,821	196,821	196,821
R^2	0.013	0.027	0.072
Number of upc_store	23,509	23,509	23,509

Note: Standard deviations appear in parentheses. The pre-period May 23 – June 26, 2016, the labeling period is July 4 – July 31, 2016, and the post-label period is August 1 – Sept. 11, 2016. Weeks split by policy implementation are dropped. Asterisks indicate: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The regression results reported in Table 3 – 4 compare the effect of each treatment to the baseline established in the pre-period, i.e. before Vermont Act 120 is passed in organic and non-GMO regressions and before the labeling period begins in GE Campbell's soup. Table 6 shows the average treatment effects of each policy change on sales, relative to the preceding period. As this analysis exists on a multi-year time frame for the non-GMO and organic categories, comparing between time periods can help to understand the effects of mandatory GE labeling. We summarize the *sequential* impact of policy changes on the sales of non-GMO, organic and GE soup in Table 6.

Table 6 Comparing average treatment effects relative to the preceding time period

	Changes in sales in VT after Act 120 is signed	Changes in sales in VT during mandatory labeling	Changes in sales in VT after mandatory labeling law lifted
Non-GMO Labeled Foods	-3.5%***	5.2%*	-4.3%*
Organic Labeled Foods	0.77%**	2.4%*	-1.3%*
GE Labeled Soup		-5.4%***	+0.9%

Note: The pre-period, Act 120, labeling and postlabel period correspond to Dec. 31, 2012-April 27, 2014, May 5, 2014 – June 26, 2016, July 4 – July 31, 2016 and August 1, 2016 – Dec. 31, 2017 for the non-GMO and organic categories, respectively. For GE *Campbell's*® Soup, the pre-period, labeling and postlabel periods are May 23 – June 26, 2016, July 4 – July 31, 2016 and August 1 – Sept. 11, 2016. Weeks split by policy implementation are dropped. Asterisks indicate: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

In Table 6, we show that after Vermont Act 120 is signed, the sales of non-GMO products decrease by 3.5%, while mandatory labeling increases the sales of non-GMO products by 5.2% compared to the preceding period (after Vermont Act 120 is signed). The sales of non-GMO products decline by 4.3% after the law is removed, that is, compared to the preceding period (Labeling period). The impact on organic foods exhibit a similar pattern as non-GMO products except that the signing of Vermont Act 120 increases the demand for organic products by 0.77%. GE Campbell's soup sees a 5.4% drop in its sales because of mandatory labeling and its sales increase slightly by 0.9% after the law is repealed compared to the mandatory labeling period.

We also investigate the effects of mandatory labeling on prices in Table 7. All variables as in the last column of Table 3 – 5 are included: product-store fixed effects for time-invariant product-store level demand differences and time fixed are incorporated to control for long-term trends and seasonality. We find that the passage, implementation, and repeal of Vermont Act 120 leads to 0.4% increase, 1.1% decrease and an insignificant increase of 0.3% in the prices of non-organic products. Compared to the 3.5% decrease, 1.7% increase and 2.7% decrease in quantities sold for non-GMO products, the changes in prices induced by the law are much smaller. In contrast, the changes result from Vermont Act 120 for prices of organic products are much larger: the passage, implementation and removal of the law increases the prices by 1.3%, 2.8% and 2.7% respectively. The prices for GE soup rise even further as Vermont Act 120 takes effect and is removed; the prices of GE soup jump by 4.9% and 10.4% in the respective periods compared to the baseline period before the mandatory labeling takes effect. These results highlight the importance of including prices as control variables in the sales regressions to isolate the impact of prices in determining demand.

Table 7 Price regressions

	(1) Log Unit Price of Non-GMO	(2) Log Unit Price of Organic	(3) Log Unit Price of GE Labeled Soup
Act 120 * VT	0.00390*	0.0128***	
	(0.00163)	(0.000795)	
Labeling * VT	-0.0113***	0.0276***	0.0491***
	(0.00241)	(0.00122)	(0.00269)
Post Label * VT	0.00330	0.0274***	0.104***
	(0.00213)	(0.00112)	(0.00295)
Act 120	-0.00966***	-0.00419***	
	(0.00140)	(0.000578)	
Labeling	-0.000921	-0.0109***	-0.0191***
	(0.00190)	(0.000927)	(0.000807)
Post Label	-0.00243	-0.0127***	-0.0811***
	(0.00203)	(0.000957)	(0.00114)
Constant	1.349***	1.168***	0.736***
	(0.00208)	(0.00106)	(0.000710)
Product-Store FE	Yes	Yes	Yes
Time FE	Yes	Yes	No
Observations	3,789,234	13,291,820	196,821
R^2	0.006	0.006	0.033
Number of upc_stores	65,149	215,277	23,509

Table 7 (continued)
Note: Standard deviations appear in parentheses. The pre-period, Act 120, labeling and postlabel period correspond to Dec. 31, 2012-April 27, 2014, May 5, 2014 – June 26, 2016, July 4 – July 31, 2016 and August 1, 2016 – Dec. 31, 2017 for the non-GMO and organic categories, respectively. For GE *Campbell's*® Soup, the pre-period, labeling and postlabel periods are May 23 – June 26, 2016, July 4 – July 31, 2016 and August 1 – Sept. 11, 2016. Weeks split by policy implementation are dropped. Asterisks indicate: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Investigating Heterogeneity

Next, we explore the heterogeneous impact of the different phases of Vermont Act 120 on the sales of all product categories. Figures 6 – 8 show the treatment effects of passage, labeling, and post-labeling on the sales of non-GMO, organic products, and labeling and post-labeling on GE Campbell's soup by income quintiles and education. Here the income and education levels are obtained for the zip codes where stores are located. Education levels are measured by the percent of adult population with a bachelor's degree while the income variable captures the median household income in the store's zip code. Both variables come from the 2012-2016 American Community Survey. We present full regression results including interaction terms between median income and education attainment with treatment x time dummies in Appendix Table A.1 and illustrate the regression results in Figures 6 - 8.

