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GM Labeling Regulation by Plebiscite: Analysis of Voting on Proposition 37 in California

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Many U.S. states have been considering proposals to introduce mandatory labeling requirements for foods containing GMOs. This paper analyzes precinct-level voting patterns in the case of California's Proposition 37, which was narrowly defeated in the November 2012 ballot. Those voting patterns can be predicted primarily by support for Democrats, their platforms, and President Obama. Projections using our estimated model imply that a majority of voters in only three of fifty states (Hawaii, Rhode Island, and Vermont) plus the District of Columbia would have passed Proposition 37 had it been on their ballots in 2012.

Key words: food labeling, genetic engineering (GE), genetically modified organisms (GMOs), Proposition 37, referendum, voting

Introduction

Many U.S. states have been considering proposals to introduce mandatory labeling requirements for foods containing genetically modified organisms (GMOs), and similar policies have been proposed federally. Some states have already voted on labeling initiatives, and many others are in play. The most significant labeling initiative to date was Proposition 37: *The California Right to Know Genetically Engineered Food Act* (also known as Prop 37 and as *Genetically Engineered Foods. Labeling*), which was rejected by a modest majority (51.4% versus 48.6%) in November 2012.

If passed, Prop 37 would have imposed significant costs on the food industry and agriculture in California, with significant implications for agriculture and food beyond California. The costs would have been borne ultimately by farmers as well as consumers and others in the food supply chain. Similar types of effects but on a smaller scale—since California is by far the biggest U.S. state in agriculture as well as in other measures of economic importance—could be expected for other U.S. states if they were to adopt policies such as those proposed in Prop 37. While the own-state impacts of adopting such policies can be mitigated by trade with other states, much more serious consequences would arise if the policies were adopted on a widespread or national basis, with potentially profound implications for the future of food, not just in the United States.

In this paper, we analyze precinct-level voting patterns for Prop 37 and use the results to project voting patterns if the same proposition had been fielded in other U.S. states. The voting patterns

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can be predicted primarily by support for Democrats, their platforms, and, in particular, President Obama. Our estimates imply that a majority of voters in three states—Hawaii, Rhode Island, and Vermont—plus the District of Columbia would have passed Prop 37 if it had been on their ballots in 2012.

Mandatory GMO Labeling Policies: History and Current Status

Genetically engineered (GE) crop varieties have been widely adopted around the world since they first became available in the mid-1990s.[1] However, genetically modified (GM) food has been controversial from the outset.[2] Governments have responded by regulating the use of the technology and, in many cases, requiring food product labels. In many countries, GE varietal technologies are effectively prohibited, and even in those countries that have most enthusiastically embraced GE varietal technologies, such as the United States, they are subject to much more stringent regulatory oversight than the "conventional" varieties they might replace—ostensibly because of concerns over the potential risks to human health or the environment (e.g., Just, Alston, and Zilberman, 2006). These regulatory barriers add many years of delay and tens of millions of dollars of overhead to the cost of developing and commercializing new GE varieties (e.g., Kalaitzandonakes, Alston, and Bradford, 2006).

As a consequence of direct economic and regulatory impediments combined with the perception of potential political-cum-market resistance, development of GM technology has been significantly discouraged for all but a few crops. Emphasis has been placed on crops grown on a large scale and used primarily as fiber (cotton lint), livestock feed or energy crops (e.g., corn, soybeans, alfalfa), or for production of ingredients used in food manufacturing (e.g., canola, corn, soybeans, cottonseed oil), rather than directly as food. In economic importance, these uses dominate by orders of magnitude the small number of instances where GE varieties are used to grow products that are consumed directly as food. In particular, the development and commercialization of GE varieties of staple food grains such as wheat and rice has been discouraged, as has the adoption of GE varieties of insect- and virus-resistant potatoes and vitamin A-inherent rice.[3] Likewise, no GE livestock products have been approved for commercial use and even the synthetic hormone rBST has been largely driven from the market for fluid milk because of organized opposition purporting to represent consumer preferences.[4]

Some governments and various non-government organizations (NGOs) have continued to resist and discourage the development, adoption, and use of GE technologies despite 1) evidence of significant benefits to farmers, consumers, and the environment, as well as biotech firms (e.g., Brookes and Barfoot, 2013; Klümper and Qaim, 2014) and 2) the accumulation of abundant and compelling evidence that the technology is safe for consumers and the environment, from both

[1] GE crop varieties first became available in the mid-1990s and, by 2013, approximately 175.2 million hectares (433 million acres) of GE crops were cultivated worldwide by 18 million farmers (James, 2014; Van Eenennaam et al., 2014).

[2] As defined by Van Eenennaam et al. (2014), genetic engineering is the manipulation of an organism's genes by introducing, eliminating, or rearranging specific genes using the methods of modern molecular biology, particularly those techniques referred to as recombinant deoxyribonucleic acid (rDNA) techniques. Products made using these methods are referred to as GE, GM, GMOs, transgenic, biotech, bioengineered, or products made with modern biotechnology. In this paper we use these terms interchangeably, but we prefer GE for the reasons given by Van Eenennaam et al. (2014).

[3] Genetically engineered potato varieties have been commercially available since 1995 (Kaniewski and Thomas, 2004). In 1999, approximately 25,000 acres of genetically engineered potatoes with resistance against the Colorado potato beetle (using Bt) and the potato mosaic virus were cultivated in the United States and Canada. This cultivation was suspended in 2001. Rice containing beta carotenes, popularly known as "Golden Rice," was developed to reduce vitamin A deficiency in developing countries and has been available since 1999 but has not yet been approved by regulators anywhere (Golden Rice Project, 2014).

[4] For example, in August 2007, the largest dairy co-operative in California, California Dairies, Inc. (CDI), asked its members to discontinue the use of rbST. "CDI attributed the ban to growing consumer demand for rbST-free milk…In response to changes in consumer preferences, national retailers such as Safeway, [Kroger], and Wal-Mart told their suppliers (large milk processors and co-operatives) that they would no longer be accepting rbST-milk" (An and Butler, 2012, p. 500, footnote 6).

scientific evaluations and extensive use in the field for many years without any problems (e.g., Van Eenennaam et al., 2014).[5]

The benefits are economically significant, in spite of the barriers to development and adoption of the technology. Brookes and Barfoot (2013) reported estimates of the cumulative economic benefits from cost savings and added income derived from planting GE crops equal to US$49.6 billion in developing countries and US$48.6 billion in industrial countries over the period 1996–2011. In recent years the annual benefits from adoption of this technology have exceeded US$20 billion per year, which is shared among farmers, consumers, biotech firms, and the environment.[6] Further, in a meta-analysis of 147 studies of impacts from the adoption of herbicide tolerant (HT) soybean, maize, and cotton and insect resistant (IR) maize and cotton, Klümper and Qaim (2014) report that, on average, GM technology has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.

Mandated Labels for GE Food

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 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. Others may see the technology as undesirable for some other reason—for instance, because it facilitates large-scale, high-tech commercial agriculture and empowers and enriches large multinational corporations. Both of these potential motivations appear to be in play in U.S. policy discussions. Proponents of mandatory GE labeling typically claim that 1) consumers have the right to know whether the foods they purchase were produced using genetic engineering and 2) mandated labels would enhance the range of choices available to consumers. But at least some proponents of this view apparently have a broader aim, to demonize and effectively ban the crops. For example, 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% 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." The tone of their comments suggests that many other proponents might share this view, and a de facto ban resulting from mandated GE labels is a plausible scenario.

In 2013, twenty-seven countries produced GE crops and sixty-four countries had laws requiring that food made from those crops be labeled as such. In those countries where these 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, though GE products are still nevertheless used in livestock feed since this use is generally allowed without requiring the livestock products to be labeled. The patterns of labeling GE foods and production of GE crops are connected,

[5] The U.S. National Academy of Sciences determined in 1987, and reaffirmed in 2000 and 2004, that GE poses no new or different risks to food safety (Institute of Medicine and National Research Council of the National Academies, 2004). Likewise, the American Medical Association (2012) has stated: "There is no evidence that unique hazards exist either in the use of rDNA techniques or in the movement of genes between unrelated organisms. . . [and] there is no scientific justification for special labeling of bioengineered foods, as a class." Alston and Sumner (2012, pp. 9–12) cite a range of studies documenting the evidence that GE technology is safe for consumers and reduces the environmental footprint of agriculture (e.g., Fernandez-Cornejo and McBride, 2002; Wu, 2006; Flachowsky et al., 2007; European Commission Joint Research Centre, 2008; European Commission Directorate-General for Research and Innovation, 2010).

[6] Citing Brookes and Barfoot (2011a,b), Alston and Sumner (2012) report estimates of pecuniary benefits of over US$15 billion in 2009 but, as Alston and Sumner (2012, pp. 37–39) discuss, this total does not include the nonpecuniary benefits to adopting farmers, which could augment their pecuniary benefits by more than 20%, nor the environmental value of reduced pesticide use, nor the benefits from the "halo effect" from area-wide suppression of pests (e.g., Hutchison et al., 2010; Tabashnik, 2010). Nor does it address costs of induced resistance in pests and weeds (Kathage and Qaim, 2012; Fernandez-Cornejo et al., 2014).

as discussed by Gruère, Carter, and Farzin (2009) who found that 1) countries producing GE crops are more likely to have less stringent labeling policies, 2) countries that export to the EU and Japan are more likely to have adopted stricter labeling policies, and 3) countries with no labeling policies are typically less developed, with important rural sectors, and are more likely to have ratified the Cartagena Protocol on Biosafety.

