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Consumer Impact of Animal Welfare Regulation in the California Poultry Industry

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This study examines the consumer welfare impact of animal welfare legislation mandating cage-free egg production in California. We estimate California egg consumers' willingness to pay (WTP) for cage-free eggs using household-level purchase data and compare the implied premium to higher production costs when calculating the potential change in consumer surplus. Our findings suggest that larger households and/or households with limited means are most likely to be affected. Furthermore, the implied welfare loss for consumers is approximately $106 million. Although consumers value cage-free eggs, higher production costs result in a net welfare loss to consumers. One implication of this finding is that a clear labeling practice may be a more efficient way to motivate animal welfare and non-cage systems.

Key Words: animal welfare regulation, California poultry, egg prices, egg supply, hen housing, mixed logit, willingness to pay

Introduction

According to the *2007 Census of Agriculture*, California is the United States' largest producer of agricultural products and the eighth largest agricultural economy in the world (U.S. Department of Agriculture, 2007). California voters and legislators have recently approved a series of legislative changes largely aimed at achieving environmental goals. Examples of proposed or enacted legislation include an increase in air quality restrictions on diesel exhaust, significant water restrictions for much of the growing season, and stricter standards for confining farm animals. These initiatives have the potential to adversely affect the state's agricultural economy and may result in a net loss of consumer welfare by raising production costs and, consequently, market prices. We seek to quantify the implied welfare effects of one specific change in regulations: mandating that egg-laying chickens be raised in a cage-free production environment.

Proposition 2, which voters approved in 2008, amends the California Health and Safety Code as it applies to all California egg, beef, and hog producers. While the changes that are due to take effect in 2015 impact all animal sectors, they promise to have the most significant implications for shell egg producers. Essentially, the new regulations mandate specific parameters that define the minimum cage size needed for chickens to perform particular behaviors; specifically, chickens must be able to "… lie down, stand up, fully extend their limbs and

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turn around freely for the majority of the day" (*National Hog Farmer*, 2008).[1] Recognizing this would simply lead to higher imports of caged eggs, the California legislature banned the sale of animal products not in compliance with Proposition 2 regardless of their source. On July 6, 2010, the Governor of California signed AB 1437, which states: "Commencing January 1, 2015, a shelled egg may not be sold or contracted for sale for human consumption in California if it is the product of an egg-laying hen that was confined on a farm or place that is not in compliance with animal care standards set forth in Chapter 13.8 [the standards described by Proposition 2]" (California State Senate, 2010). As argued by Sumner, Rosen-Molina, and Matthews (2008), conventional hen housing does not conform to Chapter 13.8 standards, so non-cage systems would have to be implemented for all eggs sold in California beginning in 2015.[2]

Other states have passed similar legislation. Most notably, Arizona's Proposition 204, which passed in 2006, maintains that all pork be produced in "stall-free" environments. While our analysis specifically addresses California's Proposition 2, our findings likely generalize to other forms of environmental regulation that cause producers to fundamentally change the way they operate.

Previous studies investigate the economic impact of animal welfare regulation as it relates to laying-hen cages. Rahn (2001) argues that restrictive regulations on cage sizes result in technical inefficiencies, since growers can no longer use their profit-maximizing choice of inputs. He suggests clear and regulated labeling practices may be a better alternative solution. In terms of production costs, Sumner, Rosen-Molina, and Matthews (2008) estimate that cage-free egg production costs are at minimum 20% higher than conventional egg production costs. In addition, they estimate that California shell egg producers will incur a $200–$800 million cost to retrofit existing housing facilities. However, these studies tend to focus on increased producer costs, which may or may not be passed to the consumer through higher retail prices.

The fact that California voters approved Proposition 2 by 63% of the vote may suggest consumers are willing to pay more for products claiming to protect animal welfare.[3] Using a hypothetical survey of egg consumers in Great Britain, Bennett (1997) reports consumers on average would be willing to pay £0.43 more for cage-free eggs (at the time of the study, the average price for a dozen eggs was £1.40). However, experimental evidence suggests people overstate their willingness to pay (WTP) when asked hypothetical valuation questions relative to nonhypothetical scenarios. Specifically, List and Gallet (2001) find that respondents state values 2%–20% greater in hypothetical questions relative to nonhypothetical valuation questions. In contrast, nonhypothetical experiments have the ability to uncover consumers' true WTP, because participants in the experiment are provided real economic incentives to make decisions that provide the most benefit at the lowest possible cost. In the alternative, revealed preference data, such as the household-panel data used here, provide a more direct way of measuring consumers' apparent willingness to pay.

Using household-level data of a panel of Danish citizens in a mixed logit framework, Andersen (2008) concludes that consumers are willing to pay DKK2.81 ($0.556) more for a dozen free-range eggs compared to regular shell eggs. However, European consumers may

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[1] For a discussion on poultry behavior and welfare relating to housing, see Appleby, Mench, and Hughes (2004).

[2] Detailed discussions of laying-hen cage systems can be found in Rahn (2001) and Bell and Weaver (2002).

[3] Clearly, many factors other than a willingness to pay for cage-free eggs may also have influenced voting behavior: altruistic feelings of empathy for farm animals, a need to make the "politically correct" choice, or even a disregard for or acceptance of the likely price impacts.

differ from their American counterparts, particularly in matters concerning animal welfare or environmental issues. No research to date has investigated the WTP of American consumers in general, or California consumers in particular, regarding laying-hen animal welfare attributes. Accordingly, the objective of this research is to determine the WTP for cage-free eggs by consumers in California and to identify market segments that are likely to bear a disproportionate impact.

We estimate WTP using household-level purchase data in a mixed-logit modeling framework. Our results suggest only 20.63% of all households would be willing to buy cage-free eggs at the average 2007–2008 prices. Furthermore, if all egg prices rise to the cage-free level, the effect is highly regressive—i.e., households that will be most impacted consist of five members or more, and have generally lower levels of income. In total, the implied welfare loss, based on a compensating variation measure, is \$106 million. Finally, we estimate the average WTP for a dozen cage-free eggs is \$0.524 above the regular shell-egg price. Taken together, the results imply that if all prices rise to cage-free levels, the quantity demanded for eggs in general will fall substantially.

