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Animal Welfare Ballot Initiatives and the Vote-Buy Gap

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Abstract: We provide empirical evidence to explain the apparent discrepancy between consumption choices and voting outcomes for a recent high-profile animal welfare case: California's ban of eggs produced with caged hens. The model juxtaposes the private good aspect of buying decisions with the public good aspect of voting, and yields testable propositions for the vote-buy gap. These implications are evaluated in a revealed-preferences setting using a novel combination of voting and egg-purchase data. Results show that the vote-buy gap depends on the egg price differential, and the distribution of consumers' heterogeneous preference for animal welfare issues.

Keywords: animal welfare; ballot initiatives; consumer heterogeneity; differentiated products; public goods; vote-buy gap

JEL Classification: D12; D72; Q18

1 Introduction

In November 2018 California voters overwhelmingly passed (61 %) a ballot measure that completely banned selling table eggs produced in any type of hen cages. Proposition 12, the provisions of which went into effect on January 1, 2022, is just the most recent in a series of similar animal welfare regulations enacted by California and other states, as well as the European Union (Hopkins et al. 2022; Ufer 2022). According to Hopkins et al. (2022), 19 state-level bills and ballot initiatives concerning farm animal welfare have been adopted across 11 states and among those, 10 of them involve confinement

standards for egg-laying hens or the sale of eggs from hens raised in battery cages (Appendix A provides more details).

According to the Association of California Egg Farmers, forty million Californians consume twelve billion eggs annually, or about 300 eggs per person per year. Based on Nielsen retail scanner data, however, the yearly consumption of cage-free eggs amounted to only 14 % of the total egg consumption. This is a stark illustration of the *citizen-consumer gap* noted in the animal welfare literature, whereby "... the percentage of the population that considers a higher animal welfare level important is typically substantially larger than the share of consumers buying products whose labels reflect this information" (Grethe 2017, p. 80). For ballot initiatives, the seemingly incongruous facets of individuals' voting and purchasing behavior is often referred to as the "vote-buy gap:" citizens vote to ban products that are purchased by a majority of consumers in the market place, leading to a type of unfunded mandate on producers (Lusk and McCluskey 2018).

Previous studies, discussed in more detail in the next section, have provided numerous insights into the economics of ballot initiatives, but a debated point still centers on the reasons why the majority of individuals vote in favor of banning controversial animal welfare practices when the majority of consumers regularly purchase products produced under these same practices. Hamilton et al. (2003) emphasize that the public's predilection for regulation derives from individual preferences for both private and public goods. Paul et al. (2019) formulate, heuristically, several (not mutually exclusive) hypotheses for the discrepancy between purchasing and voting decisions and assess them in an experimental setting. They find some support for the so-called *knowledge* and *bandwagon* hypotheses. In the first of these explanations, the vote-buy gap arises because consumers mistakenly believe that they are buying animal friendly (cage-free) eggs, when in fact they are buying standard (conventionally produced) eggs. The second explanation argues that the vote-buy gap is caused by the desire to socially conform as the availability of public information about the behaviors of others grows. The role for social desirability bias is also stressed by Lai et al. (2022), who observe the difficulties of eliciting true preferences in this context. Notably, Paul et al. (2019) do not find support for explanations rooted in more traditional economics and

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public choice theory, including the *non-buyer*, *public good*, and *expressive voter* hypotheses.

The main objective of this paper is to re-emphasize the importance of the public-good argument as an explanation for the vote-buy gap, and to provide empirical evidence in support of this rationalization based on data related to the passage of Proposition 12 in California. Thus, we focus squarely on what we believe is the core economics of the problem: consumption decisions are influenced mostly by the private good attributes of the choice, whereas voting decisions can account for the public good aspects of the problem. This is consistent with Bennett's (1997) earlier paper on framing of the role of legislation to deal with animal welfare. The public good characteristics of animal welfare have obvious externality and free-riding implications, which make consumption decisions in an unfettered equilibrium a poor metric of social support for animal welfare measures (Uehleke and Hüttel 2019).

The analysis we present proceeds from a simple theoretical model, based on stylized facts reflective of an animal welfare referendum, that predicts that the vote-buy gap depends on the size of the market, the price premium for a regulated product over an unregulated product, and the extent and heterogeneity of the population's preferences for animal welfare. Empirically, the main difference of our study relative to the existing literature is that we rely exclusively on revealed-preference data: realized voting outcomes, actual purchase decisions, and observed characteristics of voters/consumers. To the best of our knowledge, ours is the first attempt to explain the vote-buy gap by combining the voting data on a ballot initiative with the matched retail purchases data on a related product.

2 Extant Literature

The apparent discrepancy between consumption choices and voting outcomes has been explored by scholars at the intersection of economics and political science for decades. The rationalization that seems to have gained most acceptance is some combination of public good aspect with expressive benefits of voting. In this framework, a consumer/voter's utility function contains the consumption of both private and public goods and could also contain an additional *expressive* effect derived from the voting act itself (see, e.g. Buchanan 1954; Brennan and Buchanan 1984; Brennan and Lomasky 1993). In a nutshell, these models would predict that for sufficiently large constituencies, when voters' expressive utility effect from voting for a policy change (or the preference for public good resulting from that policy) is positive, but the effect on utility from the change is

negative, it is statistically optimal to vote for the policy change.

Applied studies using voting outcomes in this setting can be sorted into two broad groups. The first set of studies relies on the actual county or precinct level voting data to explore the variations in the voting outcomes. Studies that use the actual voting data focus mainly on various demographic attributes that influence voters' decisions to support or oppose ballot initiatives related to animal welfare. Videras (2006) utilizes Florida's 2002 Animal Cruelty Amendment data to test the significance of religious demographic variables in predicting voting outcomes. The results showed that Catholicism and Evangelism had strong and conflicting effects on support for Florida's ballot initiative. Smithson et al. (2014) analyzes California's 2008 ballot initiative to ban gestation crates and battery cages for egg-laying hens. They find a strong relationship between voting for Obama and support for the regulation, whereas they find the effects of education, age, and gender to be mostly insignificant. Bovay and Sumner (2019) used precinct- and town-level voting results from California's 2008 and Massachusetts' 2016 farm animal welfare ballot initiatives to draw connections between political party support and support for these initiatives. In both states, support for the restricted animal housing practices positively correlates with support for the Democratic candidate for president, with the result somewhat finessed by income.

The second group of studies explores the divergence in shopping and voting outcomes based on data generated by hypothetical surveys on purchasing and voting intentions. Several empirical studies have first asked individuals whether they would purchase a good in a market, and then whether they would support some kind of related government mandate. The results suggest that voters' and consumers' decisions generally do not align. Hamilton et al. (2003) investigate the relationship between willingness-to-pay (WTP) for pesticide-free food and voter support for a ban on pesticide and found that WTP is not a strong predictor of voting decisions. Brooks and Lusk (2012) focus on people's preferences towards animal cloning along with their intentions to vote on policies banning such products; and, again, they find inconsistency between voter support and consumer choices. Norwood et al. (2019) investigate the extent to which individuals support public action (for example, better treatment of cattle raised for beef production) and their own commitment to voluntary efforts. They find that close to 20% of the internet survey respondents would vote for laws to confront an issue but will not contribute their own private donation.