These patterns are generally consistent with a political economy model in which 1) producers (including farmers who grow GE crops, food manufacturers and retailers, and technology firms) perceive an economic interest in having a voluntary rather than mandated labeling regime whereas 2) many consumers would prefer mandated labels and environmental and other activist groups demand them, and thus 3) the policy outcome depends on the comparative strength of these competing interests. The upshot is that mandated labeling regulation is the predominant pattern in higher-income, food-importing countries and in countries that export to them. Moreover, typically, mandatory GE labeling acts as a de facto ban on the GE foods that would require labels and significantly discourages the production of GE crops that would be used to make those foods. By the same token, the political and economic cost of imposing mandated GE labels is lower in countries that do not grow those crops. The international patterns of attitudes to GE crops and mandated labels for GE foods might be mirrored in differences among U.S. states, reflecting the extent to which they currently grow GE crops and the prevalence of other socioeconomic factors that determine their perceived benefits and costs from the policy and differ among states.

U.S. Policy History and Current Status

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. However, many proposals for mandated GE labels have been made in recent years. As discussed and documented in detail by Van Eenennaam et al. (2014), at least twenty-five states have considered proposed legislation to require GE labeling, and bills have been introduced in the Senate and the House proposing a national GE labeling law.

Table 1 documents the main state-specific proposals and their status. Five statewide initiatives requiring labeling were not supported by a majority of the voters, specifically in Oregon in 2002 (Measure 27 lost 29.5% to 70.5%), in California in 2012 (Prop 37 lost 48.6% to 51.4%), in Washington in 2013 (Initiative 522 lost 48.9% to 51.1%), in Colorado in 2014 (Proposition 105 lost 34.5 to 65.5%), and in Oregon in 2014 (Measure 92 lost 49.97 to 50.03%, by 802 votes).[7] In most cases, the popular vote was very close (typically much closer and less favourable than the pre-election polls indicated), with a small majority prevailing against the policy, which has been interpreted as an encouraging sign by proponents on the grounds that their opponents outspent them significantly in the campaign, as shown in table 1.

Four other states have passed legislation mandating GE labels, but for various reasons none of these has taken meaningful effect. An Alaskan law (passed in 2005) requires labeling of GE fish sold in the state. In 2013, Connecticut and Maine passed bills that mandate GE labeling conditional on other states with a total population exceeding 20 million people enacting similar labeling rules. The first unconditional GE labeling law was passed by a huge majority (at least 79% in each chamber) of the Vermont legislature and signed into law in May 2014. It is scheduled to come into effect in July 2016. This is a broad GE labeling law, with general coverage of food containing GE ingredients sold for consumption at home, similar in scope and form to Prop 37 and the other state-specific initiatives. This law has been challenged on two points of Constitutional law (the Commerce Clause and the First Amendment protection of free commercial speech). In addition, the U.S. House of

[7] In the 2014 general election, voters in Maui County, Hawaii, passed a temporary moratorium on the cultivation of GE crops by a margin of 51.2% to 48.9%. County-level restrictions on the cultivation GE crops also can be found in Hawaii County and Kauai County, Hawaii, and Marin County and Mendocino County, California (Acosta and Law Library of Congress, 2015).

Table 1. Timeline of U.S. GMO Labeling Laws and Proposals

Year	State	Type of Legislation	Share Voting in Favor of Labeling (%)	Campaign Contributions for "Yes" Campaign ($ million)	Campaign Contributions for "No" Campaign ($ million)
2002	Oregon	Referendum	29.5	0.2	5.5
2005	Alaska	Bill†	100 (both houses)	*	*
2012	California	Referendum	48.6	10.6	44.4
2013	Connecticut	Bill	94.2 (House) 100 (Senate)	*	*
2013	Maine	Bill	97.2 (House) 100 (Senate)	*	*
2013	Washington	Referendum	48.9	9.9	22.0
2014	New Hampshire	Bill	46.7 (House)	*	*
2014	Vermont	Bill	79.2 (House) 93.3 (Senate)	*	*
2014	Oregon	Referendum	49.97	10.0	21.3
2014	Colorado	Referendum	34.5	1.0	15.3

Notes: * Lobbying expenditures need not be disclosed.
† Alaska's bill requires labeling of GE fish only.
Sources: California Secretary of State (2013), Cole (2002), Colorado Election Results (2014), Colorado Secretary of State (2015a), Colorado Secretary of State (2015b), New Hampshire General Court (2014), Oregon Secretary of State (2014), Oregon Secretary of State (2015a), Oregon Secretary of State (2015b), Oregon Secretary of State (2015c), Public Disclosure Commission (2015), State of Connecticut General Assembly (2013a), State of Connecticut General Assembly (2013b), State of Maine Legislature (2013), Alaska State Legislature (2005a), Alaska State Legislature (2005b), University of California Regents (2014a), Vermont General Assembly (2015), Washington Secretary of State (2013), Washington State Office of the Attorney General (2013).

Representatives passed a bill on July 23, 2015, that would prohibit states from mandating GMO labels, while requiring that companies seeking a "non-GMO" label use a USDA process-certification program (H.R. 1599). Thus, whether the New England states' laws will stand may be a matter for the courts to resolve.

California's Proposition 37 and the 2012 Ballot

Among the various statewide initiatives, California's Proposition 37 was seen by many to be 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. The issue was hotly contested, both sides spent a lot (table 1), and the outcome was very close, but ultimately Prop 37 was defeated 51.4% to 48.6%. Even though it failed, Prop 37 has served as a model for other states, and subsequent initiatives in other states have contained very similar provisions.

Details of Proposition 37

Prop 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 that read, "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.

Some two-thirds of food consumed in California would have been exempted, arbitrarily, from the labeling requirement. None of the following foods would require labeling, regardless of whether they contained GE ingredients or were made from ingredients produced using GE technologies: foods certified as organic,[8] foods consisting of or derived entirely from animals, beverages containing 0.5% or higher alcohol content, and foods eaten in a restaurant or other "food facility." Prop 37 also would have prohibited the use of the word "natural" (or similar words) in packaging or advertisements for GE foods or processed foods.

Likely Implications of Proposition 37

When asked whether GE labels should be mandatory, people typically respond affirmatively—it seems perfectly reasonable to think that providing information cannot be a bad idea and assisting informed consumer choice is a good thing. Indeed, proponents often argue that consumers "have a right to know." However, if it resulted in a de facto ban on GE food as it has done in other places, government-mandated labeling would not assist informed consumer choice and would in fact reduce choice and harm the food economy and consumers.[9]

Alston and Sumner (2012) argued that a mandated label would not be informative about the product or the process used to produce it, nor would it provide any relevant information regarding human health and environmental safety, but by its very existence it could have the effect of frightening and dissuading many consumers. In addition, if retailers used the mandatory labels they would become vulnerable to anti-GE lobbyists and pressure groups and, because it is uneconomic for any individual retailer to confront those groups, retailers generally would be discouraged from using GE products (as demonstrated by commercial decisions by companies such as McDonald's and McCain's in the United States not to use GE insect- and virus-resistant potatoes). The extent of this response is difficult to predict, but the U.S. market might well become much like the markets in other countries with mandated GE labels, in which the foods that would require labeling cease to exist.

The relevant alternative to a government mandate is voluntary labeling (Marchant, Cardineau, and Redick, 2010), an option now available for producers that want to certify their products as GMO-free (Roe, Teisl, and Deans, 2014, discuss these alternatives more generally). Similar schemes are also used by the substantial and growing organic foods sector; the dairy industry, in which some milk is labeled as rbST-free; and the egg industry, in which some eggs are labeled cage-free. Voluntary labels provide consumers with information while preserving or enhancing the choices available to them. Mandatory labels as proposed in Prop 37 would have the opposite effect. In addition, Alston and Sumner (2012) argued that Prop 37 would add significantly to costs for farmers and the food industry, which would raise costs to consumers; that removing GE technology would create negative environmental impacts from agricultural production; and that the longer-run costs would be much more serious because modern biotechnology holds the promise to reduce or eliminate a host of problems that plague producers, to improve products and production processes, and to enhance California's international competitiveness.

Political Spending, the Outcome, and the Aftermath

Some 51.4% of Californian voters opposed Prop 37, even though polls repeatedly reported 70% support less than a month before the election. Noting this discrepancy, McFadden and Lusk (2013)

[8] To have their food certified as organic, producers must not intentionally use GE inputs. However, organic certification does not require testing for GE content (e.g., Alston and Sumner, 2012; U.S. Department of Agriculture, Agricultural Marketing Service, National Organic Program, 2011).

[9] Alston and Sumner (2012) and Northbridge Environmental Management Consultants (2012) analyzed the likely consequences if Prop 37 were to pass and become law in California. In this section in particular we draw on the work in those reports.

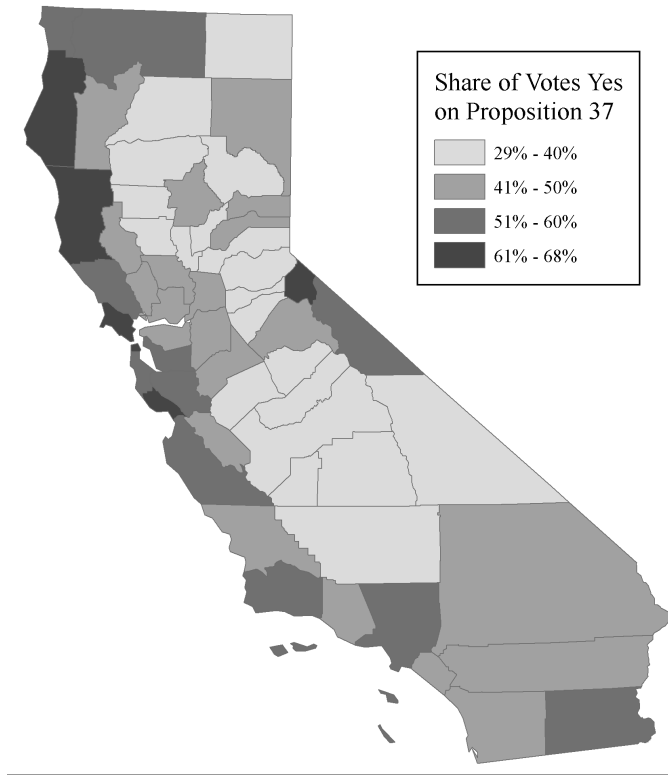

Figure 1. County-Level Support for Proposition 37

Notes: County-level support for Proposition 37 in California indicated by the colors in the legend at right.
Sources: Created by the authors using data from California Department of Food and Agriculture (2013) and University of California Regents (2014a).

conjectured that information from advocacy groups probably had some effect. To explore these possibilities, McFadden and Lusk (2013) used experimental economics methods to model the effects on respondents' stated voting intentions of 1) exposure to actual advertising messages used in the campaign and 2) (hypothetical) information about the effects of Prop 37 on food costs. They concluded that Californians would be willing to pay up to 13.8% higher food costs on average for a mandatory label and that the effectiveness of opposition advertising was likely a formative factor in the defeat of Prop 37.