Econometric Model of California Eggs

While eggs are often regarded as commodities, many suppliers differentiate their eggs by advertising attributes that ostensibly pertain to better health such as vitamin E or Omega-3 fatty-acid enriched, or animal welfare attributes such as cage-free, free-range, and vegetarian-fed hens. This makes eggs a differentiated product, because many of these attributes command a price premium in the market. Hence, a discrete choice model is appropriate (Nevo, 2001). Furthermore, in order to account for unobserved heterogeneity in consumer preferences, we use a random coefficient logit (RCL) model. A random coefficient specification also allows us to estimate consumer-specific parameter estimates, which are necessary to calculate WTP values that vary by market segment.

Formally, we assume that a sample of H households $h \in \{1, 2, ..., H\}$ make purchases among B brands $b \in \{1, 2, ..., B\}$ on purchase occasion $t \in \{1, 2, ..., T\}$. With this assumption, the conditional indirect utility of household h for alternative b on purchasing occasion t can be written as:

$$(1) \qquad U_{hbt} = \boldsymbol{\eta}^{\mathrm{T}}\mathbf{x}_{hbt} + \psi_1 d_{hbt-1} + \psi_2 d_{hbt-2} + \xi_{bt} + \varepsilon_{hbt},$$

where $\boldsymbol{\eta}$ is a k-dimensional vector of parameters including an intercept term for each brand γ_{hb}, and $\mathbf{x}_{hbt}$ is a vector of brand and household attributes. Brand attributes ($\mathbf{x}_{bt} \subset \mathbf{x}_{hbt}$) consist of several variables including brand b's retail price at time t (p_{bt}), and an indicator of whether the product is offered on a temporary discount (dd_{bt}). The temporary discount variable equals 1 if the brand was discounted more than 10% for a duration of one week and 0 otherwise. Finally, $\mathbf{x}_{bt}$ includes an interaction term between the retail price and the temporary discount ($dd_{bt}\, p_{bt}$) (Chintagunta, 2002; Richards, 2007).[4] By including an interaction term, we

[4] Inspection of households' purchase patterns reveals that almost all of the households regularly purchase the same quantity of eggs on each purchase occasion, with the time between purchases often being almost constant. Furthermore, because the code date for eggs suggests they expire 30 days after they are packaged by the manufacturer, we conclude households are not stockpiling eggs; it appears households replenish their inventory once all of the eggs are either consumed or expired. Nevertheless, the measure of inventory following Bucklin and Gupta (1992) was added to a model specification similar to that given in equation (1). Consistent with Allender and Richards (2010), the results suggested the model without inventory fit the data better (these results are available from the authors upon request). Therefore, the measure of inventory is excluded from the final model specification.

allow items on promotion to become less elastic if households perceive discounting as a means of differentiating otherwise similar products. Additionally, we include a binary cage-free variable (cf_{bt}) equal to 1 if the particular product sold had the cage-free attribute and 0 otherwise, a binary variable equal to 1 if the brand sold contained an organic attribute (org_{bt}), and a binary variable equal to 1 if the eggs sold were white eggs (we_{bt}). In order to account for any change in cage-free egg preferences due to the Proposition 2 campaign, we include an interaction term between the binary cage-free variable and the number of television commercials that were shown on any particular day ($cf_{bt}\, ad_{bt}$) in favor of Proposition 2 (Lusk, 2010).

A household's prior experiences with a brand can influence the propensity to purchase the same brand in the current period. In such cases, there is said to exist structural state dependence in the household's brand choices over time (Honoré and Kyriazidou, 2000). To account for structural state dependence, we included lagged dependent variables d_{hbt-1} and d_{hbt-2}, which equal 1 if brand b was chosen by household h at time $t-1$ and $t-2$, respectively, and 0 otherwise, and ψ_1 and ψ_2 are adjustment parameters (Erdem, 1996; Roy, Chintagunta, and Haldar, 1996; Honoré and Kyriazidou, 2000; Richards, Patterson, and Tegene, 2007). By including d_{hbt-1} and d_{hbt-2}, we account for any brand inertia or variety-seeking behavior that may carry over from one purchase occasion to the next.

Finally, error terms are included to account for all product-specific variation in demand that is unobserved by the econometrician, ξ_{bt}, and household-specific heterogeneity in preferences, ε_{bt}, which we assume to be i.i.d. type I extreme value distributed and independent over time. The assumption of serial independence suggests households have stable tastes over the sample time period and cannot forecast prices, firm promotions, etc. in optimizing their behavior. Therefore, expectations of future marketing activity do not affect current brand choices (Chintagunta, Kyriaziduo, and Perktold, 2001). With this error assumption, the utility specification in (1) implies a discrete choice, logit demand model.

It is well understood that a simple logit model suffers from the independence of irrelevant alternatives property. Because households are unlikely to obtain the same utility from each brand, we specify a random coefficient logit model which introduces a degree of curvature that the simple logit lacks. We estimate a model in which the coefficients of the price, binary cage-free, and organic variables are lognormally distributed in the population, while the brand intercept terms and lagged dependent variables are normally distributed and all other parameters are assumed fixed (Train, 1998). A lognormal distribution assures each household has a positive coefficient for the variable, which may not be the case if the coefficient is assumed to be normally distributed. Specifically, the marginal utility of the cage-free binary variable is assumed to be positive because consumers are expected to attach a positive or zero value to the animal welfare attribute. Therefore, if someone has no interest in cage-free eggs, the estimated coefficient should be zero, whereas any value placed on the cage-free attribute would imply $\eta_{cf} > 0$. Similarly, the price coefficient is expected to be negative for all households. Allowing price to be lognormally distributed and multiplying by −1 ensures this. The elements of $\boldsymbol{\eta}$ that are lognormally distributed are written as:

$$(2) \qquad \eta_k = e^{m_k + \sigma_k v_{hk}},\ v_{hk} \sim N(0,1)\ \forall\, k = -p_{bt}, cf_{bt}, org_{bt}\,.$$

The parameters m_k and σ_k represent the mean and standard deviation of $\ln(\eta_k)$, which are estimated, and v_{hk} is the random term representing the household's unobserved heterogeneity.