Some studies find different or more nuanced results. Carlsson et al. (2007a) designed a choice experiment to assess

whether Swedish consumers preferred genetically modified (GM) foods to be banned outright or whether they individually preferred avoiding them (by reading a label). They find no difference between consumers' private preferences to avoid GM foods and their willingness to ban them from the market. Studying the question of battery cages versus free-range systems in egg production, Carlsson et al. (2007b) find that there is a difference in the WTP between the market and regulation solution but the difference is not significant and does not require a ban on battery cage production. Waterfield et al. (2020), also in a GM food survey, find that the majority of respondents make purchasing and voting choices in line with the standard utility maximization model. However, low-income voters appear to be overly supportive of regulation in comparison with their private WTP and the same applies to voters who are uncertain about the safety of GM foods.

The discrepancy between consumers' and voters' behaviors has also been analyzed, albeit to a smaller degree, in the marketing literature. For example, Crosby et al. (1981) use the results of a containers deposit law referendum in Michigan to illustrate the contradiction. In the 1976 general election, the voters approved by a substantial margin (64–36 %) a proposal to require refundable cash deposits for soft drink and beer containers. However, at the time of the election, returnables accounted for less than 15 % of consumer container purchases for beer and less than 25 % for soft drinks.

Finally, as noted by a reviewer, estimated willingness to pay for animal welfare product attributes from surveys and experiments often differs from estimates that rely on actual purchases (revealed preferences). Lai and Yue (2020) provide a comprehensive review of studies that estimated WTP premiums for organic and animal welfare attributes using experiments and compared those results to their estimates based on the store scanner data. They found that their estimated WTP premium for organic eggs is consistent with experimental results, but the estimated WTP premiums for animal welfare attributes (cage-free and pasture-raised eggs) are significantly less than experimental findings. They note that these results might suggest the importance of considering biases (e.g. social desirability bias) when estimating the price premium for animal welfare attributes in experiments. Alternatively, as we do in this paper, it is essential to recognize that animal welfare is a public good, and it is well known that private purchasing decisions are a (possibly very) poor indicator of WTP for public goods. Indeed, there is a fundamental difference between these findings and our approach to explaining the vote-buy gap.

When we compare how people vote with what people buy, in both situations we rely on the actual (revealed) people's choices, we do not compare stated preference (experiments) and revealed preference (purchasing decisions) mechanisms. In other words, voting is not an experiment. Whereas consumers' attitudes towards the private good aspects of a product can be revealed by purchasing decision, voting directly concerns their attitudes towards the public good aspects of the product.

3 Consumer and Voter Choices

In this section, we develop a simple model to explain why and how the decision of an individual as a consumer relates to her decisions as a voter. As noted in the foregoing, the framework we propose emphasizes what we see as the main economic nature of the problem: consumption decisions are mostly about the private good attributes of the choice, whereas voting decisions can account for the public good implications of the problem.

We consider a vertically differentiated product context where there are two possible varieties of eggs: the conventional variety, produced by caged hens (product 1), and the animal-friendly, cage-free variety (product 2). Individual demand is cast in a discrete choice framework: the consumer picks either one unit (e.g. a dozen eggs) of product 1, one unit of product 2, or buys nothing (the outside option). Individual preferences are modeled by adapting the so-called Mussa-Rosen utility function, where the payoff associated with a unit of a good linearly relates to its price and quality, and where the intensity of preferences with respect to quality varies across consumers (Mussa and Rosen 1978). The novelty, in our context, consists of relating "quality" to the animal welfare implications of consumption decisions. In particular, a unit of either product 1 or product 2 generates the same baseline utility u , and the products can be acquired at prices p_1 and p_2 , respectively. However, consumers experience some disutility whenever eggs are produced by caged hens. The public good nature of animal welfare implies that this disutility must be related to the market-wide use of caged hens, as in canonical models of public goods (Mass-Colell et al. 1995, section 11.C). Hence, in our framework, the disutility depends on the total number of caged hens. Furthermore, consumers are heterogeneous with respect to their animal welfare preferences – some care a lot, some care little or not at all.

Consider now the choice problem of a consumer of type λ in a given market/constituency (in the empirical

application below, this will be a voting precinct). The payoffs associated with the three choices available to the consumer are written as follows:

$$U_1 = u - \lambda(N_1 + 1) - p_1 \quad (1)$$

$$U_2 = u - \lambda N_1 - p_2 \quad (2)$$

$$U_0 = -\lambda N_1 \quad (3)$$

where U_1 is the payoff of choosing good 1 (conventional eggs), U_2 is the payoff of choosing good 2 (cage-free eggs), and U_0 is the payoff of the outside option. Here, N_1 denotes the number of other consumers who are choosing the traditional product in the market of interest. Thus, the animal welfare portion of the consumer's preferences – capturing the public good (“public bad,” as it were) aspects of the problem – depends not only on their choice, but also on the total consumption N_1 of conventional eggs by all other consumers. As mentioned, consumers are presumed to differ with respect to their animal welfare preferences. Here, the consumer heterogeneity parameter $\lambda \in [0, h]$ parameterizes consumers' disutility associated with a unit of caged-hen product. As articulated below, this formulation will permit the possibility of a positive mass of consumers who do not care at all about animal welfare.

Let $\hat{\lambda}$ identify the consumer who is indifferent between traditional eggs and cage-free eggs. This is the consumer for whom $U_1 = U_2$, implying $\hat{\lambda} = p_2 - p_1$. The optimal choice for a consumer of type λ , therefore, can be stated as follows: choose good 1 if $\lambda \leq \hat{\lambda}$ and $u \geq \lambda + p_1$; choose good 2 if $\lambda \geq \hat{\lambda}$ and $u \geq p_2$; otherwise, choose the outside option.

3.1 Covered Market Equilibrium

We want to consider a situation in which, consistent with the context we are studying, both conventional eggs and cage-free eggs have positive market share. Also, and without much loss of generality, our analysis is simplified by considering the so-called covered market situation (i.e. all consumers buy eggs of one kind or the other).¹ Recall that consumer heterogeneity is parameterized by $\lambda \in [0, h]$. From

¹ To characterize an uncovered market situation in a meaningful way, the utility term u in equations – would need to be heterogeneous across consumers. The resulting model with two sources of heterogeneity would be considerably more complex. The fundamental insight about the public-good nature of the animal-welfare attribute, however, is related to the source of heterogeneity we do explicitly represent. As such, our model provides the simplest framework to bring out the related implications for the vote-buy gap.

the foregoing, it is clear that consumers with the lowest animal welfare appreciation ($\lambda = 0$) would strictly prefer conventional eggs if $p_1 < p_2$. Conversely, consumers with the highest valuation of animal welfare ($\lambda = h$) would strictly prefer cage-free eggs if $p_2 < p_1 + h$. As for ensuring the market is covered, the baseline utility from egg consumption needs to be large enough to dominate the outside option. For consumers who choose conventional eggs, the requirement is $u \geq p_1 + \lambda$, which for $\lambda = \hat{\lambda}$ (the highest λ for consumers who buy conventional eggs) reduces to $u \geq p_2$. For consumers who choose cage-free eggs, the condition is also $u \geq p_2$. Hence, to ensure that conventional eggs and cage-free eggs both have positive market shares, and that the market is covered, we assume two conditions: $p_1 < p_2 < p_1 + h$, and $p_2 \leq u$.