Figures 6 to Figure 8 show the heterogeneous impacts of Vermont Act 120, labeling and postlabel on the sales of non-GMO, organic and GE Campbell's soup across eight income-education groups. Point estimates with 95% confidence intervals are included. There are four income groups in two education categories, i.e. lower and higher education group. The lower education group includes stores located in ZIP codes in the 25th percentile of the education levels in Vermont, where 23.3% of the ZIP code's adult population have a bachelor's degree. The higher education group includes stores located in ZIP codes at the 75th percentile, where 41.4% of adult population have a bachelor's degree. The four income groups are ZIP codes at the

1^{st}, 2^{nd}, $3^{rd,}$ and 4^{th} quintile of the income distribution in Vermont and have median income of $46,166, $52,308, $58,214, $66,944, respectively. As mentioned above, after running the regression tables interacting income and education levels with treatment times time dummies, we can do a back-of-envelop calculation of how the impact varies with different income and education attainment. In this sense, Figures 6 – 8 illustrate the heterogenous impact on stores located in Zip codes at 25^{th} (lower education group) and 75^{th} percentile of education levels (higher education group) and at 1^{st} through 4^{th} income quintiles.

We find that places with higher education levels see a much smaller impact of mandatory labeling on the sales of non-GMO and organic products than those with lower education levels (Figure 6 and 7). It is possible that people with higher education levels have a better understanding of non-GMO/organic products and GE technologies (Kolodinsky and Reynolds 2014). Figure 6 shows how different stages of Vermont Act 120 affects the sales of non-GMO products between lower education areas and higher education areas. Within the same education category, the positive impact of mandatory labeling on sales increases with income, potentially due to affordability or different preferences. Similarly, we find that mandatory labeling has a bigger positive impact on organic products in lower education areas than higher education places (Figure 7). Within the same education category, the increase in sales due to mandatory labeling also rises with income, which may result from affordability or heterogeneous preferences.

Figure 8 shows how the impact of different stages of Vermont Act 120 on the sales of GE soup varies across income and education levels. In the lower education areas, the negative impact of mandatory labeling on GE soup sales decrease as income rises. In contrast, the negative impact of mandatory labeling on sales is relatively constant across income groups for higher-education areas. Overall, higher-education groups see a smaller negative impact on GE soup due to mandatory labeling, again suggesting that people with better education have more knowledge of GE technologies (Kolodinsky and Reynolds 2014). But the rebound of sales when mandatory labeling is repealed is also smaller in the higher-education group, suggesting a more stable preference even when the law is removed for those places.

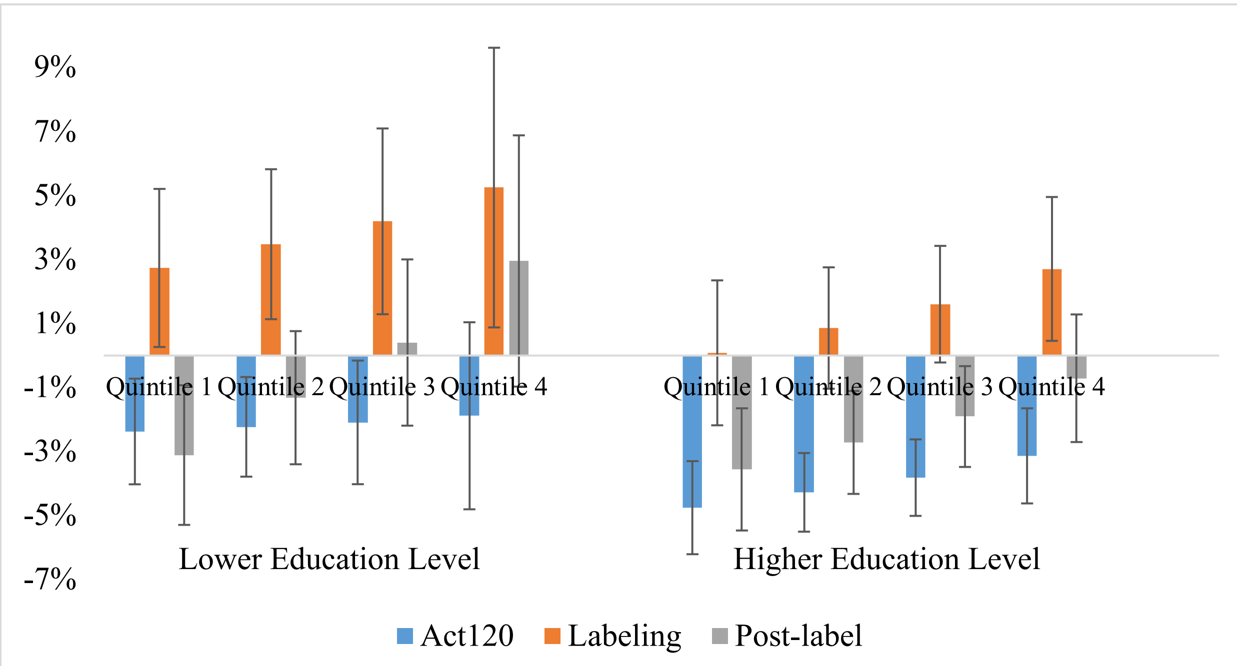

Figure 6 The impact of Act 120 on quantities sold of non-GMO products across income and education distributions in Vermont