The coefficients of the brand intercept terms and lagged dependent variables can be negative or positive factors in influencing household choices depending on their preferences. In other words, households differ in their attribute preferences so that an appropriate specification for the unobserved heterogeneity is a normal distribution. Specifically, the brand intercept terms γ_{hi} in $\boldsymbol{\eta}$ are denoted by:

$$\gamma_{hi} = \gamma_{0i} + \phi_i z_{hi} + \sigma_i v_{hi},\ v_{hi} \sim N(0,1)\ \forall\ i = 1, ..., B-1, \tag{3}$$

where γ_{0i} represents the mean of the random parameter, z_{hi} is household income, ϕ_i is the brand-specific income effects, v_{hi} is the random term representing the household's unobserved heterogeneity, and σ_i is the standard deviation of γ_{hi}. Finally, the lagged dependent variables are designated by:

$$\psi_j = \psi_{0j} + \sigma_j v_{hj},\ v_{hj} \sim N(0,1)\ \forall\ j = 1, 2, \tag{4}$$

where the parameters ψ_{0j} and σ_j represent the mean and standard deviation of the lagged dependent variables d_{hbt-j}, and v_{hj} is a random term again representing unobserved heterogeneity. Because attributes such as the quality of the previously purchased egg, cleanliness, and other factors are unobserved, accounting for household heterogeneity present in the lagged dependent variables is imperative. Moreover, because these factors can have a positive or negative effect on a household's propensity to purchase in the current period, a normal distribution is appropriate.

McFadden and Train (2000) interpret the elements of equations (2), (3), and (4) in terms of an error-components model of attribute demand. In contrast to the IIA property of a single logit model, the heterogeneity assumption in equations (2), (3), and (4) creates a general pattern of substitution over $B-1$ alternatives through the unobserved, random part of the utility function given in equation (1). Consequently, the utility from different brands is correlated according to their attributes.

The RCL model introduces a large number of parameters relative to the simple logit model. Therefore, we follow Nevo (2001), among others, and write the indirect utility function in terms of two sets of variables—those that are assumed to be random and those that are not. For convenience, we set $\boldsymbol{\sigma}^{\mathrm{T}} = (\sigma_k, \sigma_i, \sigma_j)$, $\mathbf{m}^{\mathrm{T}} = (m_k, \gamma_{0i}, \psi_{0j})$, $\mathbf{v}^{\mathrm{T}} = (v_{hk}, v_{ht}, v_{hj})$, $\mathbf{d}^{\mathrm{T}} = (d_{hbt-1}, d_{hbt-2})$, and $\boldsymbol{\psi}^{\mathrm{T}} = (\psi_1, \psi_2)$. By combining equations (1), (2), (3), and (4), the indirect utility function is expressed as:

$$U_{hbt} = \delta_{bt}(\mathbf{x}_{bt}, \xi_{bt}; \boldsymbol{\eta}) + \tau_{hbt}(\mathbf{x}_{hbt}, z_{hi}, \mathbf{d}_{hbt-j}, \mathbf{v}; \boldsymbol{\eta}, \phi_i, \boldsymbol{\psi}, \mathbf{m}, \boldsymbol{\sigma}) + \varepsilon_{hbt}, \tag{5}$$

where δ_{bt} is the mean utility level that varies over products but not households, and τ_{hbt} is the idiosyncratic part that varies by household and product. For convenience, let

$$\zeta_{hbt} = \boldsymbol{\eta}^{\mathrm{T}}\mathbf{x}_{hbt} + \boldsymbol{\psi}^{\mathrm{T}}\mathbf{d}_{hbt-j} + \xi_{hbt}$$

represent the mean utility. The probability that household h chooses brand b at purchasing occasion t conditional on $\boldsymbol{\eta}$ and $\boldsymbol{\psi}$ is written as:

$$\Pr_{ht}(b \mid \boldsymbol{\eta}, \boldsymbol{\psi}) = \prod_{t=1}^{T} \frac{e^{\zeta_{hbt}}}{\sum_{l=1}^{B} e^{\zeta_{hlt}}}, \tag{6}$$

where the utility of purchasing brand B has been normalized to 1.

The advantages of the RCL model do not come without a cost. Unlike the logit and nested logit models, there is no analytical closed form for equation (6). In order to overcome this obstacle, we integrate over the densities of the random parameters in the model. We define the densities of **v** as $f(\mathbf{v})$ so that the unconditional probability of household h purchasing brand b on purchasing occasion t is obtained by integrating over equation (6) and the distributions reflecting consumer heterogeneity. In doing so, we obtain:

$$\text{(7)} \qquad \Pr_{ht}(b) = \int \cdots \int \prod_{t=1}^{T} \frac{e^{\zeta_{hbt}}}{\sum_{l=1}^{B} e^{\zeta_{hlt}}} f(\mathbf{v})\, d\mathbf{v},$$

which is then estimated using simulated maximum likelihood (SML).

Simulated maximum likelihood uses Monte Carlo simulation to solve the integrals in equation (7) up to an approximation accurate to the number of random draws chosen, R. This method provides consistent parameter estimates under general error assumptions and is readily able to accommodate complex structures associated with consumer heterogeneity. SML also offers consistent estimates of an endogenous price variable. To aid the speed and efficiency of estimation, we employ a Halton draw sequence. Bhat (2003) provides experimental evidence suggesting Halton sequences can reduce the number of draws required to produce estimates at a given accuracy by a factor of 10. We found that $R = 100$ draws are sufficient to produce stable estimates without excessive estimation time.

By estimating equation (7), estimates are obtained for each household's preference regarding the cage-free attribute and their marginal utility of income (Train, 2003). These parameters are necessary in order to calculate each household's WTP for cage-free eggs. The $\ln(WTP)$ is distributed normal with the mean calculated as

$$\ln\left(\exp[\eta_{cf}] + \eta_{cf*ad} E[cf * ad]\right) - \eta_p = m_{WTP},$$

and variance calculated as

$$\sigma^2_{\eta_{cf}} + \sigma^2_{\eta_p} = \sigma^2_{WTP},$$

where $E[\cdot]$ indicates the expectation operator. Therefore, the mean and standard deviation of the WTP for cage-free eggs are calculated, respectively, as:

$$\text{(8)} \qquad \exp\left[m_{WTP} + \frac{\sigma^2_{WTP}}{2}\right] \text{ and } \left(\exp\left[m_{WTP} + \frac{\sigma^2_{WTP}}{2}\right]\left(\exp\left[\sigma^2_{WTP}\right] - 1\right)\right)^{1/2}.$$

We obtain the mean WTP on a household-level basis using this estimate, and from it we can determine the households that will be most impacted by the regulation.