The covered-market outcome implicitly defines an equilibrium number of consumers N_1^* who buy eggs produced by the conventional technology, and a number N_2^* who buy eggs from cage-free hens. Given a mass N of potential consumers in the constituency, the covered-market condition implies that $N_1^* + N_2^* = N$. The equilibrium number of consumers patronizing the two goods will depend on the distribution for the heterogeneity parameter λ , of course. The maximized utility of consumer of type λ , in this equilibrium, is:

$$U^*(\lambda) = \begin{cases} u - \lambda(N_1^* + 1) - p_1 & \text{if } \lambda \leq \hat{\lambda} \\ u - \lambda N_1^* - p_2 & \text{if } \lambda \geq \hat{\lambda} \end{cases} \quad (4)$$

3.2 Support for a Ban on Eggs from Caged Hens

Consider now the case where the conventional product (from caged hens) is banned. Post ban, the consumer only has the choice of cage-free eggs (product 2) and the outside option. Under the presumed parameter space, all consumers will buy product 2 (i.e. the market remains covered). Hence, the maximized utility after such a ban, for all consumers, is:

$$U^{**}(\lambda) = u - p_2 \quad (5)$$

Quite clearly, for $\lambda \geq \hat{\lambda}$ it must be that $U^{**}(\lambda) > U^*(\lambda)$. That is, all consumers who buy cage-free eggs in the unconstrained equilibrium would strictly support the ban. By continuity, this also holds for consumers close to $\hat{\lambda}$ but who buy regular eggs in equilibrium. At $\lambda = 0$, however, $U^{**}(0) < U^*(0)$. Hence, there exists a threshold level $\tilde{\lambda}$ such that $U^{**}(\tilde{\lambda}) = U^*(\tilde{\lambda})$. Thus, $\tilde{\lambda}$ characterizes the consumer who is indifferent toward supporting the ban. Because this threshold level satisfies $u - \tilde{\lambda}(1 + N_1^*) - p_1 = u - p_2$, it follows that:

$$\tilde{\lambda} = \frac{p_2 - p_1}{1 + N_1^*} \tag{6}$$

Recall that the consumer who is indifferent between buying cage-free and conventional eggs is identified by $\hat{\lambda} = p_2 - p_1$. Hence, $\tilde{\lambda} < \hat{\lambda}$, indicating that support for the ban extends beyond consumers who buy cage-free eggs in the unconstrained equilibrium. Also, as long as cage-free eggs are costlier than conventional eggs, $\tilde{\lambda} > 0$. The diagram in Figure 1 illustrates the vote-buy gap implied by the model.

The foregoing establishes that, in this vertically differentiated products context, there is indeed a vote-buy gap. That is, there is a measure $(\hat{\lambda} - \tilde{\lambda})$ of consumers who support the ban despite the fact that, in the unconstrained equilibrium, they buy product 1 (conventional eggs).

3.3 A Discrete-Continuous Distribution of Heterogeneity

To gain more insights into the nature of the vote-buy gap, we need to make assumptions about the distribution of the heterogeneity parameter λ . Here we propose a simple formulation that possesses two key desirable properties relative to the problem at hand: (a) some consumers do not care at all about animal welfare considerations; and, (b) the remaining consumers, while they do care, possess heterogeneous attitudes towards animal welfare. Specifically, we assume there is a strictly positive fraction $r \in (0,1)$ of consumers for whom $\lambda = 0$. For the remaining consumers, λ is uniformly distributed on $[0, h]$. The upper bound h of this distribution is an indicator of the heterogeneity of consumers vis-à-vis their animal welfare preferences.

Given this distribution, we can solve for the equilibrium demand for the two types of eggs. Specifically, with a mass N of consumers, the demand for the conventionally-produced eggs is:

$$N_1^* = N \left[r + (1-r) \frac{\hat{\lambda}}{h} \right] \tag{7}$$

where, as derived earlier, the effects of prices are captured by the threshold term $\hat{\lambda} \equiv (p_2 - p_1)$. Given the covered-market assumption, the demand for cage-free eggs is $N_2^* \equiv N - N_1^*$.

3.4 The Vote-Buy Gap

The divergence between voting and purchasing behavior can be defined in alternative ways. In the empirical section, we define the vote-buy gap as the difference between the percent of voters supporting the ban and the fraction of consumers who buy cage-free eggs. If N_{ban} denotes the number of voters supporting the ban, and recalling that N_1^* is the mass of consumers who buy regular eggs, then the vote-buy gap is defined as $G \equiv [N_{\text{ban}} - (N - N_1^*)]/N$. In the context of the foregoing model, $N_{\text{ban}} = N(1-r)(h - \tilde{\lambda})/h$. Recalling that $\tilde{\lambda} = \hat{\lambda}/(1 + N_1^*)$, and $\hat{\lambda} = (p_2 - p_1)$, it is readily established that:

$$G = \frac{(1-r)(p_2 - p_1)}{h} \left[\frac{N_1^*}{1 + N_1^*} \right] \tag{8}$$

Utilizing the expression for the equilibrium value N_1^* in equation (7), it is clear that the term in square brackets is increasing in N . We can then immediately conclude that $\partial G / \partial N > 0$; that is, the vote-buy gap is increasing with the size of the market. This is a standard implication of public good problems, where free riding behavior increases with the number of participants.

The model we have outlined, however, implies that the vote-buy gap G also depends on the distribution of voters' preference for animal welfare (parameters r and h), and the extent of the price premium for cage free eggs ($p_2 - p_1$). These

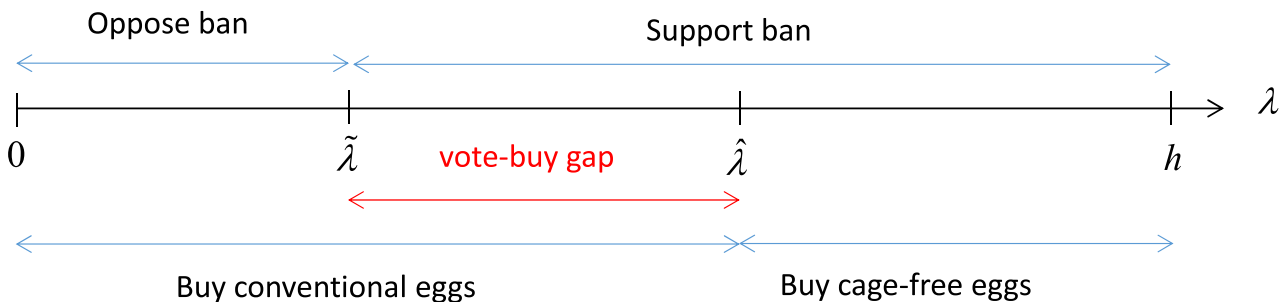


Figure 1: The vote-buy gap with vertical differentiation and heterogeneous preferences.

additional implications of the model are more easily seen by noting that, because $N_1^* \cong 1 + N_1^*$, then:

$$G \cong \frac{(1-r)(p_2 - p_1)}{h} \quad (9)$$

Thus, despite its simplicity, the model provides some clear insights into the nature of empirically-relevant determinants of the vote-buy gap. Specifically:

- $\frac{\partial G}{\partial (p_2 - p_1)} > 0$. Increasing the price difference between cage-free and conventional eggs increases the gap. This is because increasing this price premium for animal welfare friendlier eggs increases the threshold $\hat{\lambda}$ and thus widens the support segment $(\hat{\lambda} - \tilde{\lambda})$ (in this case N_1^* increases; that is, in the unrestricted equilibrium, fewer consumers want to buy cage-free eggs).
- $\frac{\partial G}{\partial r} < 0$. Increasing the fraction of consumers who do not care about animal welfare decreases the gap. (Note: this is the case even though, obviously, $\partial N_1^* / \partial r > 0$).
- $\frac{\partial G}{\partial h} < 0$. Increasing the upper bound of the heterogeneity distribution decreases the gap.