If advertising was influential, the difference in spending by the two opposing campaigns might account for the outcome, even if it accounts for only some of the difference between the polls and the ballot. The "Yes" campaign raised $10.6 million to garner 6,077,714 votes (48.6%) while the "No" campaign raised $44.4 million to garner 6,422,370 votes (51.4%) (California Secretary of State, 2013).[10] Alternatively, hypothetical bias or behavioural dissonance between voting and purchasing decisions, which is sometimes referred to as the "citizen versus consumer" conflict (e.g., Berglund and Matti, 2006), might also account for some differences. In what follows we explore the detailed patterns of the electoral outcomes by voting precinct to see what we can infer about factors other than campaign spending that may have influenced the outcomes. To motivate some of that work, figures 1 and 2 illustrate the geographic patterns in the data at the level of the county and the relationships with support for Barack Obama and the importance of agriculture in the economy.

Figure 1 demonstrates that support for Prop 37 was concentrated in counties along the Pacific coast and in the San Francisco Bay area, with voters in four other, relatively unpopulated, counties

[10] For consistency in presenting data on campaign finance across states, we refer to the amount raised by campaigners rather than the amount spent.

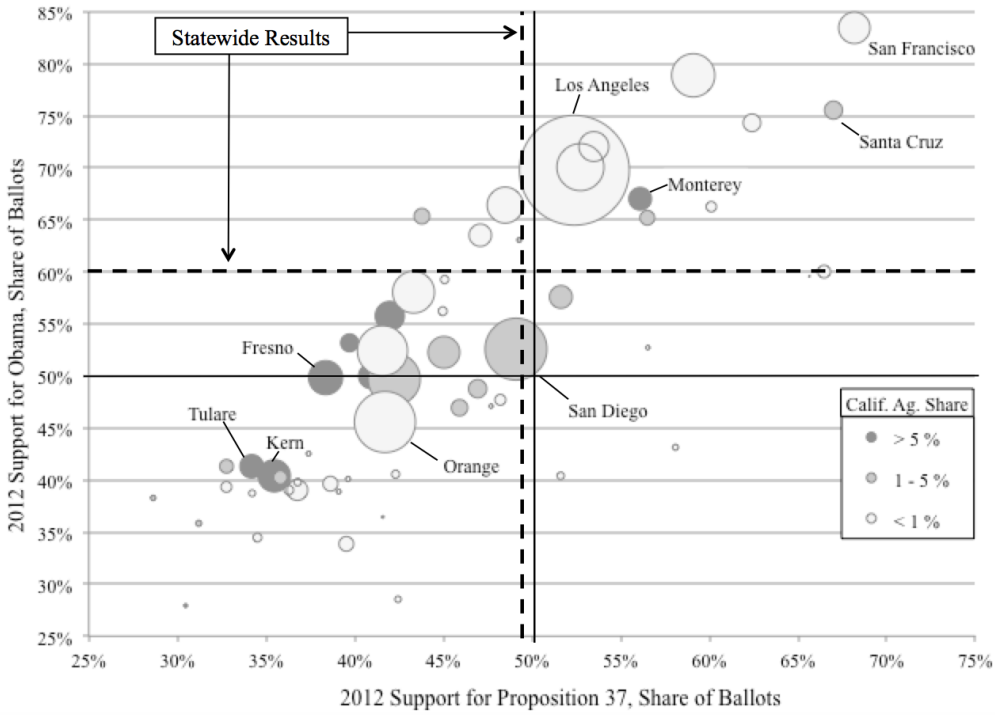

Figure 2. County-Level Support for Proposition 37 and Support for Barack Obama

Notes: Area of bubbles varies in proportion to total population of counties. Shading of bubbles indicates the value of agricultural production in the county as a share of agricultural production from California. Dashed lines represent the statewide support for Proposition 37 and Obama, respectively. *Sources:* Created by the authors using data from California Secretary of State (2013), California Department of Food and Agriculture (2013), University of California Regents (2014a), and California Department of Finance (2014).

also supporting the Proposition. Note that the Central Valley is the predominant agricultural region in the state, and that all counties in the Central Valley had less than 50% support for Prop 37. Figure 2 tells a similar story. Each circle represents one county, and the size of the circle represents the size of the county's population. Counties producing a larger share of the value of California's agricultural production are shaded more darkly. Most of the large agricultural producers opposed Prop 37, and these counties were less likely to support Obama. The exception is Monterey County, which is unusual in that its primary agricultural output is vegetables, it is near the coast, and, along with farmers and farmworkers, it has a significant population of affluent residents not employed in agriculture.

A Model

As discussed in the previous sections, various factors may have influenced choices by California voters to support or oppose Prop 37, and some of these factors can be linked to voters' social and economic characteristics. In this section we develop a voting model drawing on these ideas, conditioned by data available at the level of the electoral precinct.

General Form of the Model

Kahn and Matsusaka (1997) modelled voting behaviour on sixteen environmental propositions in California in order to model the demand for environmental public goods. We take inspiration from their approach in specifying a model of demand for mandated GE food labels, which might be seen, at least by some proponents, as a type of public good. The general form of the model is $D(I,X,P)$, such that a consumer's demand for mandated GE food labels depends on the consumer's income, I;

preferences, X (which may vary systematically with other observable socioeconomic variables); and the consumer-specific price for the good, P (which will depend on the consumer's food consumption patterns and whether the consumer has an interest as a producer). Since a labeling requirement is a collectively supplied good, individual prices and quantities are not observed, leaving us only indirect methods to characterize $D(\cdot)$.

We specify the dependent variable as the number of votes "Yes on Prop 37" expressed as a share of all votes on Prop 37.[11] Hence, a simplified econometric specification is given as

$$F_i = \beta_0 + \beta_1 I_i + \beta_2 P_i + \beta_3 X_i + u_i, \tag{1}$$

recognizing that I_i, P_i, and X_i all represent multiple variables. In this equation, $i = 1, \ldots, 16,728$ indexes a voting precinct, F_i is the fraction of votes in that precinct cast in favor of the proposition, u_i is a disturbance term, and β_j are unknown parameters to be estimated.[12]

Potential Explanatory Variables and Expected Signs of Effects

If Prop 37 had passed, producing non-exempt food without a GE label would have become significantly more expensive than producing the same food today because of the cost of certification and segregation as well as the use of more expensive ingredients. At the same time, we expect that the food industry and consumers would have shifted toward products that do not have a GE label, causing a further increase in the price of food. In this section we discuss some factors that may have led voters to support Prop 37 despite knowing that the price of food would increase and despite the prevailing evidence that the labeling required under Prop 37 would bring limited benefits.

We have characterized the arguments of equation (1) as being related to income, preferences, or voter-specific prices, noting that some of the variables used in our model are associated with both preferences and voter-specific prices. We include two variables related to income (I) in our regressions, both from U.S. Census Bureau (2013) data: per capita income and the unemployment rate. (See table 2 for detailed descriptions of all variables.) Given that passage of Prop 37 would have been expected to increase the price of many foods, we expected that support for Prop 37 would be comparatively low in areas with low per capita income. Similarly, we expected support for Prop 37 to be comparatively low in areas with high unemployment.

We include several variables related to preferences (X). Reasons given by opponents of GE technology for their opposition usually fall into one of three categories: that GE food causes human health problems, that it is harmful to the environment, or that it empowers and enriches multinational agribusinesses (both suppliers and buyers of food produced with GE technology).[13] Each of these reasons for opposing GE technology is also frequently associated with the views of supporters of the Democratic Party (e.g., Democratic National Committee, 2015b,a; Flowers, 2015). The California Democratic Party endorsed Prop 37, and this may have led some Democratic supporters to vote for Prop 37 even if they were indifferent to it. For this reason, we include in our regressions the local share of support for Barack Obama as an independent variable. In the appendix, we also examine 1) the effects of support for other Democratic candidates on support for Prop 37 and 2) the relationship between support for Prop 37 and support for Proposition 29—a referendum on the 2012 California

[11] It is common in studies using voting data to specify the dependent variable in log-of-the-odds form: $\ln(\rho_i)$, where $\rho_i =$ (votes in favor)/(votes in favor + votes against). We use the linear share to aid intuition and interpretation of coefficients.

[12] The fact that our data are precinct-level averages (estimated from census data at the tract level) rather than individual voter data affects the interpretation of estimated effects of economic and social variables on political outcomes. For example, one variable in our regressions is the share of workers employed in agriculture and related industries. If the coefficient on this variable were -0.5, it would imply that voters in areas with 10% more workers in agriculture and related industries were 5 percentage points less likely to support Prop 37 than voters in other areas.