Data Description

Eggs represent a unique opportunity to study the welfare effects of animal welfare regulation for a number of reasons. First, given the prominence of Proposition 2 in public discourse in 2008, animal welfare issues were widely discussed and understood in the context of egg production in California. Second, according to the American Egg Board (AEB, 2008), eggs have a 93% household penetration rate and a 96% rate of repurchase. After trade, terms, and handling costs, eggs generate more weekly profits than any other dairy category in a retail supermarket. The AEB estimates that eggs turn over in a supermarket every three and a half days, or more than 100 times per year. Furthermore, in the United States, the AEB reports there are 235 egg-producing companies with at least 75,000 hens, 63 companies with at least 1 million laying hens, and 15 companies that own more than 5 million layers. The AEB estimates that of the 211.1 million cases of shell eggs produced in 2007, 66 million (31.3%) were further processed, 124.6 million (59%) went to retailers in the United States, 19 million (9%) went for foodservice use, and 1.5 million (0.7%) were exported as shell eggs. Of this total, approximately 5% of eggs sold in California were cage-free in 2007 (Sumner, Rosen-Molina, and Matthews, 2008). Therefore, eggs are a staple item that many consumers rely on for their daily nutrition and, because they are positioned at the center of the animal welfare debate in California, are an ideal category for study.

The data used in this study consist of household-level, retail egg purchases for 993 sampled households in California during 2007 and 2008. The data set, A.C. Nielsen, Inc.'s "Homescan" database, is collected by requiring participating households to submit all food purchase information (price and quantity, along with a product description) each time they visit any type of retail food outlet. As such, the data include sales from traditional supermarkets, club stores, superstores, dollar stores, convenience stores, and any other outlet—a feature not captured by aggregate, store-level scanner data. In addition to a high degree of product detail, the Homescan database also includes a number of socioeconomic and demographic descriptors.

On a product level, the Homescan data contain information on each brand's price, organic attribute presence, color, size, and package size for each brand's UPC, including private labels. However, the data do not include information on whether a particular brand is cage-free. Therefore, we obtained this information by combining data from Mintel's Global New Products Database (GNPD) with data gathered directly from stores throughout central and southern California in August of 2009. The GNPD monitors new product introductions in the consumer packaged goods market covering food, beverage, healthcare, household personal care, cosmetics, fragrance, and other nonfood sectors. Information on egg product attributes was also gathered manually by visiting each grocery store outlet or chain in central and southern California and taking pictures of all egg products offered at each outlet. All relevant attributes and UPC codes were then recorded into a database and attributes were matched to the Homescan data via the UPC—which is included for all brands, including private label.

Inspection of the cage-free attribute database revealed the same brands are often offered as either cage-free or regular. For example, under the Eggland's Best brand name, an almost identical product was sold as both cage-free and non-cage-free. Because this practice is common across multiple brands, it is not possible to aggregate the cage-free attribute by brand. Therefore, we created a binary cage-free variable (cage-free = 1, non-cage-free = 0) based on our recorded observations of each egg UPC. By properly identifying whether a brand is cage-free, we can then estimate the preferences for cage-free eggs on an individual brand basis.

There are a large number of brands available in the egg category—too large to model in a tractable way and obtain reliable estimates of household demand. Thus, we selected the 13 most popular brands and aggregated the others into a single choice, used as the outside option. Focusing on the most popular brands in the category allows us to use the maximum number of households possible and retain a level of modeling complexity necessary to capture

Table 1. Demographic Distribution of Surveyed Households and U.S. Households for 2007

Variable	Households in Homescan Database (%)	Households in Our Sample (%)	Households in CPS (%)
Income Bracket:			
Less than $29,999	17.55	15.67	25.77
$30,000 to $39,999	10.80	10.16	11.18
$40,000 to $49,999	10.74	10.21	8.06
$50,000 to $59,999	10.14	10.40	8.49
$60,000 to $99,999	30.38	31.70	22.82
$100,000 and over	20.39	21.86	23.69
Marital Status:			
Married	57.57	67.88	51.77
Widowed	7.95	7.41	5.22
Divorced/Separated	15.43	12.59	9.11
Single	19.05	12.12	33.90
Household Size:			
1	26.87	17.20	9.02
2	38.88	41.45	21.42
3	14.80	16.41	18.14
4	11.79	15.66	22.52
5	4.70	5.27	14.60
6	1.96	2.70	7.38
7+	1.01	1.31	6.93

the differentiated nature of egg markets. If, throughout the course of the two years, the household made more than one brand purchase in a single shopping trip (only 2.89% of households), its purchase observations were excluded. Furthermore, Honoré and Kyriazidou (2000) demonstrate that six purchase occasions are enough to identify the parameters of equation (7). As a result, any household that made fewer than six purchases was excluded (33% of households), leaving us with 933 California households within the egg category sample. Table 1 gives a comparison of the demographics of the households in the sample with those collected in the Current Population Survey (CPS), conducted by the U.S. Census Bureau's Bureau of Labor Statistics. While the demographics of the two groups are not exactly the same, they are very close. We therefore believe that the sampled households represent the overall population of California reasonably well. To facilitate use of the lagged dependent variable, we drop the first two purchase occasions because information on the previous purchase is not available. This procedure left us with 16,055 purchase observations, which were used to estimate equation (7).