Increasing the parameter r , ceteris paribus, reduces the fraction of population sensitive to animal welfare and, as expected, reduces the vote-buy gap. The comparative statics $\partial G / \partial h < 0$, which holds r constant, can also be interpreted as the effect of increasing the average aversion to caged hens $E[\lambda]$. The fact that this is negative may seem counterintuitive at first. However, it is important to appreciate that the regular egg market size N_1^* is endogenous: a larger average aversion coefficient lowers N_1^* , but it also increases the free-riding effect. The interpretation of comparative statics results with respect to h and r may need to be more nuanced, in any case, because changes in these parameters affect both the mean and the variance of the population's aversion to caged hens. In Appendix B we reformulate the vote-buy explicitly in terms of the average “aversion” to caged hens in the population, $A \equiv E[\lambda]$, and the variance of the heterogeneous aversion parameter, $V \equiv E[(\lambda - A)^2]$. We can then show that the pure effect of increasing the average population aversion parameter A (holding V constant) is to increase the vote-buy gap, whereas the pure effect of increasing the heterogeneity of the distribution of λ , by increasing V while holding A constant, is that of decreasing the vote-buy gap.

4 Empirical Analysis

The foregoing model suggests empirically-relevant implications that, in principle, could be investigated upon observation of the vote-buy gap realizations in real-world context (or in an experimental setting). Our intent is to utilize data

from observed voting behavior in California's Proposition 12. We must conclude, at the outset, that such data is unable to say anything about the prediction $\partial G / \partial N > 0$. What matters, as far as the free-riding effect is concerned, is the size of the population of voters, i.e. the entire state of California. The data at hand, from a single “experiment,” thus provides no variability on this determinant of the vote-buy gap. However, we can observe the outcome of voting and egg consumption decisions for distinct subsets of the state of California – namely, precincts – and these subsets conceivably differ in terms of the other determinants of the vote-buy gap. Hence, our empirical strategy is to carry out the analysis at the precinct level and investigate how the egg price premium, and the parameters of the distribution of preferences concerning animal welfare, relate to the observed vote-buy gap.

4.1 Data

We combine four different data sets and then match them at the precinct level. The first two data sets are the 2009–2018 retail scanner and consumer panel data accessed through the Kilts Marketing Center of University of Chicago's Booth Business School. The retail scanner data provide weekly information generated by the point-of-sale system in the participating retail stores at the Universal Product Code (UPC) level. These data include price, quantity sold, and product characteristics of each UPC such as brand, packaging, and color. These data also provide the retail store type and location at the first-three-digit zip-code level. In our raw data for the state of California we started with 3,519 stores, 1,965 of them carried both conventional and cage-free eggs, 1,524 only conventional eggs and 30 only cage-free eggs. The distribution of channel types was as follows: convenience stores 0.26 %, department stores 32.57 %, grocery stores 47.57 %, supermarkets 7.96 %, and dollar shops 11.65 %.

Among the purchased product categories, we only consider the fresh eggs group, and ignore liquid, dehydrated, quail eggs, and similar products. There are 242 egg UPCs in the retail scanner data and 86 of them are cage-free eggs. To measure voters' purchasing patterns of cage-free eggs, we use the fraction of cage-free eggs sold (cagefree) in each of the retail stores during 2018. The variable represents the annual average of the ratio between all cage-free eggs sold and the sum of all types of eggs sold. The price difference between cage-free eggs and conventional eggs ($p_2 - p_1$) for each store is first computed for each week, as the differences between the average price (per-dozen) across all cage-free egg UPCs and the average price of all conventional egg UPCs, and then averaged into the annual figure.

The consumer panel data collects information on grocery shopping trips of each panelist. The panelists are provided with in-home scanners to scan the UPCs of all of products they purchase intended for personal, in-house use. The scanner automatically records the UPC, the quantity and price of the product purchased, the date of the purchase, and the retail store in which the purchase was made. In addition, the data also contain some geographic information such as the household's five-digit zip code. Because the retail scanner data has only a three-digit zip code for each store, we use the consumer scanner data as a link to create a mapping file. In this way, we match the consumer panel data and the retail scanner data from 2009 to 2018 using the purchase date and the retail store identifier. For example, if a consumer who resides in the zip code area 90001 patronizes store A, then we assume that store A belongs to zip code 90001. If multiple retail stores are matched to a single zip code, then *cagefree* and $(p_2 - p_1)$ variables of each of these stores are averaged into a single number for that zip code. Note that we utilize the period 2009–2018 data only for the purpose of matching households and stores, but we use only 2018 retail scanner data for the creation of the required variables. The number of stores that were actually patronized and matched with households is 886, among these, 9 additional stores were dropped because they did not sell both types of eggs. The final data set includes 877 stores in 1,151 zip-codes: 0.68 % convenience stores, 25.2 % department stores, 60.89 % grocery stores and 13.23 % dollar shops.

The third source of data is the 2018 California General Election results. This data is open to the public and can be obtained from the Statewide Database (SWDB), which is the redistricting database for the state of California. We use the Statement of Vote data, which contains precinct level voting results for the 2018 General Election. This provides the fraction of voters supporting Proposition 12, which is denoted *prop12* in what follows, and the Statement of Registration data, which contains information on registered voters, including their demographic information, their political party affiliation, and whether they voted. We use the consolidated precinct (geographic unit constructed for statistical merging purposes by SWDB) or the “SR precinct” data, because it is the only precinct type that is common to both the Statement of Vote and the Statement of Registration data.

The fourth data set used is the 2018 American Community Survey five-year estimates (ACS5Y) data from the U.S. Census. From this source we obtain information about demographic variables not available in the Statement of Registration data. In particular, we use the voting-age population, median household income, the Gini index for income inequality, and the average educational attainment – all at the census tract

level. A census tract is designed to have on average about 4,000 inhabitants. The ACS5Y data is matched with 2018 General Election results data. The California SWDB provides a conversion scheme between census tracts and SR precincts, although there is no one-to-one matching between those two units. Usually, the census tract unit is smaller in terms of geographic coverage, so multiple tracts belong to a single precinct. However, it is also possible that one census tract lies in multiple precincts. In cases where multiple tracts belong to a single precinct, the tracts data is averaged using the number of registered voters in each tract as weights. The same approach has been used by Bovay and Sumner (2019).

The final step of the construction of the working data set is matching zip-code-level purchase pattern data to precinct-level election data and demographic data. Matching between zip codes and precincts presents some challenges because there is no one-to-one relationship between the two entities. To accomplish this task, we rely on the ArcGIS polygon boundary data of zip codes, which are matched with the polygon boundary of each SR precinct,² and also available in the SWDB. In cases where multiple zip codes are matched with a single precinct, the zip code that has the highest coverage of that precinct is chosen as the relevant match. Initially, there are 21,694 precincts in the Statement of Vote. Among these, we matched 19,958 precincts with the Statement of Registration data. We manage to match 19,957 precincts to the ACS5Y data. In addition, 849 precincts do not have purchasing data while 271 precincts have some missing values and hence needed to be dropped. The final number of usable precinct observations in our working data set 18,837. The data set construction process is illustrated in Figure C1 in Appendix C.

4.2 Empirical Model

We estimate a regression model where the variable to be explained is the precinct-level vote-buy gap. This is a simple cross-section regression as follows:

$$y_i = \alpha + \mathbf{x}_i\boldsymbol{\beta} + \varepsilon_i \quad (10)$$

where y is the observed vote-buy gap, and i indexes the precinct. The vote-buy gap variable is defined as $y \equiv \text{prop12} - \text{cagefree}$. The vector \mathbf{x} on the right-hand side includes the explanatory variables for the vote-buy gap articulated in the theoretical model. In each regression, we consider three explanatory variables: the price differentials between cage-free eggs and conventional eggs ($p_2 - p_1$); the fraction of

2 Specifically, we rely on the zip code polygon maps provided by ESRI, <https://www.esri.com/en-us/home>.

consumers who do not care about animal welfare (r); and, the preference heterogeneity of buyers/voters vis-à-vis animal welfare (h).