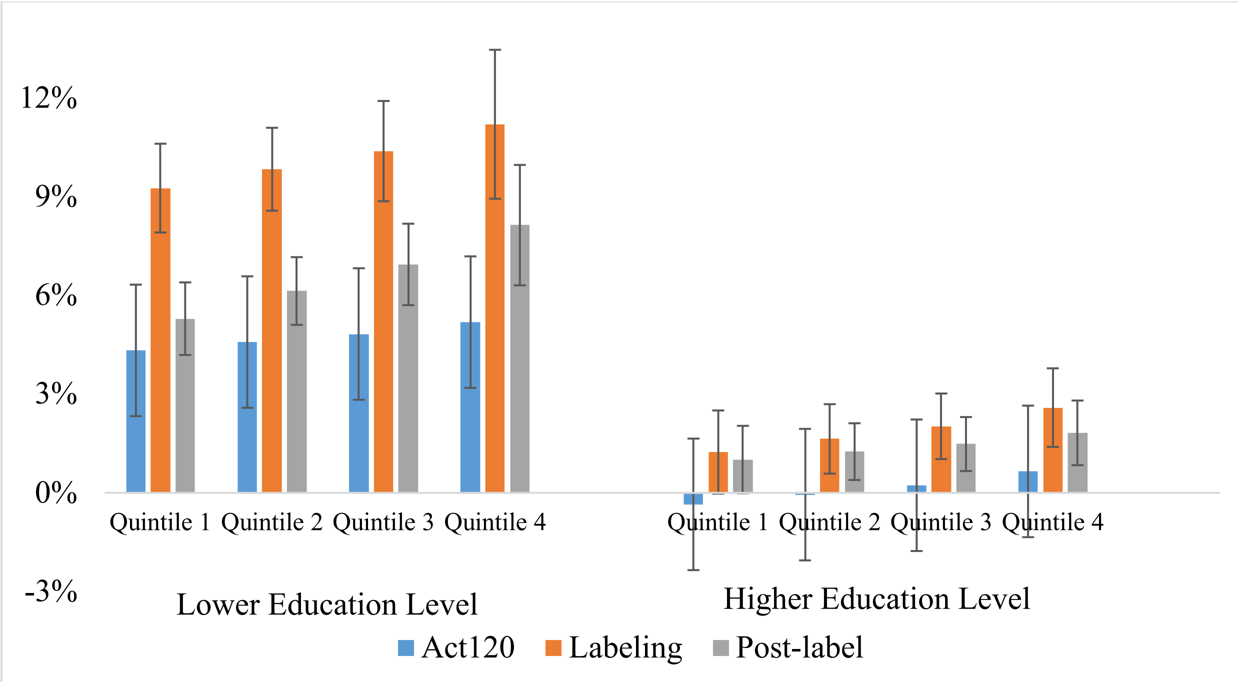

Figure 7 The impact of Act 120 on quantities sold of organic products across education and income distributions in Vermont

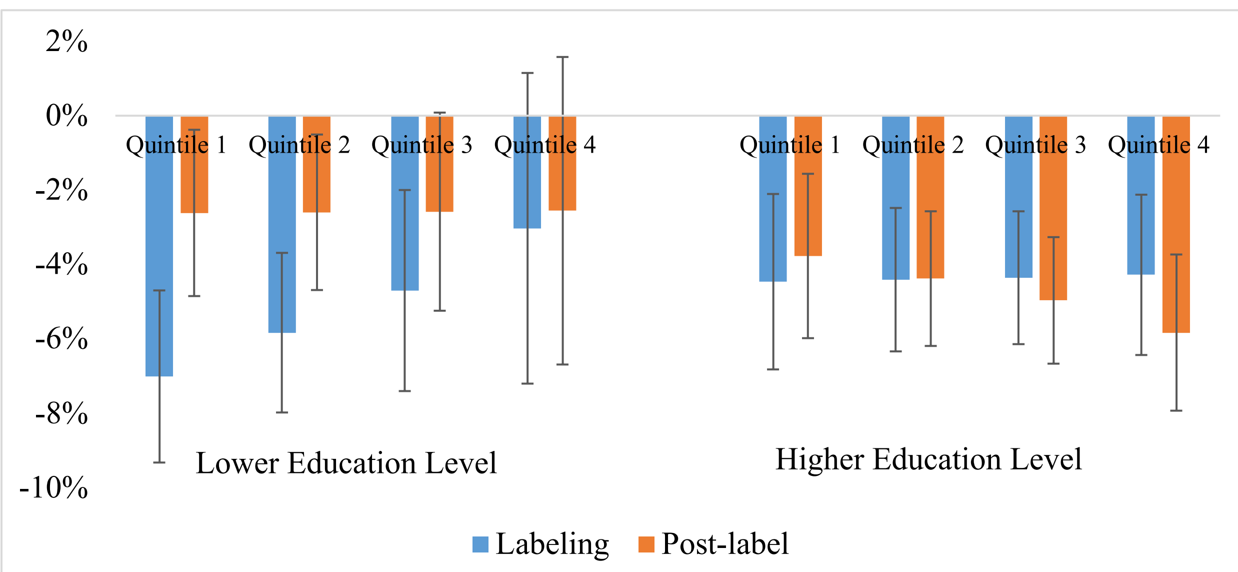

Figure 8 The impact of Act 120 on quantities sold of GE Campbell's Soup across education and income distributions in Vermont

External Validity

As we are using GE Campbell's soup as an example of GE products that followed labeling requirements, we explore the generalizability of our results using HomeScan data to analyze the characteristics of GE Campbell's Soup buyers in Vermont and compare their characteristics with average consumers in the U.S. HomeScan is a data product derived from the Consumer Network household data from the National Consumer Panel, a joint project between IRI and Nielsen. We specifically use the MedProfiler subset, which includes additional health and medical information from a subsample of households. In addition to the household's demographic and health information, the dataset provides the weekly transaction data itemized at the UPC level for each household. We only use households from the static panel, which is weighted to be representative of the full U.S. population. In this analysis, we compare GE Campbell's Soup buyers to non-buyers in both the United States and Vermont using logit regressions. The dependent variable is a dummy variable for if a household purchased a GE Campbell's soup product in 2016, with a soup-buyer equal to one and a non-soup-buyer equal to zero. 70.1% of Vermonters in the dataset are soup-buyers, while 68.1% of households in the United States as a whole are soup-buyers. Results are presented in Table 8.