The brands used for the analysis are reported in table 2 along with summary statistics, including the frequency of purchase throughout 2007 and 2008 and the average price of each brand. As observed from the data in table 2, non-cage-free (or regular) private label brands were purchased a majority of the time by consumers. During 2007–2008, on average, Eggland's Best has the lowest average price for cage-free eggs and the highest market share. Not surprisingly, the table also shows that the brands with the highest average price tend to have the highest standard deviation in prices, while those with the lowest average price tend to

Table 2. California Egg Sales Summary Statistics by Brand and Attribute

Variable	Attribute [a]	% Purchased	Average Price ($/doz.)	Std. Dev. of Price ($/doz.)	% Organic Sales	% White Egg Sales
Overall	—	—	2.04	0.77	0.25	95.48
Overall	Reg.	94.99	1.96	0.70	0.26	97.48
Overall	CF	5.01	3.48	0.69	0.29	57.57
Private Label	Reg.	58.74	2.39	0.70	0.33	98.93
	CF	1.79	3.55	0.64	0.00	0.49
Eggland's Best	Reg.	1.71	2.02	0.23	0.00	98.61
	CF	5.24	3.46	0.76	0.44	86.20
Willamette Egg Farms	Reg.	0.84	2.39	0.66	0.00	86.26
	CF	0.00	3.51	0.46	0.00	0.00
Becky Farms	Reg.	9.79	2.23	0.70	0.00	99.98
Norco Ranch	Reg.	4.20	1.49	0.38	2.51	98.04
CA Ranch Fresh	Reg.	4.89	1.48	0.39	0.00	98.87
Country Creek	Reg.	5.42	1.70	0.34	0.57	96.86
Petaluma Farms	Reg.	6.03	1.71	0.37	0.00	100.00
Cal Eggs	Reg.	0.96	1.59	0.36	0.00	100.00
Nulaid	Reg.	2.33	2.14	0.77	0.00	99.21
Yucaipa Valley	Reg.	1.95	2.20	0.63	0.00	100.00
Ross Swiss	Reg.	0.73	1.61	0.47	0.00	100.00
Olivera	Reg.	0.72	2.93	0.94	0.00	99.90
All Other Brands	Reg.	2.15	1.75	0.26	0.00	86.48

[a] Attribute indicates whether the summary statistics are for regular (Reg.) or cage-free (CF) eggs.

have the lowest standard deviations (among both cage-free and regular). In fact, we find the correlation between average price and standard deviation to be 0.960, an observation consistent with eggs sold at the retail level following either a HILO or everyday low price (EDLP) strategy. Finally, cage-free eggs are purchased about 5% of the time, consistent with findings reported by Sumner, Rosen-Molina, and Matthews (2008) and Smith (2010).

Because few consumers were aware of animal welfare issues prior to the public debate surrounding the campaign for Proposition 2, it is likely that demand for cage-free eggs changed during the sample period as a result of advertising on either side (Lusk, 2010). Accordingly, our data set incorporates a measure of the number of "yes" and "no" television ads to which each household was likely exposed over the sample period. This information was obtained from TNS Media Intelligence, New York, and is exhaustive of all Proposition 2-related television advertisements aired during the 2007–2008 time period.

Empirical Results and Discussion

Household Demand

The additional complexity of the random coefficient logit (RCL) model is warranted only if it provides a better fit to the data than a simpler alternative. In a discrete choice framework, that alternative is a simple multinomial logit (MNL) model. Table 3 presents the results of the RCL model and, for comparison purposes, the MNL. As a first step, we assess the validity of

Table 3. Multinomial and Random Coefficient Logit Demand Estimates: California Eggs

	MNL Parameters		RCL Parameters		RCL (σ) Std. Dev.	
Variable	Estimate	*t*-Ratio	Estimate	*t*-Ratio	Estimate [a]	*t*-Ratio
Binary Cage-Free (cf_{bt})	0.8644*	8.14	−4.7113* [b]	−7.91	2.1336* [c]	10.70
(neg.) Price ($-p_{bt}$)	0.4576*	17.32	−0.9139* [b]	−14.93	1.1311* [c]	24.10
Organic (org_{bt})	3.7747*	19.89	1.0702* [b]	11.82	0.4403* [c]	5.34
Lagged Dependent (ψ_1)	1.9220*	76.70	1.1318*	38.93	0.4945*	15.30
Lagged Dependent (ψ_2)	1.8634*	73.79	0.9386*	34.03	0.1223*	4.01
Discount Dummy (dd_{bt})	−0.8827*	−3.24	−0.8617*	−3.68		
Disc. Dummy∗Price ($dd_{bt}\, p_{bt}$)	0.3500*	3.53	0.3769*	4.31		
Binary White Egg (we_{bt})	1.9783*	15.95	1.6899*	19.82		
Cage-Free∗Ad ($cf_{bt}\, ad_{bt}$)	0.0197*	2.24	0.0263*	2.55		
Variable	(γ_{0i}) Intercept Parameters				(σ_i)	
Private Label	1.0532*	4.32	2.1671*	10.23	0.9671*	22.53
Becky Farms	−0.0252	−0.09	−1.1423*	−4.65	1.5036*	24.31
Norco Ranch	−1.9645*	−5.42	−4.1784*	−9.97	1.9948*	15.77
CA Ranch Fresh	−1.0536*	−3.27	−5.7008*	−11.30	3.8778*	18.48
Country Creek	0.4087	1.49	0.4648*	2.10	1.3311*	22.82
Petaluma Farms	0.1200	0.42	−1.9355*	−5.81	2.4347*	24.50
Eggland's Best	−0.9045*	−2.68	−1.2250*	−4.05	1.4052*	15.58
Cal Eggs	−1.9069*	−4.06	−5.9292*	−8.95	3.7302*	12.63
Nulaid	−0.0213	−0.07	−1.4724*	−4.84	1.7682*	21.81
Yucaipa Valley	−1.4431*	−3.80	−6.5598*	−9.92	3.1877*	16.47
Ross Swiss	−1.1238*	−2.58	−2.9904*	−4.53	3.3511*	10.41
Olivera	−3.5625*	−4.97	−8.3143*	−5.87	2.6679*	14.30
Willamette Egg Farms	0.4180	1.04	−6.1594*	−7.14	7.2373*	11.29
Variable	(ϕ_i) Household Income Parameters					
Private Label	0.0322*	2.92	0.0269*	2.91		
Becky Farms	0.0409*	3.31	0.0641*	6.20		
Norco Ranch	0.0822*	5.29	0.1081*	7.05		
CA Ranch Fresh	0.0523*	3.70	0.0486*	3.23		
Country Creek	0.0039	0.31	−0.0168*	−1.74		
Petaluma Farms	0.0159	1.24	0.0324*	2.33		
Eggland's Best	0.0499*	3.41	0.0407*	3.15		
Cal Eggs	0.0495*	2.43	0.0275	1.11		
Nulaid	0.0074	0.51	0.0093	0.71		
Yucaipa Valley	0.0574*	3.48	0.1302*	6.15		
Ross Swiss	−0.0013	−0.07	−0.1061*	−2.91		
Olivera	0.1305*	4.48	0.2156*	4.16		
Willamette Egg Farms	−0.0587*	−2.93	−0.3182*	−6.88		
Log Likelihood	−13,826.38		−12,178.07			
Likelihood Ratio	25,842.91		60,384.00			
Likelihood Ratio Index	0.483		0.713			

Note: An asterisk (*) denotes statistical significance at the 5% level.
[a] Heterogeneity was modeled using a normal distribution unless otherwise noted.
[b] This is the mean of the ln(coefficient).
[c] This is the standard deviation of the ln(coefficient).