The consumer price differentials ($p_2 - p_1$) is directly observable and computed as described in the Data section. This is not the case, however, for the fraction r of consumers whose utility function do no feature animal welfare. Hence, we proxy this variable with the percentage of registered voters affiliated with parties traditionally perceived as positioned on the right of the political spectrum. This is consistent with the literature that, since Kahn and Matsusaka (1997), finds that partisan identification is a strong predictor of voting on social issues. The Statement of Vote data contains information on voters' party registration: Democrats, Republicans, American Independent, Peace and Freedom, Libertarian, Natural Law, Green, Reform, and other miscellaneous parties. We define the variable of politically right-leaning parties ($right$) as consisting of Republican, American Independent, Libertarian, and Reform parties.³ Specifically, our presumption here is that the higher the proportion of registered voters belonging to one of the conservative political parties, the higher the fraction of people in the precinct who do not feature animal welfare in their choice function.

Finally, to represent heterogeneity of consumers'/voters' preferences towards animal welfare issues (h), we use two alternative metrics, one related to income and the other to education. Specifically, income inequality is captured by the Gini index ($gini$) of income distribution. The Gini index assumes values between 0 and 1, where a higher index value indicates greater income inequality. To measure heterogeneity in education attainment, we construct a Herfindahl–Hirschman index (hhi) based on the educational attainment of voters categorized into four categories: less than high school; high school; some college or associate degree; and, bachelor's degree or higher. Given this classification, hhi is defined as the sum of squared shares for each of these categories, where share values are measured as between 0 and 1. A lower hhi value indicates a more uniform distribution of educational attainments.

Summary statistics of the matched precinct-level data, used to estimate the cross-section regression model, are

Table 1: Descriptive summary statistics in precinct-level model.

Variable name	Source	Mean	Std. dev.	Median	Min	Max
<i>vbg</i>	Election, scanner	0.48	0.15	0.48	-0.28	0.99
<i>prop12</i>	Election	0.62	0.16	0.64	0	1
<i>cagefree</i>	Scanner	0.15	0.07	0.14	0.002	0.435
$(p_2 - p_1)$	Scanner	1.37	0.17	1.38	0.06	2.11
<i>right</i>	Election	0.30	0.19	0.28	0	1
<i>gini</i>	Census	0.32	0.13	0.35	0.05	0.67
<i>hhi</i>	Census	0.34	0.09	0.31	0.25	0.85
<i>population</i>	Census	1.46	1.08	1.40	0.001	19.82
<i>income</i>	Census	81.98	30.57	87.5	10	175
<i>college</i>	Census	0.65	0.18	0.67	0.06	0.99

Note: The dependent variable *vbg* (the vote-buy gap) is the difference between *prop12* and *cagefree*. The explanatory variables are the egg price difference ($p_2 - p_1$), the proxy for the fraction of consumers/voters with low sensitivity to animal welfare (*right*), and two measures of consumers/voters heterogeneity (*gini* and *hhi*). The variables *population*, *income*, and *college* serve as instrumental variables. See the text for more explanations on these variables. Total number of precincts: 18,837.

given in Table 1. As noted earlier, the data comes from three sources. The fraction of cage-free eggs sold relative to total consumption (*cagefree*), and the price difference between cage free and conventional eggs ($p_2 - p_1$), come from retail scanner data. As seen from Table 1, only 15 % of total eggs sold in California in 2018 were cage-free eggs and the average price spread between cage-free eggs and conventional eggs was \$1.37 per dozen. The percentage of voters who supported Proposition 12 relative to all votes cast (*prop12*) and the percentage of registered voters in the right-leaning parties (*right*) come from the election data. The data show that Proposition 12 passed by 62 % of the popular vote and that 30 % of voters belong to parties that we have classified as belonging to the right of the political spectrum.

The variable to be explained in the model, the vote-buy gap (*vbg*), constructed using both voting and purchasing data, is defined as the difference between the percentage vote in support of Proposition 12 (*prop12*) and the percentage of purchased cage-free eggs relative to all eggs purchased (*cagefree*). The average magnitude of the vote-buy gap across all precincts is 47 percentage points. Lastly, income and education variables are obtained from the census data. As seen from Table 1, the average median household income across all precincts is 81 thousand dollars, and the average percentage of adult population with some college or higher degree is 65 %. The average heterogeneity of the population is 0.32 (*gini*) when measured in terms of income, and 0.34 (*hhi*) when measured in terms of educational attainment.

³ The voter allegiance to political parties in California is quite fluid. According to the Public Policy Institute of California, the total number of registered voters has increase from 17.72 million in May 2014 to 19.02 million in May 2018, an increase of 7.34 %. The share of independents has increased by 4 points (from 21.2 % to 25.5 %), the share of Democrats has also risen from 43.4 % to 44.4 %, while the share of Republicans has fallen by 3 points (from 28.4 % to 25.1 %).

Table 2: Precinct-level model regression result.

Variable	Proxy for:	OLS		IV	
$(p_2 - p_1)$		0.0437***(0.0049)	0.0327***(0.0048)	0.808***(0.0618)	0.0725(0.0503)
<i>right</i>	<i>r</i>	-0.517***(0.0046)	-0.533***(0.0045)	-0.568***(0.0081)	-0.535***(0.0054)
<i>gini</i>	<i>h</i>	-0.0218***(0.0067)		-0.0154(0.0101)	
<i>hhi</i>	<i>h</i>		-0.301***(0.0095)		-0.295***(0.0119)
Constant		0.579***(0.0072)	0.695***(0.0077)	-0.455***(0.0837)	0.639***(0.0706)
Adj. R^2		0.405	0.434		
No. of obs.		18,837	18,837	18,837	18,837
Anderson canon. corr. LM statistic				273.36	174.26
Cragg-Donald Wald F statistic				92.43	58.61
Sargan statistics				409.54	556.79

Note: Standard errors are reported in parentheses. *** indicate parameter significance level of 1 %.

4.3 Estimation

We consider a cross-sectional regression using ordinary least squares (OLS). As noted, we use two proxy variables for the heterogeneity parameter h (that is, *gini* based on income, and *hhi* based on educational attainment). The first two columns of results in Table 2 report OLS estimates, which are valid under the assumption that the (zero-mean) error term is uncorrelated with the explanatory variables. The justification for such orthogonality assumption is that the right-hand-side variables of the model are pre-determined at the precinct level.

Among the right-hand-side variables, we view *right*, *gini*, and *hhi* as being rooted in the demographic diversity across precincts and thus predetermined relative to the observed vote-buy gap. The possible concern, however, is that the price difference variable ($p_2 - p_1$) may be affected by omitted variables that also explain the vote-buy gap, and thus be correlated with the error term. Because our analysis is at the precinct level, the variable ($p_2 - p_1$) measures precinct level variation in egg price differentials. Such variation can have multiple sources, in principle. Cost differences in egg procurement (e.g. transportation) may play a role. Furthermore, competition in the retailing sector may result in an egg pricing model that considers the demographics of local consumers. We note at this juncture, however, that individual retail store managers typically do not set retail prices for their stores – instead, prices are usually determined at the level of the retail chain’s regional headquarters. As the *prima facie* evidence corroborating this claim are the weekly or biweekly flyers regularly issued by retail chains that customers can pick up at each store. The main characteristic of those leaflets is the fact that, for hundreds of listed items, there is only one price per i.e. yet the flyer typically covers a large geographic area, including

hundreds of zip codes.⁴ Such consideration provides some support for viewing precinct-level price difference ($p_2 - p_1$) as exogenous, for the purposes of our model.