Table 8 Comparing soup-buyers to non-soup buyers in Vermont and nationally

	(1)	(2)
	U.S.	Vermont
Children in HH	0.193***	-2.723*
	(0.0341)	(1.127)
Married	0.488***	2.384*
	(0.0280)	(1.085)
Income	-0.000000727	-0.00000549
	(0.000000384)	(0.0000121)
White, non-Hispanic	0.383***	1.072
	(0.0746)	(1.707)

Table 8 (continued)

Black, non-Hispanic	-0.0342	0
	(0.0824)	(.)
Asian, non-Hispanic	-0.361***	0
	(0.0988)	(.)
Hispanic	-0.119	0
	(0.0885)	(.)
Education	-0.324***	1.039
	(0.0287)	(0.926)
Obese	0.127***	2.113*
	(0.0254)	(0.852)
Type II Diabetes	0.137***	-1.183
	(0.0357)	(1.194)
High Cholesterol	0.0954***	0.114
	(0.0271)	(0.941)
High Blood Pressure	0.158***	0.699
	(0.0276)	(0.911)
Heartburn	0.176***	-2.168*
	(0.0258)	(0.977)
Very concerned about GMO's	-0.125**	-3.366**
	(0.0387)	(1.217)
Somewhat concerned about GMO's	-0.000922	0.790
	(0.0325)	(0.899)
Somewhat or very concerned about rBST	-0.0621*	0.824
in dairy products	(0.0309)	(0.911)
Somewhat or very concerned about	0.0193	0.133
antibiotics in meat	(0.0354)	(0.991)
Follows an organic or non-gmo diet	-0.687***	-2.397
	(0.0466)	(1.586)
Describes health status as excellent or very	0.0654*	-0.250
good	(0.0331)	(0.955)
Exercise most days or sometimes	0.0245	0.236
	(0.0344)	(1.282)
Constant	0.108	-0.831
	(0.0866)	(2.353)
N	33,920	85
Pseudo R^2	0.0429	0.3629
LR Chi2(20)	1821.2	36.71
Prob > chi2	0.0000	0.0037

Note: The dependent variable is a dummy variable for if a household purchases GE Campbell's soup in 2016 (soup buyer = 1). For all variables regarding heath or diet concerns, a dummy variable of 1 indicates that at least one individual in the household has the ailment or agrees with the statement. Observations are at the household level. Asterisks indicate: * p < 0.05, ** p < 0.01, *** p < 0.001

Most household characteristics are not significant when comparing Vermont soup-buyers and non-soup-buyers. For the characteristics that show significance in both U.S. households and Vermont households, having the head of household be married or at least one obese household member is positively associated with being a soup buyer, and having at least one family member be "Very concerned about GMOs" is negatively associated with being a soup buyer. One of the most important findings from these results, is that a household is much less likely to purchase GE Campbell's Soup if they are "very" concerned about GMOs. This indicates that people who were wary of GMOs, may already avoid purchasing GE Campbell's Soup products in the half-a-year leading up to mandatory labeling going into effect on July 1st. Thus, the reduction of sales of GE soup products during labeling was likely driven by people who were not as concerned or not concerned at all about GMOs to begin with. In all, 23.9% of households nationally and 19.7% of households in Vermont indicated they were very concerned about GMOs.

Robustness Tests

In addition to the previous analyses, we conduct several robustness tests. First, we add a UPC count variable to each regression from the main analysis. The UPC count variable is the number of unique UPCs sold in one store in one week and attempts to control for the differing number of products available in each category over time. Results are consistent and presented in the appendix in Table A.2. We acknowledge that the number of UPCs sold may not represent the number of UPCs available in a store-week. The next robustness test aims to control for the availability issue by limiting the UPCs used in the analysis to UPCs that appear in each state in every week of the analysis. The results are presented in Table A.3. The conclusions remain largely consistent. Thirdly, we test the GE Campbell's Soup regression to account for average weekly temperature in a store's zip code, presented in Table A.4. The results in the robustness tests remain consistent with the main results.

Synthetic control method

In this section, we use synthetic control methods to see if the results change substantially. Although Washington and Oregon show largely parallel pre-existing trends as Vermont, both states are quite different from Vermont in several other ways: for example, Washington and Oregon are much larger and more racially diverse than Vermont. In addition, Table 4.2 shows that the average income and education levels in zip codes around treated and control stores are significantly different. If we assume average income, education levels, population and racial distributions are largely time-invariant, then store fixed effects can account for those differences between treated and control stores. Alternatively, we use the synthetic control method (Abadie, Diamond, and Hainmueller 2010; 2015) to relax this assumption and test the robustness of the results. The synthetic control approach creates a control group based on the pre-labeling sales volume data and estimates the effect of the GE labeling law by measuring the difference in volume sold of the product categories of interest and the synthetic control group. The synthetic control method can construct close pre-treatment trends between the treatment and control group.