Table 4. Matrix of Own- and Cross-Price Elasticities: Random Coefficient Logit Model

	Private Label	Becky Farms	Norco Ranch	CA Ranch Fresh	Country Creek	Petaluma Farms	Eggland's Best
Private Label	−0.4362	0.5914	0.8245	0.5221	0.7788	0.6053	0.5794
Becky Farms	0.0610	−1.0235	0.1563	0.0883	0.1264	0.0920	0.0791
Norco Ranch	0.0250	0.0452	−1.2919	0.0611	0.0803	0.0587	0.0365
CA Ranch Fresh	0.0139	0.0231	0.0564	−0.7763	0.0377	0.0287	0.0192
Country Creek	0.0544	0.0876	0.1807	0.0939	−1.1931	0.1005	0.0789
Petaluma Farms	0.0369	0.0567	0.1154	0.0634	0.0888	−0.9390	0.0498
Eggland's Best	0.0296	0.0389	0.0549	0.0336	0.0549	0.0391	−1.1584
Cal Eggs	0.0087	0.0146	0.0340	0.0178	0.0237	0.0178	0.0125
Nulaid	0.0201	0.0317	0.0566	0.0306	0.0449	0.0325	0.0287
Yucaipa Valley	0.0133	0.0195	0.0350	0.0210	0.0299	0.0214	0.0191
Ross Swiss	0.0067	0.0124	0.0315	0.0181	0.0197	0.0144	0.0116
Olivera	0.0087	0.0119	0.0173	0.0111	0.0164	0.0121	0.0126
Willamette Egg Farms	0.0042	0.0058	0.0091	0.0070	0.0074	0.0064	0.0060
All Other Brands	0.0270	0.0472	0.1013	0.0484	0.0820	0.0531	0.0475

(extended . . . →)

the RCL model against the simple logit specification. Because an MNL model is a special case of the more general RCL, we use a likelihood-ratio (LR) test. The LR statistic for the null hypothesis that the parameter vector from the RCL is equal to that of the MNL is 3,296.62, which is chi-square distributed with 53 degrees of freedom. We easily reject the MNL model at the 5% level and conclude the RCL provides a better fit to the data. This conclusion is further supported by tests of the significance of the coefficients that govern the distributions of the random parameters, $\boldsymbol{\sigma}$. If there is no heterogeneity among California egg consumers, the coefficients $\boldsymbol{\sigma}$ will equal zero for all i, k, j, and the RCL will collapse into the simple MNL logit—a hypothesis that is easily rejected by the RCL model results presented in table 3.

We allow for curvature in the demand model that is driven by the interaction between the demographic attributes of each household and the unobservable components of demand by introducing random coefficients. Flexibility in substitution patterns is evident from the matrix of demand elasticities shown in table 4. While the own-price elasticities are less than zero, as expected, there is considerable variation in the cross-price elasticities for most brands. Such variation in cross-price elasticities does not exist in a simple logit specification due to the IIA property, but is generally thought to be present in the data. Therefore, we conclude that the RCL model fits that data better than the simple multinomial logit.

In the demand model, there are several parameters of inherent interest, from both a managerial and a theoretical perspective. First, the point estimates for the lognormal distributions in table 3 imply the binary cage-free parameter (cf_{bt}) has a mean of 0.0876 and a standard deviation of 0.849, which suggests California households do prefer eggs containing animal welfare attributes ($cf_{bt} > 0$). However, there is significant variation in the degree of preference across households. Similarly, the mean of the price coefficient estimate is −0.760 with a standard deviation of 1.224, which suggests the marginal utility of income is negative as expected.

Second, we find the coefficient on discount effect (dd_{bt}) is negative and statistically different from 0 at the 5% significance level. Furthermore, the discount-price interaction term ($dd_{bt}p_{bt}$) is positive, which suggests that discounting a brand will shift the demand curve out and rotate it counterclockwise. While this may not be the intended result from the retailer's

Table 4. Extended

	Cal Eggs	Nulaid	Yucaipa Valley	Ross Swiss	Olivera	Willamette Egg Farms	All Other Brands
Private Label	0.6393	0.6717	0.5526	0.7027	0.5218	0.4586	0.9010
Becky Farms	0.1045	0.1056	0.0818	0.1292	0.0748	0.0692	0.1534
Norco Ranch	0.0678	0.0569	0.0436	0.0932	0.0341	0.0347	0.0999
CA Ranch Fresh	0.0345	0.0283	0.0234	0.0486	0.0198	0.0217	0.0443
Country Creek	0.1120	0.1041	0.0852	0.1330	0.0693	0.0561	0.1813
Petaluma Farms	0.0749	0.0674	0.0544	0.0890	0.0468	0.0446	0.1059
Eggland's Best	0.0434	0.0476	0.0388	0.0566	0.0407	0.0373	0.0752
Cal Eggs	−1.0205	0.0173	0.0150	0.0272	0.0137	0.0154	0.0303
Nulaid	0.0363	−1.2072	0.0286	0.0463	0.0290	0.0282	0.0582
Yucaipa Valley	0.0256	0.0236	−1.0440	0.0338	0.0213	0.0229	0.0391
Ross Swiss	0.0182	0.0153	0.0131	−1.2263	0.0118	0.0143	0.0295
Olivera	0.0146	0.0153	0.0131	0.0192	−1.2283	0.0194	0.0215
Willamette Egg Farms	0.0080	0.0073	0.0078	0.0118	0.0102	−1.0876	0.0092
All Other Brands	0.0644	0.0583	0.0507	0.0915	0.0418	0.0329	−1.5489

perspective, it is consistent with the literature that argues for enhanced price competition due to price promotion (Hosken and Reiffen, 2001; MacDonald, 2000). Collectively, these results indicate that eggs are only moderately conducive to price promotions, which is true of any perishable, staple item.