The OLS results are broadly supportive of the predictions from the simple consumer/voter model discussed earlier. The estimated coefficients of the explanatory variables included in the model all have the expected sign, and, despite the small number of explanatory variables included in the cross-section regression, the fit of the models is good. Most of the estimated coefficients are also statistically significant at the 1 % level. Consistent with the model’s predictions, the price differential between cage-free and conventional eggs ($p_2 - p_1$) is positively related to the vote-buy gap outcome. Our proxy variable for the fraction of consumers who do not care about animal welfare (*r*) negatively affects the observed vote-buy gap. Lastly, the model articulated earlier also predicts that increased heterogeneity of voters/consumers, as captured by the distribution parameter h , should decrease the vote-buy gap. The estimated parameters for both the Gini index of income inequality and the Herfindahl–Hirschman index of education diversity have the anticipated negative sign, lending additional support for the model.

Next, as suggested by one of the referees, we estimated the model using quantile regression, specifically at the quartile points. The results are reported in Table 3. The results for the mid-point percentile (the median) are more robust to outliers than the OLS estimates for the conditional mean in Table 2. Comparison of these estimates, however, reveals that they are fairly similar in magnitude, with the

⁴ For example, in North Carolina the prices published in the Harris Teeter flyer for March 12-18, 2025, are valid for the following stores: Asheville, Hendersonville, Morehead City, Greenville, New Bern, Wilmington, etc., effectively covering the entire state. We have no reason to believe that the situation is different with retail stores in California.

median results displaying a somewhat stronger response of the vote-buy gap to the $(p_2 - p_1)$ and right variables. The estimated effects across the distribution shows the response to $(p_2 - p_1)$ is increasing as one moves to higher percentiles, whereas the response to right is fairly stable across the distribution of the vote-buy gap. The impact of the heterogeneity metrics, on the other hand, is attenuated as one moves from the 0.25 percentile to the 0.75 percentile. This is particularly the case when heterogeneity is proxied by the *gini* variable, where we find that, at the higher 0.75 percentile, the sign of the response is reversed. It is difficult to say whether this effect is intuitively plausible, as our motivating model of Section 3 is silent on this matter.

We reiterate at this juncture that the main objective of our study is to investigate the nature and origins of the vote-buy gap, with emphasis on the public good effects articulated in the theoretical model. Given the stylized nature of the model, and the limitations of the data at hand (as discussed in the foregoing), we are reluctant to provide normative policy implications. Unlike, for example, in Hopkins et al. (2022) where the model allows the authors to assess whether and when a given state would consider farm animal welfare regulations, and if yes, the likelihood that such measures are passed, our model is not meant to predict the outcomes of different ballot initiatives. Because of that, we have focused the discussion so far on the sign of the estimated coefficients, ignoring their magnitude. Some comments about the latter are possible, however. Consider for example the median results from the quantile regression in Table 3 which, as noted, may be more robust to outliers than those for the conditional mean. The magnitude of the estimated coefficients can be assessed by considering the ceteris paribus impact of changing each right-hand-side variable by an arbitrary small amount, for example one standard deviation away from the mean (as reported in Table 1). The variable

with the strongest impact is right, for which we find the estimated value of the coefficient equal to -0.586 in either of the two models. An increase by one standard deviation of the voters registered in one of the right-leaning political parties would decrease the conditional median of the vote-buy gap by 0.11 percentage points (0.586×0.19 , because the standard deviation for the right variable is 0.19). In this case, the conditional median is the difference between the median vote-buy gap of people that are registered in one of the right-leaning parties and the median vote-buy gap of all other people that do not belong to that conservative group. The other variables have quantitatively much smaller impacts. For example, a one standard deviation increase in the price differential would change the estimated median vote-buy gap by 0.01, and for *gini* and *hhi*, the corresponding estimates are -0.0025 and -0.032 , respectively.

4.4 Robustness

Although we view the OLS estimation procedure as reasonable, in our context, concerns about the possible endogeneity of the price difference variable $(p_2 - p_1)$ may remain. Hence, in the last two columns of Table 2 we report results that rely on the use of instrumental variables (IVs). With the data at our disposal, we have been able to construct three other demographic variables, at the precinct level, that may serve as relevant instruments, namely income, population, and college (described earlier). The reported IV estimation results pertain to the model estimated with two-stage least squares while using these three variables as instruments for the variable $(p_2 - p_1)$.

The sign of the estimated coefficients from the IV procedure in Table 2 is consistent with those obtained with OLS, although the magnitude of the price coefficient is clearly

Table 3: Quantile regression results.

Variable	1st quartile (0.25)	Median (0.50)	3rd quartile (0.75)	1st quartile (0.25)	Median (0.50)	3rd quartile (0.75)
$(p_2 - p_1)$	0.0295 (0.0056)	0.0553 (0.0044)	0.0778 (0.0033)	0.0169 (0.0041)	0.0467 (0.0040)	0.0585 (0.0034)
<i>right</i>	-0.5540 (0.0053)	-0.5856 (0.0066)	-0.5899 (0.0052)	-0.5937 (0.0066)	-0.5864 (0.0048)	-0.5815 (0.0063)
<i>gini</i>	-0.0641 (0.0084)	-0.0192 (0.0051)	0.0199 (0.0046)			
<i>hhi</i>				-0.3886 (0.0095)	-0.3562 (0.0071)	-0.2625 (0.0097)
Constant	0.5678 (0.0088)	0.5949 (0.0064)	0.6023 (0.0050)	0.7132 (0.0070)	0.7196 (0.0060)	0.7184 (0.0048)
Pseudo R^2	0.2799	0.3049	0.3097	0.3216	0.3377	0.3302
No. of obs.	18,837	18,837	18,837	18,837	18,837	18,837

Bootstrapped standard errors are reported in parentheses.

affected. We note, however, that the implementation of IV estimation raises subtle issues that are increasingly recognized by practitioners (Henningsen et al. 2024). The required assumptions concerning instruments – relevance and exogeneity – are often challenging to articulate convincingly a priori, and difficult to test empirically. In our case, we report three statistics. The Anderson underidentification statistics (which has a p -value of 0.00) provides some support for the notion that the instruments are relevant (correlated with the endogenous regressor). The Cragg-Donald Wald F statistic is larger than the rule-of-thumb value of 10 (Andrews et al. 2019), suggesting that the included instruments are not weak. The Sargan test of overidentifying restrictions, however, yields statistics with a p -value of 0.00, meaning that the validity of instruments (which need to be uncorrelated with the error term) is rejected. Furthermore, the first-stage regressions have a low fit ($R^2 \cong 0.02$). All of this leads us to be skeptical of the IV results. Indeed, this is probably one of the cases, not uncommon in practice (Lal et al. 2024), where the bias of the IV estimator may exceed the presumed endogeneity bias of OLS.

5 Conclusions

California voters passed Proposition 12 as a ballot initiative in the November 2018 election, and its final provisions went into effect on January 1, 2022. The new law established the standard for confinement of certain farm animals and bans the sale of eggs, veal, and pork products that do not comply with the new confinement standards. Meat producers, farmers, and agricultural associations have brought numerous legal challenges to Proposition 12, but the U.S. Supreme Court settled the matter in May 2023, upholding the constitutionality of Proposition 12. This implies that a state can establish its own rules on animal products sold in its jurisdiction, and operators must comply with state law even if the products are produced outside of the state.