As synthetic control method is best applied to aggregate-level data, we use aggregate grocery-store level sales across 4-week time periods for the organic and non-GMO product category instead of the upc-store-week approach used in our main analysis. As the time frame for the GE soup category is only four months instead of four years, an observation is the aggregate sales of GE soup per store-week. The synthetic control method also only allows for one treated group. Therefore, we create a composite Vermont grocery store, consisting of the average total volume sold per 4-week period of 52 grocery stores in the state for the organic and non-GMO categories, and per one-week period of 54 grocery stores for GE soup.

For the potential donor pool (candidate comparison stores), we include all grocery stores from Washington, Oregon, and Northeastern states with sales of the respective product categories in every period. This results in a potential donor pool of 1,106 stores in the organic and non-GMO categories, and 1,225 stores for GE soups. Stores located within Vermont's dominant T.V. market, the Burlington-Plattsburgh Designated Marketing Area (DMA), are excluded because of potential spillover effects of Vermont Act 120 from media coverage. We choose candidate stores that minimize the Root of Mean Squared Prediction Error (RMSPE) for pre-trends in sales. For the organic and GE soup labeled categories, the comparison stores consist of 126 and 73 total stores respectively from Connecticut, Massachusetts, Maine, New Jersey, Pennsylvania, Rhode Island, and Washington. For the non-GMO labeled category, the comparison stores consist of 195 stores from the same states as the organic and GE soup categories, with the addition of Oregon.

Mathematically, let us denote the total volume sales in ounces of the composite Vermont stores as $Y_{j,t}$ $(j = 2, 3, \ldots, n)$. A set of weights, w_j $(j = 2, 3, \ldots, n)$ are assigned to create a synthetic control group $Y_t^{Synth} = \sum_{j=2}^{n} w_j Y_{j,t}$ so that, $\sum_{t=1}^{x} \left(Y_{1,t} - Y_t^{Synth}\right)^2$ is minimized. The time period, *x,* is 18 four-week long time periods for the organic and non-GMO categories, and 7 weeklong time periods for the GE soup category.

The optimal set of weights are calculated using the Stata *"synth*" package. For the non-GMO synthetic control group, weights ranged from 0.004 - 0.01 with the highest weight assigned to a grocery store in Springfield, OR. The organic product category's synthetic control weights ranged from 0 - 0.01, with the highest weight assigned to a grocery stores in New Haven and Torrington, CT, and Raritan, NJ. The GE soup product category's synthetic control weights range from 0.008 - 0.295, with the highest weight assigned to a grocery store in Great Barrington, MA.

Figure 9 shows the total sales volume in ounces of non-GMO and organic products sold in Vermont and its synthetic control per 4-week period, from 2013 to 2017. While the volume of non-GMO labeled products sold rose steadily over the four-year period, the volume of organic products sold was more volatile. Figure 10 shows the total sales volume for GE Soup from May 23 – Sept. 18, 2016. Sales for soup remained fairly flat during this period, then spike dramatically in September. When looking at long term soup sales, a similar spike occurs annually in mid-September. This annual spike may be due to the transition from summer to fall or correspond with September as Feeding America's Hunger Action Month. We calculate the impacts of mandatory GE labeling during three distinct time periods, after Vermont Act 120 is passed but before labeling, during labeling, and after labeling is removed, by taking the average difference between the Vermont composite store and synthetic control over each period.

We find that the passage, implementation, and repeal of Vermont Act 120 leads to 0.18% decrease, 5.44% and 1.41% increases in the sales of organic products compared to the baseline periods before the law is passed (Table 5.7). Similarly, the sales of non-GMO products increase by 0.88% when the mandatory labeling is in effect and drop when the law is repealed but not quite to the baseline levels. Lastly, the mandatory labeling decreases the sales of GE soup by 3.16%. Its sales rebound when the law is repealed and only decrease by 0.16% compared to baseline levels at the end of the study period.

In sum, although the magnitude of the estimated impacts of various stages of the policy are smaller, the signs of the estimates from the synthetic control method are largely consistent with our main DiD results. The exceptions are the effects of Vermont Act 120's passage. Using DiD, we find that the act's passage leads to a decrease in sales of non-GMOs and an increase in sales of organics (Tables 3 and 4). Using Synthetic Control, we find that the act's passage leads to an increase in sales of non-GMOs and a decrease in sales of organics (Table 9).

Table 9 Synthetic control estimates of average treatment effects of GE labeling policy changes on food sales

	Organic		Non-GMO		GE Soups	
Act 120	-373.36	-0.18%	125.79	0.32%		
Labeling	11,643.03	5.44%	382.89	0.88%	-170.80	-3.16%
Post Labeling	2,994.38	1.41%	-451.37	-0.91%	-6.46	-0.16%

Note: The outcome variable is in ounces sold per store. Percentages are calculated using the Vermont composite store's average sales volume per product category over a 4-week period for each individual period. The pre-period, Act 120, labeling and postlabel period correspond to January 2013-April 27, 2014, May 5, 2014 – June 26, 2016, July 4 – July 31, 2016 and August 1, 2016 – Dec. 31, 2017 for the non-GMO and organic categories, respectively. For GE Campbell's Soup, the pre-period, labeling and postlabel periods are May 23 – June 26, 2016, July 4 – July 31, 2016 and August 1 – Sept. 11, 2016