[13] For examples of the rhetoric espoused by opponents of GE technology and supporters of mandatory GE labels, see, for example, http://www.carighttoknow.org/facts (accessed August 11, 2015). In a survey of Swiss voters faced with a referendum that imposed a five-year moratorium on the cultivation of GE crops in that country, Schläpfer (2008) found that supporters of the moratorium were more likely to believe that GE food is harmful to human health and that non-GM agriculture would better conserve natural diversity.

Table 2. Weighted Averages of Economic and Political Variables, Precinct-Level Observations

Variable	Weighted Mean	Standard Deviation of Unweighted Data
Votes for Barack Obama as share of two-party vote[a]	0.635	0.213
Share of adults (age 25 and older) with at least a bachelor's degree[b]	0.366	0.201
Share of Asians among adult citizens[b]	0.131	0.143
Share of blacks among adult citizens[b]	0.0656	0.120
Share of whites among adult citizens[b]	0.687	0.208
Share of Hispanics among adult citizens[b]	0.224	0.204
Share of females among adult citizens[b]	0.515	0.0434
Per capita income (thousands of dollars)[b]	36.412	18.986
Adults employed in agriculture and related industries, as a share of all workers[b]	0.0136	0.0473
Unemployment rate[b]	0.0995	0.0458
Old-age dependency ratio (number of adults 65 and older per adult under 65)[b]	0.235	0.261
Child-dependency ratio (number of children per adult under 65)[b]	0.364	0.122
Bushels of corn harvested per person (at county level)[c]	0.451	3.666
Farm sales of organic agricultural products ($m per capita, at county level)[c]	0.0364	0.109
Population density (thousands per square mile)[b]	8.110	9.499
Share of voters living in food deserts ("Vehicle" definition)[d]	0.0521	0.225
Share of votes Yes on Proposition 37[a]	0.498	0.140

Notes: $N = 16,728$ precincts with at least one vote cast for either Obama or Romney and at least one vote cast for or against Proposition 37. Means are weighted by the number of votes cast on Proposition 37 in each precinct.
Sources: [a]University of California Regents (2014a), University of California Regents (2014b); [b]U.S. Census Bureau (2014); [c]U.S. Department of Agriculture, National Agricultural Statistics Service (2015); [d]Ver Ploeg and Breneman (2013).

Primary Election ballot that would have increased the tax on cigarettes to fund cancer research—which provides insight on the extent to which voters' concerns about health determined their support for Prop 37.

Perspectives on social issues vary with education, race, ethnicity, gender, and age, and we hypothesize that these may have been reflected in voters' support for Prop 37. Our gender variable, the share of women among adult citizens (which closely reflects the voting population), is likely to be greater in poor areas with many single mothers and also in areas with large elderly populations (and thus more widows). For these groups, affordable food may be particularly important, and therefore we expect to see decreased support for Prop 37 in precincts with a greater share of females among adult citizens. Previous research has also suggested that women are more likely than men to oppose GE technology or avoid purchasing GE products (National Science Board, 2000; Blaine, Kamaldeen, and Powell, 2002). Both of our "age" variables are dependency ratios: the ratio of elderly (age 65 and older) to working-age adults (age 18 to 64) and the ratio of children (under age 18) to working-age adults. Again, the consumer-specific price effects of the passage of Prop 37 were likely to be especially important to the elderly and families with children. It is also important to note that the elderly and adults of typical child-rearing age spend less on food-away-from-home (as a share of total expenditures) than younger adults (U.S. Bureau of Labor Statistics, 2015a) and that food-away-from-home would not have been subject to a labeling requirement under Prop 37. Hence, the gender and age variables relate to both preferences and consumer-specific price effects. We have no clear view about the effects of education, race, and ethnicity on support for Prop 37 (or other regulations). Note that our gender, race, and ethnicity variables include only adult citizens, to better reflect the composition of the voting population. In addition to these variables, which cannot be observed at the level of individual voters, we include the population density of the census tract. We expected that residents of urban areas would have less connection to farming and would be more likely to misunderstand the role of GM technology in food production and so be more likely to support Prop 37.

The third category of variables relates to consumer-specific price effects. One indicator of the salience of Prop 37 for voters is the availability of food for which information on GE ingredients is provided using voluntary labels. Some grocery stores (particularly high-end ones) carry a range of products certified by the Non-GMO Project.[14] Grocery stores that carry "Non-GMO" products are not easily accessible to all consumers, and millions of California residents do not have easy access to large grocery stores of any kind. Census tracts where many residents have low incomes and do not live near conventional grocery stores or supermarkets are often termed "food deserts." We created a variable for the share of residents of each precinct who live within a food desert, according to the definition by Ver Ploeg and Breneman (2013), which incorporates access to a vehicle.[15] If consumers are concerned about GMO content, residents of food deserts will be more likely to support mandatory labeling for GE ingredients because they have poor access to food voluntarily labelled as Non-GMO and their cost of consuming products certain to be GMO-free would be reduced with the passage of such laws.

Prop 37 was likely to reduce the income of some farmers, farmworkers, and employees of agribusinesses. This voter-specific price effect would have been most important for those engaged in producing crops or ingredients for which GE varieties are in use. Corn is the only GE crop used directly as an ingredient in human food that is produced in economically significant quantities in California.[16] We include as independent variables in some regressions the share of workers employed in agriculture and related industries and the county's per capita production of corn for grain. Furthermore, farmers and farmworkers may have opposed Prop 37 because of concerns about the health effects of increased use of more toxic pesticides in growing non-GE varieties.

On the other side of the issue, growers and marketers of organic food were likely to gain income from passage of Prop 37 because of the blanket exemption for organic food from the labeling requirements. We thus included farm sales of organic products as another independent variable related to the voter-specific price effects of Prop 37.

Description of Data

The U.S. Census Bureau's American Community Survey (ACS) provides demographic and economic data (counts and averages) for each of California's 8,057 census tracts. Not all tracts are covered by any single edition of this survey, and the estimates presented here use the 2008–2012 edition of the survey, which provides a broad range of economic and social variables for 5,655 of California's census tracts.[17]

California had 23,671 electoral precincts in 2012, and each populated census tract contains part of one or more electoral precincts. The State of California's redistricting database includes precinct-level results for all statewide elections and all state Assembly, Senate, and Congressional elections since 1992, as well as the number of registered voters who live in each of the census tracts partially contained within each precinct.

[14] The Non-GMO Project was started by two co-operative 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.

[15] This definition of "food desert" is a low-income census tract (as defined by the Department of the Treasury's New Markets Tax Credit program) in which either 1) at least 100 residents live half a mile from a supermarket (or similar store) and have no access to a vehicle or 2) at least 500 residents or 33% of residents live at least twenty miles from supermarkets (or similar stores), regardless of vehicle access.

[16] Other economically important GE crops in California include alfalfa, cotton, and summer squash (which is grown in such limited quantities everywhere that we exclude it from our analysis).

[17] Other versions of this survey including data from 2012 are available, covering either 2010 to 2012 or 2012 alone, but these versions do not include as many variables or as many census tracts.

(a) (b)

Figure 3. Census Tract and Electoral Precinct Boundaries in Davis, California

Notes: (a) Indicates boundaries of census tracts.
(b) Indicates boundaries of electoral precincts.
Sources: Created by the authors from Google Maps image, with reference to data from U.S. Census Bureau (2013) and Yolo Elections Office (2009).

Census tracts may contain part or all of several precincts, and electoral precincts may also contain part or all of multiple census tracts.[18] Thus, to estimate average economic and social characteristics of the voting population in each precinct, we computed weighted averages of the corresponding measures in the census tracts constituting the precinct, using as weights the number of registered voters by census tract, within each precinct.[19] This method assumes that the average characteristics of voters within the same tract are the same as the average characteristics for precincts associated with the same tract. Figure 3 illustrates the concept of boundaries of census tracts and electoral precincts overlapping.

Regression Results and Interpretation

Using the 2008–2012 edition of the American Community Survey (ACS), we are able to obtain weighted estimates of economic variables for 16,805 electoral precincts representing 79.0% of votes cast on Prop 37.[20] The distribution of these votes is quite representative of those in the state as a whole: 49.8% of votes in the sample were in favor of Prop 37 compared with 48.6% in the state as a whole. Similarly, 63.5% of voters in the sample were in favor of Obama, while 60.2% of voters in the state supported Obama. (The census sample is somewhat skewed toward more densely populated areas, where voters tended to support both Prop 37 and Obama.)

The smaller precincts (those with fewer votes cast) tended to be in rural areas, which, as mentioned, tended to vote more strongly Republican (and against Prop 37). In addition, the variance of the vote outcome decreases as the number of votes increases. We control for this bias and heteroskedasticity by weighting the regressions by the number of votes cast for Prop 37 in each precinct such that the precincts with more voters receive more weight. Table 2 presents weighted averages of values for each economic or social variable at the precinct level and unweighted standard deviations.

As discussed, we use a simple share as the dependent variable (yes votes/total votes) to aid in interpretation of coefficients. Figure 4 displays the weighted cumulative distribution function of the share of support for Prop 37 by precinct. Over 80% of voters lived in precincts with 35–65% support for Prop 37. Over this region, the cumulative distribution function is essentially linear. Thus, the

[18] Populated census tracts ranged from 2 to 39,143 people according to the 2008–2012 ACS, with a mean of 4,657 and a median of 4,433. The size of precincts that contain any registered voters also varies dramatically, from 1 registered voter to 10,939, with a mean of 846 and a median of 905. Some tracts and precincts are listed in the databases but do not contain any residents or registered voters, respectively. The average precinct overlaps with part or all of 2.09 census tracts for which the 2008–2012 ACS provides data.

[19] In examining a different political issue, Costa and Kahn (2003) assigned the same weights using the same method.

[20] Of these, 16,728 precincts had at least one vote cast for both Prop 37 and the presidential election.