Whereas Proposition 12 raises major issues with deep repercussions on animal agriculture and food markets, this paper has focused more narrowly on the apparent discrepancy between animal welfare preferences as conveyed by voters' decisions and consumers' choices. As Paul et al. (2019) rhetorically ask, "Why did Californians vote to ban a product they regularly consume?" Indeed, observed gaps between purchasing and voting behavior are often taken as *prima facie* evidence of unwarranted actions that, by mandating restrictive production practices, increase production costs, the burden of which falls mostly on producers. The concern is that suboptimal policies may ensue by failing to

fully account for such costs (Ortega and Wolf 2018; Lee et al. 2023), and may lead to welfare losses for both farmers and consumers. As Lusk (2015) notes, "... there is apparent disconnect between the way people vote on food issues and how they shop for food." Insofar as this seeming paradox is caused by the lack of information about what exactly is bought or voted for, knowledge gaps about the relevant tradeoffs, or other behavioral mores, concerns about animal welfare ballot initiatives would be justified. It has long been known, however, that orthodox economics can provide a plain explanation for the vote-buy gap: the purchasing choices of an individual account mostly for the private good aspect of the product, and the public good attributes of the purchased good are likely ignored. Voting for a ballot initiative, on the other hand, squarely refers to the public good attributes in question.

The extent to which one can invoke the public-good explanation for the observed vote-buy gap appears underappreciated in economic analyses of animal welfare ballot initiatives, and indeed alternative behavioral explanations are often proffered. In this paper, we provide empirical evidence that reconciles the vote-buy gap within a rational, individual choice model. The empirical analysis is motivated by a simple theoretical model that embeds and contrasts the private good aspect of buying a product with a public good aspect of voting on the product. The model accounts for the heterogeneity of individual preferences concerning the animal welfare attributes of the good in question and provides several implications about the drivers of the vote-buy gap. We evaluate the qualitative properties of the model empirically, based on a unique dataset on precinct-level voting and purchasing outcomes, and find that the empirical results are broadly supportive of the public good explanation for the vote-buy gap.

Related literature reviewed by Matsusaka (2005) is generally supportive of the role of "direct democracy," yet the suitability of ballot initiatives to adjudicate controversial issues remains much debated. Misguided initiatives may risk imposing unwarranted inefficiencies in the food supply chain of course, but other controversial proposals may well be consistent with maximizing social welfare. In particular, just because historically observed buyers' behavior has not favored certain products with friendly animal welfare attributes, it is not by itself a sufficient condition to dismiss the desirability of animal welfare ballot initiatives. Insofar as the rationalization of the vote-buy gap phenomenon articulated in this paper is generally applicable, however, opposition and concerns about mandating restrictive production practices via the ballot box may need to be carefully qualified.

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Appendix A: Proposition 12 – History, Similar Initiatives and Impacts

California has been at the forefront of animal welfare regulations in the United States since passing Proposition 2, Standards for Confining Farm Animals, in November 2008. This state statute bans the use of confinement systems, such as egg-laying hen cages and veal and sow gestation crates, which prohibit those animals from turning around freely, laying down, standing up, and fully extending their limbs. Proposition 2 was set to go into effect as of January 2015. Because this law did not prohibit the sale of eggs that were produced outside California, it led to serious concerns among egg farmers that cheaper eggs imported from other states that did not comply with the new regulation would overwhelm the California egg markets (Sumner et al. 2008). Recognizing this problem, in July 2010 the California state assembly passed Assembly Bill 1,437, which banned the state-wide sales of eggs that do not comply with the confinement regulation in Proposition 2.

The confinement system regulated in Proposition 2 was based on the behavior and movement of animals and did not specify the minimum space requirement for hens. Potential difficulties in compliance with, and enforcement of, such vague requirements led the California Department of Food and Agriculture (CDFA) to adopt a specific rule on the minimum spacing in May 2013. The CDFA rule required at least 116 square inches of space per bird. This forced the

replacement of conventional battery type cages with only 67–86 square inches per bird with new enriched colony cage systems that housed 60 hens with 116 square inches of space per hen. The CDFA spacing rule was implemented together with the Proposition 2 and AB 1437 in January 2015.

Next, in the November 2018 general election, California voters passed Proposition 12, the Farm Animal Confinement Initiative (amending California Health and Safety Code Section 25990–25993). Proposition 12 establishes new minimum space requirements for confining veal calves, breeding pigs, and egg-laying hens; requires egg-laying hens be raised in a cage-free environment after December 31, 2021; prohibits certain commercial sales of specified meat and egg products derived from animals confined in a noncomplying manner; defines sales violations as unfair competition; creates a good faith defense for sellers relying upon written certification by suppliers that meat and egg products comply with new confinement standards; and, requires the State of California to issue implementing regulations (Oh and Vukina 2022). The confinement regulation required by Proposition 12 was implemented in two phases. First, housing egg-laying hens in houses with less than 144 square inches of usable floor space per hen was banned at the beginning of 2020. Second, all types of cages for laying hens were banned by the end of 2021. A cage-free housing system is defined as an indoor or outdoor controlled environment equipped with scratch areas, perches, nest boxes and dust bathing areas, within which hens can roam freely and exhibit natural behaviors and where farm employees can provide care while standing inside the hens' usable floor space.

Including California, similar animal welfare regulations have been enacted in other states. Based on the data set prepared by Hopkins et al. (2022), 19 state-level bills and ballot initiatives concerning farm animal welfare have been adopted across 11 states (Florida, Arizona, Oregon, Colorado, California, Michigan, Ohio, Washington, Rhode Island, New Jersey, Massachusetts). Among those, 10 of them involve confinement standards for egg-laying hens or the sale of eggs from hens raised in battery cages, 11 involve confinement standards for gestating sows, and 11 involve confinement of veal calves. There were an additional two bills regulating the confinement of veal calves and gestating sows that were vetoed by the states' governors (Michigan in 2019 and New Jersey in 2013). Farm animal legislations in the U.S. are passed at the state level through bills voted on in the state legislatures or through ballot initiatives voted on directly by citizens. Six of the mentioned legislations were passed by referenda and the rest by legislative bills.

Many studies have investigated the economic impact of Proposition 2 on egg production, prices, and social welfare.

Malone and Lusk (2016) measured price changes and consumer welfare loss using wholesale price spreads between the United States and California before and after the effective date of Proposition 2 (January 2015). They found that Californians pay \$0.48–\$1.08 per dozen more than they would have paid without the ban. This amounts to a 33–70 % price increase or the annual consumer welfare loss (as a form of changes in consumer surplus) of between \$400 million and \$850 million. Mullally and Lusk (2018) found that both egg production and the number of egg-laying hens were about 35 % lower than they would have been in the absence of the new regulations. For consumers, based on the five years of scanner data, they found that the average price per dozen eggs from 2014 to 2016 was about 22 % higher than it would have been in the absence of Proposition 2. Their results suggest that California consumers can expect to experience annual welfare losses of at least \$25 million in future years from higher retail egg prices alone. Carter, Schaefer, and Scheitrum (2021) developed a conceptual model for analyzing the effects of Proposition 2 by comparing market equilibria under two regulatory scenarios: with and without the regulation. They modeled the demand and supply of conventional and California-compliant eggs, and numerically solved for equilibrium prices and quantities under two scenarios. They estimated a reduced form model of the price effects based on the time series data. They found a long-term increase in California egg prices of 39 cents per dozen eggs (about 14 %) and increase in wholesale egg prices in the rest of the U.S. of 7–10 cents per dozen (about 4–6 %).