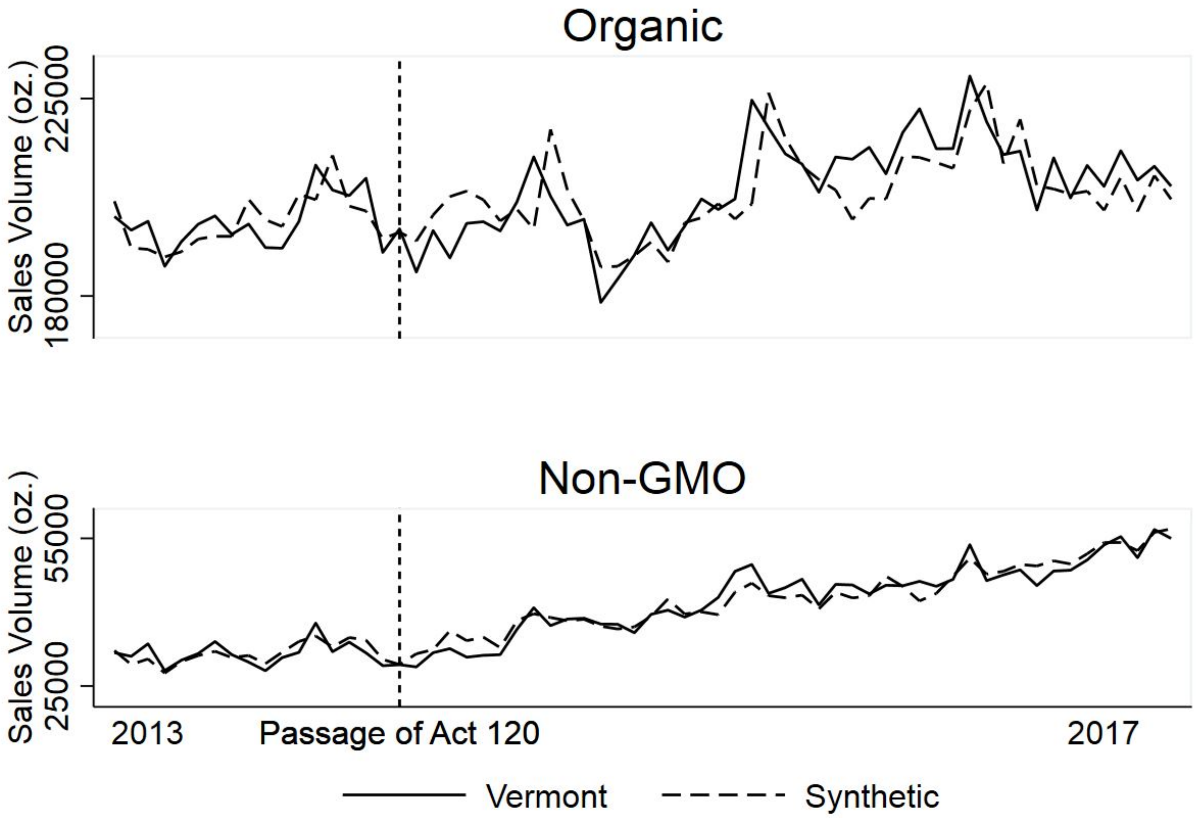

Figure 9 Aggregate volume sold for organic and non-GMO foods per grocery store per 4-week period

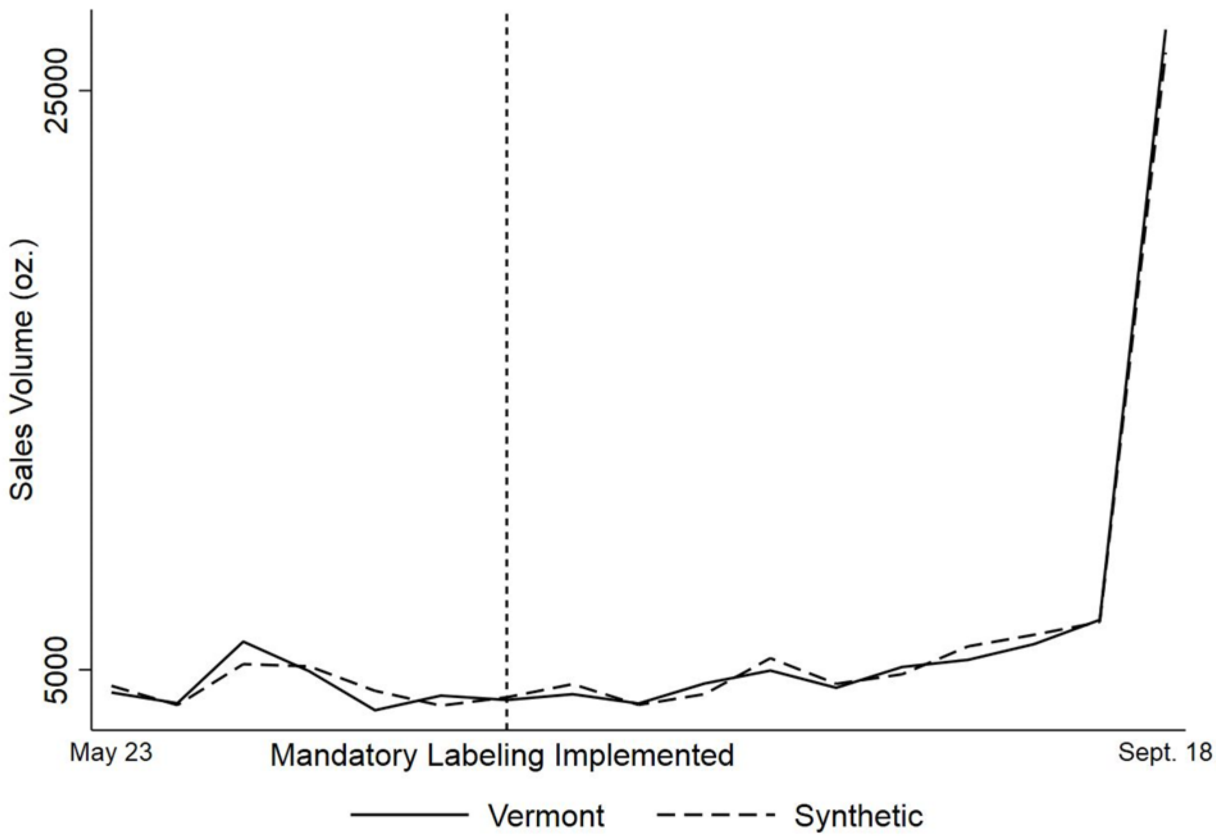

Figure 10 Aggregate volume sold for GE Campbell's Soup per grocery store per week