Third, the results in table 3 show the binary white egg variable is positive and statistically significant. Fourth, consistent with other empirical studies, the parameters on the lagged dependent variables (ψ_1 and ψ_2) that measure structural state dependence are both positive and statistically significant (Seetharaman, 2004; Richards, Patterson, and Tegene, 2007; Thunström, 2008). Therefore, we infer that brand inertia exists for both the last and second-to-last purchase occasions. Furthermore, $\psi_1 > \psi_2$ suggests brand inertia has a possible decaying effect over time. In addition, the estimates for the lagged dependent variables in table 3 imply that brand inertia is one of the most important predictors of brand choice, in agreement with findings reported by Seetharaman (2004). Fifth, we find the parameter estimate on the interaction term of cage-free and television advertising ($cf_{bt}\,ad_{bt}$) is positive and statistically significant as expected. Consistent with Lusk (2010), we conclude the 2008 campaign for Proposition 2 had a positive effect on California households' preference for the cage-free attribute. Finally, we find that as household income increases, the probability of purchasing almost all of the brands increases (i.e., $\phi_i > 0$). This finding suggests that eggs are a normal, as opposed to an inferior, good.

Willingness to Pay

In order to determine which households will be most affected by regulating cage-free egg production, we use household-specific parameter estimates calculated from equation (1) to estimate the WTP for cage-free eggs for each household. Because prices will rise by approximately 20% as a result of higher production costs (Sumner, Rosen-Molina, and Matthews, 2008), consumers who are not willing to pay the premium will be excluded from the market and thus adversely affected by the cage-free egg mandate. We are able to separate each household's brand preference and cage-free attribute preference following Train (2003, p. 262). Consequently, all of the WTP calculations below represent estimates of the cage-free attribute independent of the brand. We begin our analysis by investigating the WTP estimates for California households in general.

Using the household-specific WTP estimates, we determine the proportion of households in the sample that are willing to pay for a dozen cage-free eggs at the average 2007–2008 market prices. Figure 1 shows the distribution of the WTP estimates across our sample of California households. The estimates indicate 79.37% of the households in the sample would not buy cage-free eggs, while 20.63% would.[5] The household-specific parameter estimates are then used to estimate the mean WTP, conditional on a household's willingness to buy cage-free eggs. Among this group, we estimate the mean WTP for the cage-free attribute is $0.524/dozen with a standard deviation of 0.796. These estimates seem reasonable given the low market share of cage-free eggs and that the average 2007–2008 price for regular eggs was $1.963/dozen and for cage-free eggs was $3.481/dozen. Because the observed premium of $1.518 likely includes the value of other attributes correlated with cage-free, our econometric estimate of the average WTP is intuitively plausible, as it reflects the revealed pricing behavior of egg marketers.

Knowing that some portion of California households would not be willing to buy cage-free eggs, we then aggregate the WTP estimates by demographic segments. Here, we focus on those households willing to pay the cage-free egg premium a majority of the time.[6] Specifically, we select only those households whose WTP is greater than the average difference between regular and cage-free eggs minus two times the standard deviation of the difference (i.e., $1.024). This process yielded 79 households in total, representing 7.956% of the total number of households; this is consistent with the average market share of cage-free eggs. The mean of the WTP across demographic groups is calculated using a simple mean, which is appropriate for observational data. We calculate the mean WTP for household income (*HH Income*), and the size of the household measured by the number of members in the household (*HH Size*). Identifying patterns in the mean WTP will allow us to determine the demographic distribution of the consumers most impacted by cage-free regulation, i.e., those most likely to be unwilling to purchase eggs at the new, higher market prices.

Of all the household attributes, income is the most relevant for policy purposes. Figure 2 shows the mean WTP for different income ranges and suggests there is a great deal of variation. Not surprisingly, we find that households with annual incomes of less than $10,000 are not included in the figure because none of them were willing to pay $1.024 for the cage-free attribute. An ANOVA is used to test the sample means over the different income ranges. The ANOVA produces a test statistic of 0.41, which is less than the critical value at the 5% level of significance (1.79). Based on these results, the mean WTPs over the different income ranges are not statistically different from one another—likely a result of the large number of demographic groups (15) and the small number of households (79). Nevertheless, the results are consistent with Andersen (2008) and imply that California households are generally willing to pay more for the cage-free attribute as income increases. Consequently, the households most likely to leave the market if cage-free eggs become the only option are those with lower incomes.

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[5] Somewhat paradoxically, a majority of California voters elected to regulate cage-free egg production, even though almost three-quarters of egg consumers are not willing to pay the price difference required.

[6] Throughout 2007 and 2008, the average difference between regular eggs and those containing the cage-free attribute was $1.765, with a standard deviation of 0.370, and a minimum and maximum of 0.425 and 3.420.

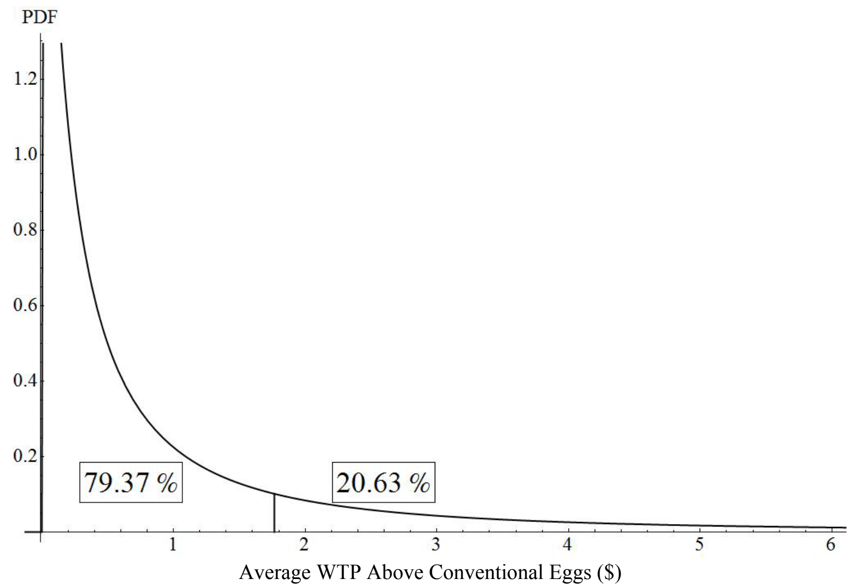

Figure 1. Distribution of premium paid for cage-free eggs over conventional eggs by California households