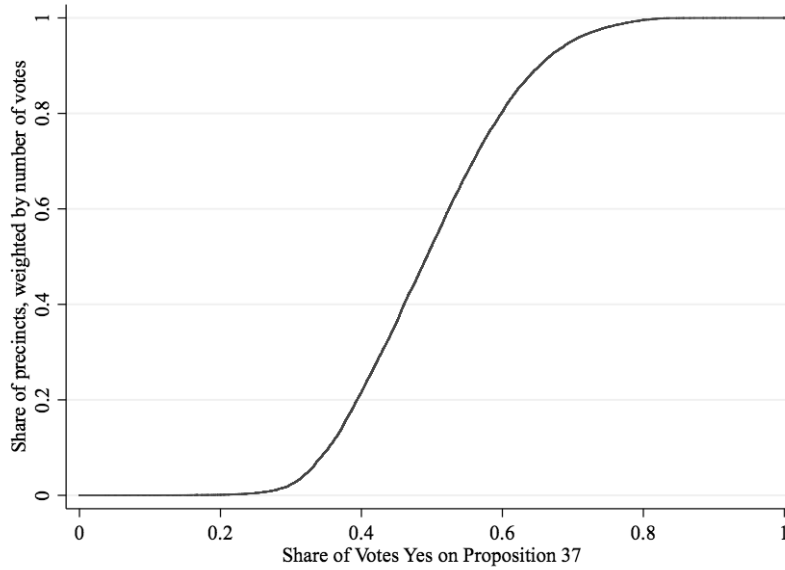

Figure 4. Cumulative Distribution of the Share of Support for Proposition 37, by Precinct, Weighted by Number of Votes

Notes: The x-axis represents the share of votes in favor of Proposition 37 at the precinct level, sorted in ascending order. The y-axis represents the share of all voters in California who lived in precincts with no more than (x) share of support for Proposition 37. Even though the number of voters varied significantly among precincts, no precinct had more than 8,436 voters (or 0.09% of the total number of votes), so the cumulative distribution appears smooth.
Sources: Created by the authors from University of California Regents (2014a).

choice to specify the dependent variable as a simple share rather than as a log-odds ratio raises no significant concern. We include only the precincts with at least one vote cast in both the Prop 37 referendum and the presidential election.

Table 3 presents results from a regression model of voter support for Prop 37 using precinct-level data on the variables described above. Nearly all of the estimated coefficients are statistically significant. We now interpret the coefficients from a political economy perspective.

Influence of Party Politics on Support for Proposition 37

The results in table 3 show the strong influence of the support for Barack Obama for president on predicted support for Prop 37. If support for Obama increased by 10 percentage points, predicted support for Prop 37 would increase by more than 5 percentage points, *ceteris paribus*—see table 3 and Appendix table A1. Support for Obama is by far the most important correlate of support for Prop 37. Support for other Democratic Party candidates was also strongly associated with support for Prop 37 (see Appendix). This was to be expected: in addition to several of the leading arguments in favor of Prop 37 being consistent with other positions favored by Democratic Party supporters, the California Democratic Party endorsed Prop 37, while the Republican Party did not take an official position on it.[21]

Effects of Other "Preference" Variables on Support for Proposition 37

If the share of the population with (at least) a bachelor's degree increased by 10 percentage points, predicted support for Prop 37 would increase by 0.62 to 0.65 percentage points—see table 3 and Appendix table A1. This estimated effect of education is surprising, if we think that being generally

[21] In other states that have recently faced similar ballot initiatives, the issue was more or less a partisan one. The Washington State Republican Party officially opposed Initiative 522, while several county-level Democratic organizations endorsed it (Yes on I-522 Committee, 2013). The Democratic Party of Denver endorsed Proposition 105, and Democratic Congressman Peter DeFazio supported Measure 92 in Oregon (Right to Know Colorado, 2014; Staver, 2014).

Table 3. Effects of Political and Economic Variables on Share of Support for Prop 37 at the Precinct Level in California, 2012

Variable	Coefficient
Share of support for Obama (among two major parties)	0.5053^{***}
	(0.0040)
Share of adults with at least a bachelor's degree	0.0651^{***}
	(0.0088)
Share of Asians among adult citizens	0.0442^{***}
	(0.0091)
Share of blacks among adult citizens	0.0209^{**}
	(0.0096)
Share of whites among adult citizens	0.0679^{***}
	(0.0082)
Share of Hispanics among adult citizens	-0.0871^{***}
	(0.0051)
Share of females among adult citizens	-0.1078^{***}
	(0.0169)
Per capita income ($10,000s)	-0.0256^{***}
	(0.0019)
Per capita income, squared ($10,000s)^2	$1.40 \times 10^{-3***}$
	(1.21×10^{-5})
Share of adults employed in agriculture	−0.0129
	(0.0154)
Unemployment rate	−0.0188
	(0.0130)
Old-age dependency ratio	-0.0289^{***}
	(0.0028)
Child dependency ratio	-0.0793^{***}
	(0.0054)
Log of bushels of corn for grain harvested per capita (county level)	$-2.51 \times 10^{-3***}$
	(2.00×10^{-4})
Farm sales of organic agricultural products ($ millions per capita, county level)	0.1021^{***}
	(0.0080)
Population density (persons per square mile)	$7.81 \times 10^{-7***}$
	(5.88×10^{-8})
Share of residents living in a food desert ("Vehicle" definition)	$6.26 \times 10^{-3***}$
	(2.26×10^{-3})
Constant	0.2561^{***}
	(0.0141)
N	16,728
R^2	0.804

Notes: Robust standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.
Sources: Authors' regression based on data from University of California Regents (2014a), University of California Regents (2014b), U.S. Census Bureau (2014), U.S. Department of Agriculture, National Agricultural Statistics Service (2015), Ver Ploeg and Breneman (2013).

better educated should imply that a voter would be better informed about and more likely to give weight to the scientific evidence indicating that GE food is safe to eat and environmentally beneficial. One possibility is that better-educated people are also more influenced by popular food writers, such as Michael Pollan and Mark Bittman, who advocated support for policies like Prop 37. Another is that this variable is picking up an effect of income or political party affiliation in addition to the

effects we have measured directly. By comparing columns (1) and (3) of Appendix table A1, one can see that when the education variable is removed, the positive effect of support for Obama on support for Prop 37 is slightly inflated and the negative effect of income on support for Prop 37 is slightly diminished.

Most of the variables for racial and ethnic composition of the census tracts had statistically significant effects: controlling for the local voting outcome for the presidential election and other factors, voters in precincts with more Asians and whites were more likely to support Prop 37, while voters in precincts with more Hispanic residents were less likely to support Prop 37. Voters in precincts with greater population densities were slightly more likely to support Prop 37, an effect we attribute, in part, to urban residents being less connected with farmers and farming and more likely to misunderstand the role of GE technology in food production. If the population density increased by 1,000 residents per square mile, predicted support for Prop 37 would increase by 0.07 to 0.08 percentage points.

The share of residents living in a food desert had a small but positive and statistically significant effect on support for Prop 37. For a 10 percentage point increase in the share of residents in a precinct living in a food desert, support for Prop 37 increased by 0.05 to 0.17 percentage points, reflecting our hypothesis that some people with poor access to larger grocery stores may find it difficult to ascertain information about GE ingredients in food products and be concerned about GE technology.

Our other "preference" variables—the share of women among adult citizens and the two age-dependency ratios—may also be thought of as consumer-specific price variables. Each of these variables had the expected negative relationship with support for Prop 37. A 10 percentage point increase in the share of women among the adult citizen population was associated with a 1.0 to 1.1 percentage point decrease in support for Prop 37. Increases in the old-age dependency ratio and the child dependency ratio by 10 percentage points were associated with decreases by 0.29 to 0.32 percentage points and 0.77 to 0.96 percentage points, respectively, in support for Prop 37, as seen in tables 3 and A1.

Effects of Income Variables and Voter-Specific Price Variables on Support for Proposition 37

Holding other variables constant, a rise in per capita income was associated with decreased support for Prop 37: at the mean, an increase in per capita income of $10,000 was associated with a decrease in support for Prop 37 of around 2.6 percentage points. The coefficient on per capita income squared is positive but does not completely offset the negative linear coefficient even at the right tail of the income distribution. The unemployment rate did not have a statistically significant effect on support for Prop 37 in the main regression but had the predicted negative sign in all other specifications (in table A1). The main regression controls for both the food desert variable and education, which are strong correlates for unemployment. As discussed above, both the share of women among adult citizens and the two age-dependency measures had negative effects on predicted support for Prop 37. These variables may be interpreted either as preference variables—that women and men have different preferences, and that age affects views about Prop 37—or as price variables, reflecting that food prices may matter more to women (e.g., as single parents) and the elderly than to other groups.

Estimates in table 3 show that the share of adults employed in agriculture and related industries, among all workers, had an insignificant effect on support for Prop 37 when controlling for all other variables, including county-level corn production and organic sales per capita. The latter variables had the expected effects: as corn production per capita rose, support for Prop 37 decreased, and as farm-level organic product sales per capita rose, support for Prop 37 increased. The measures of these variables, from the 2012 Census of Agriculture (U.S. Department of Agriculture, National Agricultural Statistics Service, 2015), reflect county-level production and sales and are not as localized as the other data used to explain support for Prop 37.

Summary of Regression Analysis for California

In our regression analysis, the most important predictor of local support for Prop 37 in California was whether voters also supported Barack Obama for president. Holding constant many other social and economic variables, support for Prop 37 increased by more than 5 percentage points when support for Obama increased by 10 percentage points. Given that the California Democratic Party endorsed Prop 37 and that many opponents of GE technology support their position by appealing to causes celebrated by many Democrats, this finding is not surprising. Other variables with important effects on predictions of local support for Prop 37 were per capita income, some racial and ethnic variables, corn production, organic agricultural sales, and the age distribution of the population. The effects related to agricultural production and sales are intuitive: in counties with more per capita production of GE crops, support for Prop 37 was lower, while in counties with more sales per capita of organic crops, support for Prop 37 was higher. We have discussed how the age variables may relate to either preferences or consumer-specific price effects, and the findings conform with our hypotheses about these variables.