CONCLUSION

Our research measures the consumer purchasing responses of the implementation of mandatory GE labeling and the associated increase in consumer awareness of it on non-GMO, organic, and GE labeled foods using a panel of product-store level scanner data and Vermont Act 120. Our estimations show that each food product category was affected differently by the passage, implementation, and overturn of the law. After Vermont Act 120 was passed, sales of non-GMO foods decreased by 3.5% and sales of organics increased slightly by about 0.8% compared to before the law was passed. Importantly, both non-GMO and organic labeled foods, which can be viewed as “safe” alternatives for people seeking to avoid GE ingredients in their food, saw increases in quantity sold in Vermont during labeling, of 5.2% and 2.4%, respectively when compared to the preceding period (after Vermont Act 120 is signed). Meanwhile, GE labeled soup saw sales decline by 5.4% when compared to that analysis' preceding period (when labeling was not yet mandatory). After mandatory labeling in Vermont was preempted by the NBFDS, non-GMO and organic products decrease from their increased sales during labeling, by -4.3% and -1.3%, and GE labeled soup rebounds slightly by 0.9% but statistically insignificantly.

Our primary robustness check utilizes the synthetic control method to compare aggregate monthly, for non-GMO and organic foods, and weekly, for GE Campbell’s soup, sales volumes at the grocery-store level. It confirms that during labeling non-GMO and organic labeled goods saw heightened sales and GE soups saw diminished sales. However, the effect estimates using synthetic control were mostly smaller in magnitude than the main DiD analysis and the signs of the effects of Vermont Act 120's passage in particular are reversed. Using DiD, we find that the act's passage leads to a decrease in sales of non-GMOs and an increase in sales of organics, while using synthetic control, we find that the act's passage leads to an increase in sales of non-GMOs and a decrease in sales of organics. Given the inconsistency of estimated impacts of law passage on sales, the true impact of passage of Vermont Act 120 may be noisy. In contrast, the implementation and repeal of Vermont Act 120 gives a more robust estimate of impacts on sales.

Not all consumers react alike to mandatory GE labels. For all three product categories, areas with lower levels of education are more responsive to labeling than areas with higher levels of education. As more educated people are more likely to be aware of GE technologies (Kolodinsky and Reynolds 2014), their lower response rates may be due to having already formed an opinion on GE foods prior to the Vermont labeling law.

Although Vermont is not representative of the United States demographically and politically as a whole and there were many complications in the roll out of labeling, it is the only place that has seen mandatory GE labeling to date. As the National Bioengineered Food Disclosure Standard goes into effect, and will be fully enforced by Jan. 1, 2022, this research can inform policymakers and the food industry what to expect from the consumers. Our conclusion that mandatory labeling did affect the sales of non-GMO, organic, and GE labeled products differs from a previous study on consumer purchasing effects to mandatory GE labeling, which found no significant changes (Pazuniak 2018). Additionally, while survey studies find the law led to a reduction in opposition to GE foods (Kolodinsky and Lusk 2018), this was not reflected in consumer purchasing behavior during labeling implementation. Instead, during labeling they purchased GE alternatives, non-GMO and organic labeled products, and reduced purchases of GE labeled soup.

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Table A.1 Difference-in-differences regression for log of quantity sold including income and education variables

variables	Non-GMO	Organic	GE Campbell's Soup
Inc*Edu*Act 120*VT	0.0000300	0.00000375	
	(0.0000321)	(0.0000149)	
Inc*Edu*Labeling*VT	0.00000293	-0.0000157	-0.000101*
	(0.0000492)	(0.0000259)	(0.0000504)
Inc*Edu*Post Label*VT	-0.0000855*	-0.0000541**	-0.0000563
	(0.0000428)	(0.0000209)	(0.0000488)
Income*Act 120*VT	-0.000463	0.000327	
	(0.00145)	(0.000660)	
Income*Labeling*VT	0.00114	0.00130	0.00427*
	(0.00217)	(0.00113)	(0.00217)
Income*Post Label*VT	0.00491*	0.00263**	0.00134
	(0.00193)	(0.000917)	(0.00213)
Education*Act 120*VT	-0.00270	-0.00276**	
	(0.00182)	(0.000860)	
Education*Labeling*VT	-0.00160	-0.00371*	0.00607*
	(0.00280)	(0.00151)	(0.00292)
Education*Post Label*VT	0.00370	0.000131	0.00196
	(0.00241)	(0.00121)	(0.00282)
Act 120 * VT	0.0283	0.0885*	
	(0.0770)	(0.0356)	
Labeling * VT	0.00886	0.136*	-0.300*
	(0.116)	(0.0616)	(0.117)
Post Label * VT	-0.252*	-0.0133	-0.0731
	(0.102)	(0.0496)	(0.114)
Act 120	0.0405***	0.0139***	
	(0.00545)	(0.00263)	
Labeling	0.0245***	0.00367***	-0.000177
	(0.00725)	(0.00376)	(0.00451)
Post Label	0.0709***	0.0336***	0.142***
	(0.00801)	(0.00417)	(0.00427)
Unit Price	-0.202***	-0.221***	-0.515***
	(0.00245)	(0.00169)	(0.00784)
Constant	1.803***	1.769***	1.985***
	(0.0144)	(0.00795)	(0.0172)
Product-Store FE	Yes	Yes	Yes
Time FE	Yes	Yes	No
Observations	3,789,234	13,291,820	196,821
R^2	0.045	0.030	0.072
Number of upc_store	65,149	215,277	23,509