There are also studies that quantified welfare changes under a hypothetical regulatory scenario like Proposition 12 where all types of cages were banned. For example, Norwood and Lusk (2011) employed equilibrium displacement models using non-hypothetical auction data and estimated the cage-free premium to be \$0.47–\$0.55 per dozen. They projected that converting all cage eggs to cage-free eggs in the United States would result in a US\$ 1872.7 million decline in consumer surplus and a US\$ 187.3 million decline in producer surplus, assuming no consumer demand shift in response to change in the type of eggs sold. Allender and Richards (2010) accounted for unobserved heterogeneity in consumer preferences in their demand estimation but did not take into account the equilibrium price effects. They assumed that prices would increase by approximately 20 % due to higher production costs, and perfectly inelastic demand for eggs such that the cost increase would be passed 100 % to consumers. They estimated the willingness to pay for cage-free eggs over conventional eggs of \$0.54 per dozen and the welfare loss due to animal welfare legislation mandating cage-free egg production in California of \$106 million.

The welfare effects of the actual Proposition 12 have also been studied by Oh and Vukina (2022). Relying on the combination of 2015–2017 Nielsen consumer panel and retail scanner data used in this study as well, within a partial equilibrium model and structural estimation, they find substantial negative welfare effects on both consumers and egg suppliers in California. Their results show that the new marginal costs of what used to be conventional eggs would increase, on average, by 56 %. The prices of originally conventional eggs would increase by 65 %, the prices of cage-free eggs would decrease by 3.4 %, and the overall welfare, measured as the sum of consumer and producer surplus, would decrease. The state-level expected annual welfare loss to households was estimated at \$72 million and the industry welfare loss at the retail level would amount to 17.6 % of their original quasi-profits. These welfare estimates, in any case, pertain only to Marshallian surplus and ignore the public-good components of Proposition 12.

California's Proposition 12 has been extensively litigated. The case was ultimately decided in May 2023 by the Supreme Court ruling in the *National Pork Producers Council v. Ross*. The case questioned whether a California regulation violated the so-called Commerce Clause (Sumner 2017) by effectively imposing its regulatory requirements on citizens in other states. Plaintiffs in the case argued that a California regulation prohibiting the sale of certain pork products in the state unconstitutionally affects interstate commerce by requiring that pork producers nationwide follow the state's requirements in order to sell their products in California. In a 5–4 ruling, the Supreme Court affirmed the decision of the U.S. Court of Appeals for the 9th Circuit and dismissed the challenge against California's Proposition 12.

Appendix B: Further Comparative Statics for the Vote-Buy Gap

Recall the assumed distribution for the disutility parameter: For a fraction r of consumers $\lambda = 0$, and for the remaining fraction $(1 - r)$ of consumers λ is uniformly distributed on $[0, h]$. The mean and variance of this distribution, labeled A and V , respectively, therefore are:

$$A = \frac{h(1-r)}{2} \quad (11)$$

$$V = \frac{h^2}{12} (1-r)(1+3r) \quad (12)$$

By using (11) the variance can be alternatively stated as:

$$V = \frac{A}{3}(2h - 3A) \tag{13}$$

The vote-buy gap derived in the text, meanwhile, was stated as $G \cong (p_2 - p_1)(1 - r)/h$. By using (11), this gap can be expressed as:

$$G \cong (p_2 - p_1) \frac{2A}{h^2} \tag{14}$$

Next, by using (13), the vote-buy gap can be stated in terms of the mean and variance of the disutility parameter λ , that is:

$$G \cong \frac{8}{9}(p_2 - p_1) \frac{A^3}{(V + A^2)^2} \tag{15}$$

It is now apparent that $\frac{\partial G}{\partial V} < 0$: an increase of the dispersion of the disutility parameter's distribution, holding its mean constant, decreases the vote-buy gap. As for the mean:

$$\frac{\partial G}{\partial A} \propto \frac{3A^2}{(V + A^2)^2} - \frac{4A^4}{(V + A^2)^3} = \frac{A^2}{(V + A^2)^3} [3V - A^2] \tag{16}$$

In view of (11) and (13), we can then conclude that $\frac{\partial G}{\partial A} > 0$: a ceteris paribus increase in the average population aversion to caged hens increases the vote-buy gap.

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Appendix C

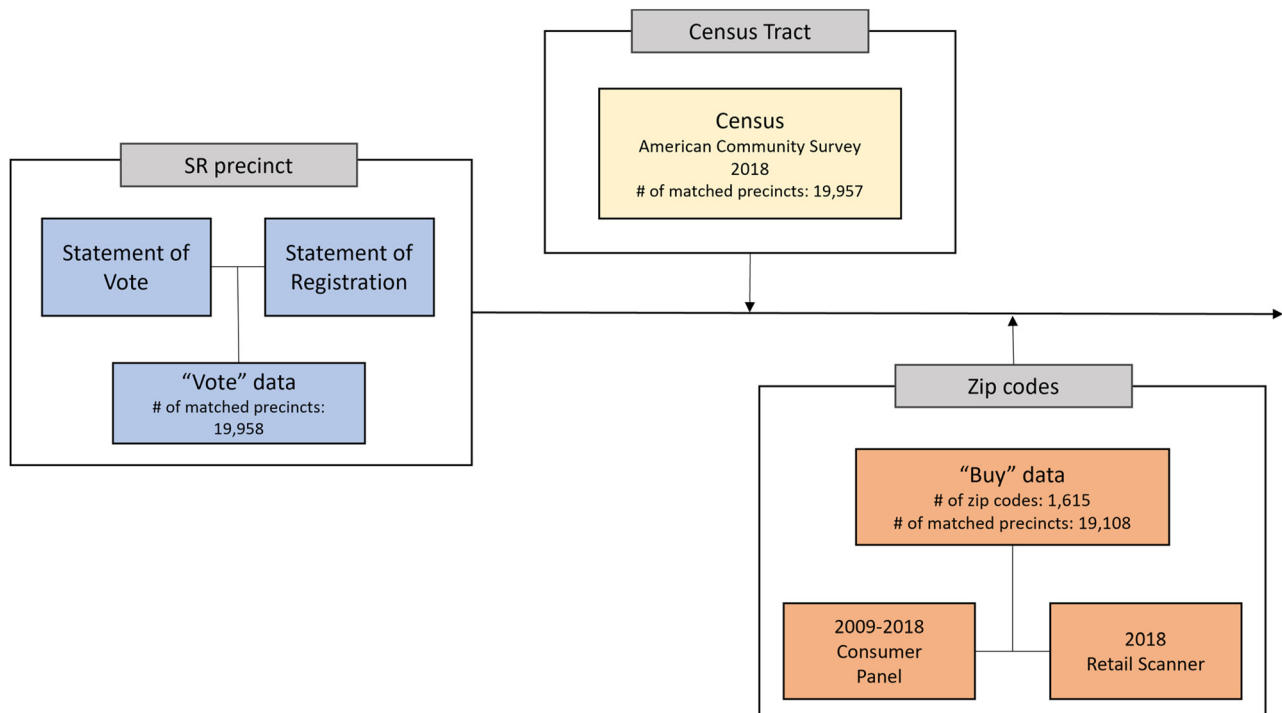


Figure C1: Construction of the working data set. Note: The units of observation in Election data, Census American Community Survey data, and Retail Scanner data are SR precinct, census tract, and zip codes, respectively. Census tract and zip codes are converted into SR precinct. The final number of observations is 18,837 SR precincts.

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