Two other major findings from our regression analysis bear more careful attention. Given the scientific evidence that GE brings environmental benefits without health or environmental harm, we expected that better-educated voters would have been more likely to oppose Prop 37. Our results contradicted this expectation. One possibility is that voters with higher educational attainments were influenced more than the general population by the advertisements and rhetoric of the campaign supporting passage of Prop 37 or the broader argument against GE technology. Alternatively, this variable might be picking up other factors not fully captured elsewhere in the model. For example, voters with higher educational attainments typically also have higher incomes, and we hypothesized that higher-income consumers would be more likely to support Prop 37. If our model did not fully capture this effect, the coefficient on the education variable might have been biased as a result.

Prior to conducting the analysis, we hypothesized that support for Prop 37 would rise with per capita income, for several reasons. Voters with higher incomes would have incurred a smaller burden, as a share of income, from the passage of Prop 37. Adding to this standard Engel relationship were effects of the specifics of the policy that exempted food away from home. Higher-income consumers tend to spend much more than lower-income consumers on food away from home, both absolutely and as a share of their food budget (U.S. Bureau of Labor Statistics, 2015b). Recall that, under Prop 37, food served in restaurants would not have been required to be labeled, so the relative food prices would have risen less for higher-income consumers than for lower-income consumers. Further, to the extent that GM-free food products were (incorrectly) perceived to be an environmental bad or a health risk, higher-income consumers may also have had greater demand for these attributes.

In contrast with our expectations, however, we found that support for Prop 37 decreased with an increase in per capita income.[22] One possibility is that per capita income is serving as a proxy for other factors that have not been fully captured by the other variables included in the model—such as advanced educational degrees. The fact that the signs of the measured effects of both education and income are surprising could reflect this kind of effect. Finally, note that per capita income does not reflect the income of the median voter or any other subset of voters, and analysis of income distributions at the precinct level might reveal different conclusions about the relationship between income and support for Prop 37.

Projection of Support for GM Labeling in Other States

In this section, we extrapolate from the election results in California, Colorado, Oregon, and Washington to predict support for GM labeling in other states. For this prediction, we use county-level results from each of the four states (see table 4), rather than more localized results (such as precinct and census tract) because 1) precinct-tract mapping is not available for states other than

[22] The quadratic income term implies that support for Prop 37 increased with income only when per capita income was greater than $201,000. No electoral precinct in California had a per capita income that high.

California and 2) using the precinct-level election results from California to predict county-level results in other states gives confidence intervals that are unreasonably tight because the populations of precincts are so much smaller than those of counties.

Using a slight variation of the main precinct-level regression used for California (table 3),[23] we estimate that a majority of voters in only three states—Hawaii, Rhode Island, and Vermont—plus the District of Columbia, would have supported a measure like Prop 37 had they faced it in the 2012 general election.[24] Table 5 presents the predicted share of voters in each state that would have supported such a ballot measure, with a 95% confidence interval (assuming that prediction errors are normally distributed). So far, our prediction is close to reality. Three of Hawaii's four counties have passed ordinances or referendums banning the cultivation of GM crops (except for papaya).[25] In 2014, the Vermont legislature passed the first unconditional statewide labeling requirement for GM ingredients. Our model predicts that both Maine and Connecticut, states whose legislatures passed conditional labeling requirements in 2013, are among the twelve states most likely to have supported GM labeling requirements in 2012. Our model accurately predicts rejection of GM labeling laws for each of the four states whose voters recently faced a referendum (namely, California, Colorado, Oregon, and Washington), with especially accurate results in California (the only state that faced a referendum in 2012).

Given the prevalence of referendums and bills on GM labeling in recent years in certain locations, it would be wise to expect activists to target additional states to legislate GM labeling (if permitted under federal law). Likely candidates would include the District of Columbia, Hawaii, Rhode Island, and Massachusetts, the latter two states being strong candidates for intense GM-labeling activism because of conditional laws in place in Connecticut and Maine. To a lesser extent, based on our predictions, Nevada, New York, New Jersey, or Michigan may be likely to support GM labeling.

A few caveats are worth noting with regard to our predictions of voting outcomes in other states. Most important, because the voting outcome in the presidential election was so important in predicting the outcome of the GM labeling referendums, and support for politicians and political parties may vary widely year-to-year, our predictions certainly should not be taken literally with respect to the outcomes of future referendums.

In addition, it is presumed that campaign spending and effective advertising may sway the outcomes of elections. We opted not to include campaign spending in our regressions or predictions for a few reasons. First, data on the geographical distribution of spending is vague: television or newspaper advertisements are not specific to either precincts or counties. Second, the effect of advertising spending on election outcomes, like the effect of advertising on consumer demand, is endogenous. If campaigners believe that certain areas have many swing voters, they are likely to spend more on advertisements in those areas. We do not have the ability to identify the effect of a dollar of campaign expenditures without a control (untreated) group of precincts or counties.

Two states have unusual administrative structures that may affect our predictions. Virginia has 95 counties and, in 2012, had 39 independent cities, which function independently from counties in all government respects but are often completely contained within counties. Some of Virginia's independent cities have very small populations, and city-level observations in Virginia may bias the predictions for that state in favor of Prop 37 (because of, for example, opposition to

[23] The regression used for the prediction in this section uses county-level observations of variables from the 2008–2012 American Community Survey and results from the 2012 presidential election as independent variables and weights observations by the number of votes cast for the two major parties in the 2012 presidential election. See table 4 for a list of sources for the elections data.

[24] For Colorado, Oregon, and Washington, the dependent variable in the regression is the actual county-level vote outcome in 2013 or 2014, even though the independent variable used for political affiliation (votes for Obama) is from the local outcome of the 2012 general election.

[25] Hawaii technically has five counties. One, Kalawao, is a former colony for leprosy patients with a population of several dozen and zero votes cast in the 2012 election.

Table 4. List of Sources for County-Level Voting Results, 2012 Presidential Election

State	Source
Alabama	http://www.alabamavotes.gov/ElectionsData.aspx
Arizona	http://www.azsos.gov/elections/voter-registration-historical-election-data
Arkansas	http://www.sos.arkansas.gov/elections/Pages/Research.aspx
Colorado	http://www.sos.state.co.us/pubs/elections/Results/Abstract/2012/general/president.html
Connecticut	http://www.ct.gov/sots/cwp/view.asp?a=3179&q=489624
Delaware	http://elections.delaware.gov/archive/elect12/elect12_election_index.shtml
District of Columbia	https://www.dcboee.org/election_info/election_results/2012/November-6-General-Election/
Florida	http://election.dos.state.fl.us/elections/resultsarchive/Index.asp?ElectionDate=11/6/2012&DATAMODE=
Georgia	http://sos.ga.gov/index.php/Elections/current_and_past_elections_results
Hawaii	http://hawaii.gov/elections/results/2012/
Idaho	http://www.sos.idaho.gov/elect/results/index.html
Illinois	http://www.elections.state.il.us/ElectionResults.aspx?ID=33
Indiana	http://www.in.gov/apps/sos/election/general/general2012
Iowa	http://sos.iowa.gov/elections/results/#11
Kansas	http://www.kssos.org/elections/elections_statistics.html
Kentucky	http://elect.ky.gov/results/2010-2019/Pages/default.aspx
Louisiana	http://staticresults.sos.la.gov/11062012/Default.html
Maine	http://www.maine.gov/sos/cec/elec/results/index.html
Maryland	http://www.elections.state.md.us/elections/2012/index.html
Massachusetts	http://www.sec.state.ma.us/ele/ele12/ele12idx.htm
Michigan	http://www.michigan.gov/sos/0,4670,7-127-1633_8722—,00.html
Minnesota	http://electionresults.sos.state.mn.us/
Mississippi	http://www.sos.ms.gov/Elections-Voting/Pages/Results-2012.aspx
Missouri	http://enrarchives.sos.mo.gov/enrnet/default.aspx?eid=750002497
Montana	http://sos.mt.gov/elections/Results/
Nebraska	http://electionresults.sos.ne.gov/resultsSW.aspx?type=SEARCH&text=2012
Nevada	http://nvsos.gov/index.aspx?page=93
New Hampshire	http://sos.nh.gov/2012GenElectResults.aspx
New Jersey	http://www.state.nj.us/state/elections/election-information-archive.html
New Mexico	http://www.sos.state.nm.us/Elections_Data/2012.aspx
New York	http://www.elections.ny.gov/2012ElectionResults.html
North Carolina	https://www.ncsbe.gov/ncsbe/Election-Results
North Dakota	http://results.sos.nd.gov/ArchivedElections.aspx
Ohio	http://www.sos.state.oh.us/SOS/elections/Research/electResultsMain/2012Results.aspx
Oklahoma	http://www.ok.gov/elections/Election_Info/Election_Results/2012-ElectionResults.html
Oregon	http://sos.oregon.gov/elections/Documents/results/results-11-2012.pdf
Pennsylvania	http://www.electionreturns.state.pa.us/Default.aspx?EID=27&ESTID=2&CID=0&OID=0&CDID=0&PID=0&DISTID=0&IsSpecial=0
Rhode Island	http://www.ri.gov/election/results/2012/general_election/
South Carolina	http://www.enr-scvotes.org/SC/42513/116143/en/summary.html
South Dakota	https://sdsos.gov/search/default.aspx?q=2012%20general%20results
Tennessee	https://www.tn.gov/sos/election/results/2012-11/index.htm
Texas	http://elections.sos.state.tx.us/index.htm
Utah	http://elections.utah.gov/election-resources/2012-election-information
Vermont	https://www.sec.state.vt.us/elections/election-results/election-results-search.aspx?primaryFilterId=12449&secondaryFolderName=2012+Election+Results&q=
Virginia	https://voterinfo.sbe.virginia.gov/election/DATA/2012/68C30477-AAF2-46DD-994E-5D3BE8A89C9B/Official/1_s.shtml
Washington	https://wei.sos.wa.gov/agency/osos/en/press_and_research/PreviousElections/2012/General-Election/Pages/Results.aspx
West Virginia	https://apps.sos.wv.gov/elections/results/Default.aspx?year=2012&eid=13
Wisconsin	http://gab.wi.gov/elections-voting/results/2012/fall-general
Wyoming	http://soswy.state.wy.us/Elections/Docs/2012/2012GeneralResults.aspx

Notes: Accessed November 2014.