Table A.1 (continued)

Note: The income variable is median household income by zip code, per $1,000. The education variable is percentage of the adult population with a bachelor's degree or higher. Income and education data are from the U.S. Census Bureau, 2012-2016 American Community Survey, 5-year estimates. Asterisks indicate: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A.2 Difference-in-differences regression for log of quantity sold with the addition of a UPC count variable

variables	Non-GMO	Organic	GE Campbell's Soup
Act 120 * VT	-0.0347***	0.0579***	
	(0.00549)	(0.00280)	
Labeling * VT	0.0106	0.119***	-0.00859
	(0.00832)	(0.00454)	(0.00782)
Post Label * VT	-0.0406***	0.117***	-0.0131
	(0.00725)	(0.00384)	(0.00738)
Act 120	0.0410***	-0.00888***	
	(0.00545)	(0.00264)	
Labeling	0.0246***	-0.0355***	-0.00118
	(0.00726)	(0.00378)	(0.00451)
Post Label	0.0710***	-0.0184***	0.0793***
	(0.00801)	(0.00420)	(0.00444)
Unit Price	-0.202***	-0.221***	
	(0.00245)	(0.00168)	
UPC Count	0.000912***	0.000951***	0.00833***
	(0.000599)	(0.0000151)	(0.000179)
Constant	1.651***	1.378***	1.230***
	(0.0171)	(0.0101)	0.0230)
Product-Store FE	Yes	Yes	Yes
Time FE	Yes	Yes	No
Observations	3,789,234	13,291,820	196,821
R^2	0.046	0.032	0.085
Number of upc_store	65,149	215,277	23,509

Note: Standard deviations appear in parentheses. The pre-period is January 2013 through April 27, 2014, the Act 120 period is May 5, 2014 – June 26, 2016, the labeling period is July 4 – July 31, 2016, and the postlabel period is August 1, 2016 – Dec. 31, 2017. Weeks split by policy implementation are dropped. Asterisks indicate: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A.3 Difference-in-differences regression for log of quantity, only including products sold in each state in every week

variables	Non-GMO	Organic	GE Campbell's Soup
Act 120 * VT	-0.0541***	-0.0165*	
	(0.00862)	(0.00781)	
Labeling * VT	0.0381*	0.0309*	-0.0492***
	(0.0149)	(0.0137)	(0.00824)
Post Label * VT	-0.0751***	-0.0267*	-0.0387***
	(0.0125)	(0.0107)	(0.00780)
Act 120	0.0451***	0.0492***	
	(0.00819)	(0.00678)	
Labeling	0.0107	0.0275**	-0.00270
	(0.0122)	(0.0104)	(0.00475)
Post Label	0.0992***	0.0876***	0.143***
	(0.0141)	(0.0116)	(0.00447)
Unit Price	-0.241***	-0.229***	-0.528***
	(0.00497)	(0.00489)	(0.00823)
Constant	2.167***	1.644***	2.036***
	(0.0294)	(0.0215)	(0.0178)
Product-Store FE	Yes	Yes	Yes
Time FE	Yes	Yes	No
Observations	1,140,486	1,798,810	177,872
R^2	0.072	0.034	0.073
Number of upc_store	7,372	14,545	

Note: Standard deviations appear in parentheses. The pre-period is January 2013 through April 27, 2014, the Act 120 period is May 5, 2014 – June 26, 2016, the labeling period is July 4 – July 31, 2016, and the postlabel period is August 1, 2016 – Dec. 31, 2017. Weeks split by policy implementation are dropped. Asterisks indicate: $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Table A.4 Difference-in-differences for log of quantity of GE Campbell's Soup, including temperature

variables	(1)	(2)	(3)	(4)
Labeling * VT	-0.0677***	-0.0874***	-0.0538***	-0.0484***
	(0.00840)	(0.00780)	(0.00776)	(0.00776)
Post Label * VT	-0.136***	-0.131***	-0.0449***	-0.0512***
	(0.00804)	(0.00750)	(0.00737)	(0.00737)
Labeling	0.0262***	0.0183***	-0.000184	0.0547***
	(0.00504)	(0.00455)	(0.00451)	(0.00472)
Post Label	0.206***	0.221***	0.142***	0.180***
	(0.00492)	(0.00438)	(0.00427)	(0.00437)
Vermont	0.165***			
	(0.0112)			
Unit Price			-0.515***	-0.498***
			(0.00784)	(0.00774)
Avg. Weekly Temperature				-0.230***
				(0.000591)
Constant	0.809***	0.873***	2.030***	2.346***
	(0.00673)	(0.00259)	(0.0172)	(0.0195)
Product-Store FE	No	Yes	Yes	Yes
Observations	196,821	196,821	196,821	196,821
R^2	0.013	0.027	0.072	0.08
Number of upc_store	23,509	23,509	23,509	23,509

Note: Standard deviations appear in parentheses. The pre-period May 23 – June 26, 2016, the labeling period is July 4 – July 31, 2016, and August 1 – Sept. 11, 2016.Weeks split by policy implementation are dropped. Asterisks indicate: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.