Table 5. Predicted Share of Voters in each State that Would Have Supported Legislation like Proposition 37 in the 2012 General Election

State	Predicted Share	State	Predicted Share	State	Predicted Share	State	Predicted Share	State	Predicted Share
AL	0.275 ± 0.032	*HI*	0.587 ± 0.114	MA	0.459 ± 0.015	NM	0.397 ± 0.028	SD	0.279 ± 0.016
AZ	0.340 ± 0.021	ID	0.296 ± 0.012	MI	0.412 ± 0.026	NY	0.419 ± 0.042	TN	0.300 ± 0.032
AR	0.277 ± 0.022	IL	0.386 ± 0.035	MN	0.359 ± 0.012	NC	0.332 ± 0.020	TX	0.250 ± 0.019
CA	$\mathbf{0.484 \pm 0.006}$	IN	0.317 ± 0.015	MS	0.245 ± 0.027	ND	0.283 ± 0.017	UT	0.194 ± 0.021
CO	$\mathbf{0.392 \pm 0.012}$	IA	0.330 ± 0.010	MO	0.312 ± 0.022	OH	0.356 ± 0.017	*VT*	0.501 ± 0.014
CT	0.415 ± 0.025	KS	0.270 ± 0.014	MT	0.378 ± 0.014	OK	0.278 ± 0.018	VA	0.343 ± 0.016
DE	0.359 ± 0.052	KY	0.298 ± 0.016	NE	0.258 ± 0.017	**OR**	$\mathbf{0.476 \pm 0.010}$	**WA**	$\mathbf{0.474 \pm 0.010}$
DC	0.555 ± 0.204	LA	0.255 ± 0.031	NV	0.463 ± 0.023	PA	0.369 ± 0.021	WV	0.308 ± 0.010
FL	0.392 ± 0.025	ME	0.450 ± 0.012	NH	0.414 ± 0.015	*RI*	0.502 ± 0.023	WI	0.362 ± 0.015
GA	0.309 ± 0.031	MD	0.372 ± 0.045	NJ	0.411 ± 0.018	SC	0.299 ± 0.025	WY	0.276 ± 0.016

Notes: Predicted shares are given with 95% confidence intervals, assuming prediction errors are normally distributed. States with referendums on GM labeling, since 2012, are indicated with boldface. States predicted to support Proposition 37 in the 2012 general election, plus the District of Columbia, are indicated with italics. As discussed in the text, Alaska is not included here.
Sources: Authors, using data from U.S. Census Bureau (2012), U.S. Census Bureau (2014), U.S. Department of Agriculture, National Agricultural Statistics Service (2015), Ver Ploeg and Breneman (2013), Washington Secretary of State (2013), University of California Regents (2014a), Colorado Election Results (2014), Oregon Secretary of State (2014), and 2012 presidential election results (given in table 4).

labeling in rural counties that happen to have a small independent city within their borders). Alaska is not included in our analysis, because the administrative divisions there do not correspond with census areas. Presumably, in view of the strong support for Republican candidates in Alaska, GM labeling regulations would not gain strong support there (irrespective of the state law, passed by the legislature in 2005, to require labeling of GE fish).

Conclusion

California's Proposition 37 would have mandated labels for certain foods and beverages purchased for home consumption if they were "or may have been entirely or partially produced" with genetic engineering. Our analysis of the patterns of voting on Prop 37 at the precinct level shows that various economic and social variables influenced support for the referendum. Precinct-level support for Obama in the 2012 presidential election was the most important predictor of support for Prop 37. Voters' education and income also played important roles, although they did not have the expected signs: predicted support for Prop 37 was higher in precincts where voters were better educated and lower in precincts with higher per capita income. These surprising findings might reflect biases resulting from our use of variables to represent education and income that did not fully capture their effects, such as our use of average income at the precinct level, and an indicator for post-secondary education that did not account for higher degrees. Lastly, race and ethnicity variables had some important effects on predicted support for Prop 37.

The main results can be rationalized in terms of the arguments put forth by proponents and opponents of GE technology and mandatory GM labels. Some groups might see GM labels as a private good or to some extent a public good if they take the view that GMOs are bad because they threaten the environment or human health or because they empower and enrich multinational corporations. If these social concerns were more popular among better-educated people or voters from certain ethnic groups, this might help explain some aspects of our estimates, including the surprising signs on the effects of education and income. To some extent, environmental concerns, concerns about public health, and dislike of corporations are characteristic of Democratic Party voters. Other supporters of Prop 37 might not have had clear views of the issue but went along with the Democratic Party platform.

Opponents of Prop 37 probably included many people who believed that GMO technology is safe (as most authorities claim) and that mandatory GM labels would do more to scare consumers than to inform them, while probably adding to the cost of food and resulting in reduced choice. Others may have opposed Prop 37 merely because the Democratic Party supported it. Finally, some opponents or supporters of Prop 37 and similar regulations might have affiliated with groups who had a vested interest of some sort, such as the organic food sector or the GM food sector. We found that precinct- and county-level support for Prop 37 was in part determined by the local economic importance of organic agriculture and corn for grain (the only GM food crop produced with any significant commercial value in California).

Our results have implications for what may be expected in terms of both future proposals of mandatory labels for GM foods and the political outcomes. Washington, Colorado, and Oregon voters faced referendums very similar to Prop 37 in 2013 and 2014. We used county-level election results from these states and California to predict the results of hypothetical referendums in each county in the United States, had voters in those counties faced their own referendums in 2012. We found that voters in only three states—Hawaii, Rhode Island, and Vermont—and the District of Columbia would have supported such a referendum. These results are highly reasonable given the history of relevant legislation in Hawaii, Vermont, and other New England states.

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Appendix: Alternative Regression Specifications for California

In this appendix, we present several alternative regression specifications for precinct-level voting outcomes in California. Table A1 presents several regression specifications using the same regressors as in the regression presented in table 3. These regressions support the robustness of the regression presented in table 3. Column (1) of table A1 presents the results of a univariate regression with support for Obama as the dependent variable and shows that, for a 10 percentage point increase in support for Obama, support for Proposition 37 increased by about 5.2 percentage points. The other regression specifications, in columns (2) through (7), indicate a similar magnitude of effect. Demographic variables have generally similar coefficient estimates across the regressions presented in columns (2) through (7). Support for Prop 37 took a quadratic form with respect to per capita income, declining at a decreasing rate up to an income of at least $162,000 in all regression specifications, greater than the per capita income in all but four of the more than 16,000 precincts in our data set.

The effect of agricultural employment on local support for Prop 37 was ambiguous, and was statistically insignificant in six of the eight regressions in tables 3 and A1. The magnitude of the coefficients on unemployment and the two age-dependency ratios (all negative) were quite consistent across all regression specifications in table A1. Column (4) also confirms the robustness of the finding in table 3 that support for Prop 37 increased when the share of the population with a bachelor's degree increased.

The regression presented in column (3) indicates that, in electoral precincts where a higher share of residents lived in a food desert, support for Prop 37 increased, similar to the effects estimated in table 3. The regressions in table A1 also confirm the effects estimated in table 3 of population density and production of corn and organics on support for Prop 37.

We investigated the relationships between alternative political variables and support for Prop 37 in a series of regressions presented in table A2. Column (1) demonstrates a strong correlation between support for Prop 29—which would have increased the tax on cigarettes—and support for Prop 37.[26] However, support for Prop 29 clearly was not a perfect proxy for support for Obama, as the signs of several other coefficients in column (1) differ from the corresponding coefficients in table 3. The regression in column (2) adds the share of support for Obama to the regression in column (1), which shows that the inclusion of the Prop 29 variable dampens the effect of support for Obama on support for Prop 37. In other words, conditional on support for Obama, supporters of Prop 29 were somewhat more likely than opponents of Proposition 29 to also support Prop 37. However, this model has worse explanatory power than the main model in table 3 because about 3,000 precincts had some ballots returned for Prop 37 but not for Prop 29 (which was on the 2012 Primary Election ballot).

Finally, we considered alternative regressions in which the explanatory political variable was either support for the local Democratic Party candidate(s) for the House of Representatives or support for Dianne Feinstein for the Senate. As we expected, because of heterogeneity in personalities and other local idiosyncrasies, correlation between support for local Democratic Congressional candidates and support for Prop 37 was not strong (see table A2, column 3). As a consequence, we do not devote any attention to the coefficient estimates from that regression. However, support for Feinstein had a nearly identical effect on support for Prop 37 as support for Obama did (see table A2, column 4). The signs and magnitudes of nearly all coefficients in column 4 are similar to those in the main regression in table 3, again verifying the robustness of our estimates of the economic incentives to support Prop 37.

[26] We reasoned that supporters of Prop 37, which increased regulation of a product believed by some to be unhealthy or harmful to the environment, might have had similar views on GMOs and cigarettes.

Table A1 (Part 1). Effects of Political and Economic Variables on Share of Support for Proposition 37 at the Precinct Level in California, 2012, Alternative Specifications

	(1)	(2)	(3)	(4)
Share of support for Obama (among two major parties)	0.5182***	0.5567***	0.5558***	0.5464***
	(0.0026)	(0.0036)	(0.0036)	(0.0040)
Share of Asians among adult citizens		0.0526***	0.0531***	0.0392***
		(0.0091)	(0.0091)	(0.0092)
Share of blacks among adult citizens		-2.73×10^{-3}	-4.29×10^{-3}	-6.30×10^{-4}
		(0.0098)	(0.0098)	(0.0098)
Share of whites among adult citizens		0.0716***	0.0716***	0.0669***
		(0.0084)	(0.0084)	(0.0083)
Share of Hispanics among adult citizens		−0.1020***	−0.1008***	−0.0942***
		(0.0052)	(0.0053)	(0.0053)
Share of females among adult citizens		−0.0990***	−0.1008***	−0.1015***
		(0.0156)	(0.0155)	(0.0176)
Per capita income ($10,000s)		−0.0184***	−0.0178***	−0.0273***
		(0.0012)	(0.0012)	(0.0020)
Per capita income, squared ($10,000s)^2		1.12×10^{-3}***	1.08×10^{-3}***	1.52×10^{-3}***
		(9.30×10^{-5})	(9.40×10^{-5})	(1.22×10^{-4})
Share of adults employed in agriculture		0.0109	9.21×10^{-3}	0.0223
		(0.0143)	(0.0144)	(0.0142)
Unemployment rate		−0.0454***	−0.0479***	−0.0287**
		(0.0136)	(0.0136)	(0.0134)
Old-age dependency ratio		−0.0314***	−0.0316***	−0.0299***
		(0.0029)	(0.0030)	(0.0028)
Child dependency ratio		−0.0911***	−0.0913***	−0.0893***
		(0.0052)	(0.0053)	(0.0053)
Share of residents living in a food desert ("Vehicle" definition)			8.69×10^{-3}***	
			(0.0023)	
Share of adults with at least a bachelor's degree				0.0621***
				(0.0092)
Population density (persons per square mile)				
Log of bushels of corn for grain harvested per capita (county level)				
Farm sales of organic agricultural products, ($ millions per capita, county level)				
Constant	0.1692***	0.2559**	0.2556***	0.2667***
	(0.0016)	(0.0127)	(0.0127)	(0.0144)
Observations	16,728	16,728	16,728	16,728
R^2	0.743	0.793	0.793	0.795

Notes: Robust standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.

Sources: Authors' regressions based on data from University of California Regents (2014a), University of California Regents (2014b), U.S. Census Bureau (2014), U.S. Department of Agriculture, National Agricultural Statistics Service (2015), Ver Ploeg and Breneman (2013).

Table A1 (Part 2). Effects of Political and Economic Variables on Share of Support for Proposition 37 at the Precinct Level in California, 2012, Alternative Specifications

	(5)	(6)	(7)
Share of support for Obama (among two major parties)	0.5474***	0.5296***	0.5170***
	(0.0038)	(0.0036)	(0.0038)
Share of Asians among adult citizens	0.0511***	0.0586***	0.0577***
	(0.0091)	(0.0090)	(0.0090)
Share of blacks among adult citizens	-1.20×10^{-3}	0.0163*	0.0193**
	(0.0097)	(0.0097)	(0.0096)
Share of whites among adult citizens	0.0769***	0.0685***	0.0731***
	(0.0083)	(0.0083)	(0.0082)
Share of Hispanics among adult citizens	−0.1071***	−0.0926***	−0.0968***
	(0.0053)	(0.0051)	(0.0051)
Share of females among adult citizens	−0.1016***	−0.0999***	−0.1040***
	(0.0153)	(0.0152)	(0.0149)
Per capita income ($10,000s)	−0.0172***	−0.0184***	−0.0167***
	(0.0012)	(0.0012)	(0.0012)
Per capita income, squared ($10,000s)^2	1.02×10^{-3}***	1.13×10^{-3}***	1.00×10^{-3}***
	(9.54×10^{-5})	(9.09×10^{-5})	(9.32×10^{-5})
Share of adults employed in agriculture	0.0286**	−0.0275*	−0.0223
	(0.0143)	(0.0159)	(0.0157)
Unemployment rate	−0.0379***	−0.0439***	−0.0338**
	(0.0135)	(0.0132)	(0.0131)
Old-age dependency ratio	−0.0302***	−0.0315***	−0.0301***
	(0.0028)	(0.0030)	(0.0029)
Child dependency ratio	−0.0770***	−0.0957***	−0.0801***
	(0.0053)	(0.0052)	(0.0053)
Share of residents living in a food desert ("Vehicle" definition)			
Share of adults with at least a bachelor's degree			
Population density (persons per square mile)	6.99×10^{-7}***		8.28×10^{-7}***
	(5.58×10^{-8})		(5.80×10^{-8})
Log of bushels of corn for grain harvested per capita (county level)		-2.55×10^{-3}***	-2.40×10^{-3}***
		(2.00×10^{-4})	(1.99×10^{-4})
Farm sales of organic agricultural products, ($ millions per capita, county level)		0.0871***	0.0999***
		(0.0081)	(0.0082)
Constant	0.2459***	0.2540***	0.2445***
	(0.0126)	(0.0124)	(0.0123)
Observations	16,728	16,728	16,728
R^2	0.795	0.800	0.802

Notes: Robust standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.
Sources: Authors' regressions based on data from University of California Regents (2014a), University of California Regents (2014b), U.S. Census Bureau (2014), U.S. Department of Agriculture, National Agricultural Statistics Service (2015), Ver Ploeg and Breneman (2013).

Table A2. Effects of Political and Economic Variables on Share of Support for Proposition 37 at the Precinct Level in California, 2012, Alternative Political Variables

	(1)	(2) President	(3) Congress	(4) Senate
Share of adults with at least a bachelor's degree	0.0787***	0.0488***	0.1864***	0.0811***
	(0.0141)	(0.0099)	(0.0131)	(0.0094)
Share of Asians among adult citizens	−0.0159	0.0327***	0.0236**	0.0158*
	(0.0110)	(0.0094)	(0.0116)	(0.0092)
Share of blacks among adult citizens	0.1938***	0.0431***	0.0144***	0.0308***
	(0.0115)	(0.0100)	(0.0122)	(0.0098)
Share of whites among adult citizens	-1.48×10^{-3}	0.0585***	-5.13×10^{-3}	0.0618***
	(0.0099)	(0.0084)	(0.0104)	(0.0083)
Share of Hispanics among adult citizens	0.0376***	−0.0707***	7.41×10^{-3}	−0.0789***
	(0.0056)	(0.0053)	(0.0062)	(0.0051)
Share of females among adult citizens	−0.0399	−0.1035***	−0.0819***	−0.1253***
	(0.0342)	(0.0208)	(0.0314)	(0.0188)
Per capita income ($10,000s)	−0.0361***	−0.0260***	−0.0401***	−0.0290***
	(0.0033)	(0.0022)	(0.0030)	(0.0021)
Per capita income, squared ($10,000s)^2	1.99×10^{-3}***	1.47×10^{-3}***	2.01×10^{-3}***	1.35×10^{-3}***
	(1.95×10^{-4})	(1.33×10^{-4})	(1.78×10^{-4})	(1.26×10^{-4})
Share of adults employed in agriculture	8.67×10^{-3}	-9.31×10^{-3}	−0.0199	−0.0159
	(0.0218)	(0.0171)	(0.0208)	(0.0159)
Unemployment rate	0.0702***	8.01×10^{-3}	0.0500***	−0.0261*
	(0.0181)	(0.0138)	(0.0179)	(0.0135)
Old-age dependency ratio	−0.0434***	−0.0312***	−0.0386***	−0.0356***
	(0.0063)	(0.0046)	(0.0041)	(0.0034)
Child dependency ratio	−0.1919***	−0.0905***	−0.1898***	−0.0890***
	(0.0071)	(0.0058)	(0.0072)	(0.0057)
Log of bushels of corn for grain harvested per capita (county level)	-5.25×10^{-3}***	-2.43×10^{-3}***	-4.63×10^{-3}***	-2.62×10^{-3}***
	(2.93×10^{-4})	(2.32×10^{-4})	(2.55×10^{-4})	(2.06×10^{-4})
Farm sales of organic agricultural products ($ millions per capita, county level)	0.1474***	0.0959***	0.2445***	0.1010***
	(0.0101)	(0.0091)	(0.0093)	(0.0080)
Population density (persons per square mile)	1.58×10^{-6}***	6.95×10^{-7}***	1.72×10^{-6}***	8.21×10^{-7}***
	(1.25×10^{-7})	(7.00×10^{-8})	(1.07×10^{-7})	(6.09×10^{-8})
Share of residents living in a food desert ("Vehicle" definition)	8.43×10^{-3}***	5.16×10^{-3}**	0.0171***	6.85×10^{-3}***
	(0.0030)	(0.0024)	(0.0030)	(0.0023)
Share of support for Proposition 29	0.4828***	0.1029***		
	(0.0068)	(0.0073)		
Share of support for Democrat (between two major parties)		0.4324***	0.2093***	0.5099***
		(0.0064)	(0.0041)	(0.0043)
Constant	0.3413***	0.2577***	0.4552***	0.2759***
	(0.0252)	(0.0164)	(0.0236)	(0.0153)
N	13,353	13,352	16,720	16,730
R^2	0.690	0.795	0.644	0.794

Notes: Robust standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) represent significance at the 10%, 5%, and 1% level.

Sources: Authors' regressions based on data from University of California Regents (2014a), University of California Regents (2014b), U.S. Census Bureau (2014), U.S. Department of Agriculture, National Agricultural Statistics Service (2015), Ver Ploeg and Breneman (2013).