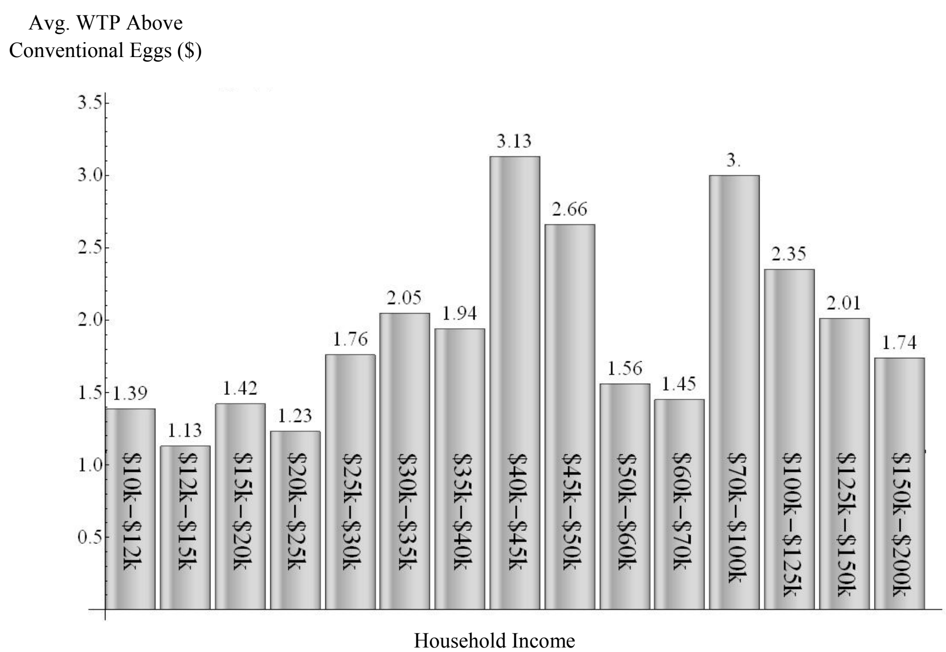

Figure 2. Mean WTP of households currently willing to purchase cage-free eggs at average 2007–2008 markup, aggregated by household income range

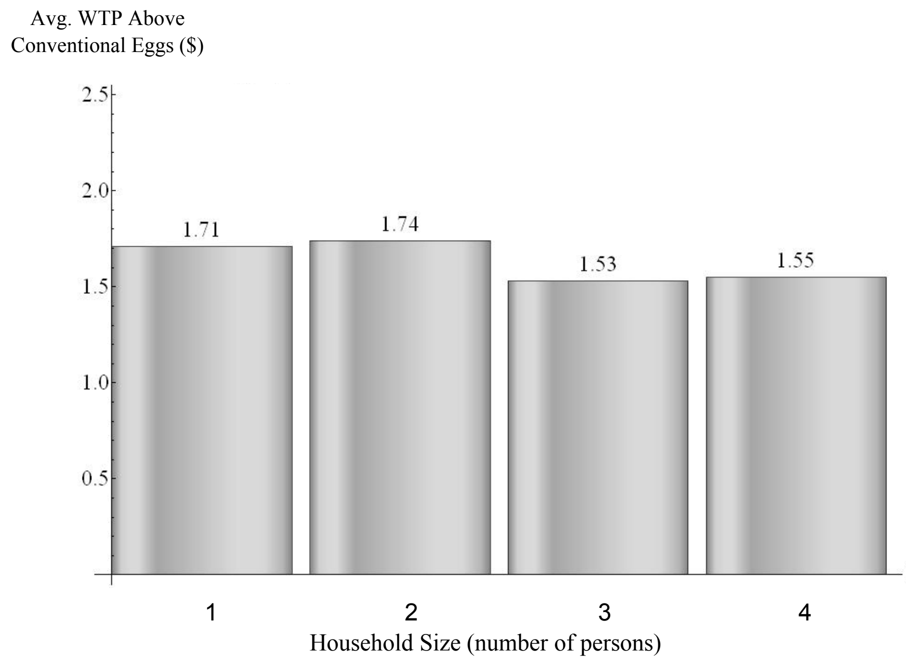

Figure 3. Mean WTP for cage-free eggs, aggregated by household size

Next, we investigate the impact on households of different sizes. Figure 3 shows the mean WTP based on the number of members in the household. Within the full sample of households, there are household sizes with as many as eight individuals, but none of the households with five or more were willing to pay the price the market demanded for the cage-free attribute. Thus, these households are not included in the analysis below. Clearly, as the number of people in the household increases, the average WTP for the cage-free attribute decreases. We test the hypothesis that the mean WTP is equal across all household sizes using an ANOVA test. The hypothesis is not rejected at the 5% level of significance given a test statistic of 0.82. Therefore, we conclude that none of the means are statistically different from one another. Nevertheless, the inverse relationship between household size and average WTP shown in figure 3 is expected because the household's variable cost of consuming eggs will increase proportionally to the number of members. Based on this analysis, we conclude that smaller household sizes (generally in the range of 1–4 members) are willing to pay more for the cage-free attribute, so larger households are more likely to be adversely affected by requiring all eggs be cage-free.

We also determine the net change in welfare for all California egg consumers to provide a more general illustration of the impact of mandating cage-free eggs. Because welfare effects are critically dependent upon assumptions regarding the elasticity of demand, we calculate the implied change in consumer welfare under a range of demand elasticity and likely price-change scenarios. Note also that consumers who are currently willing to pay existing cage-free premiums will not be affected by the Proposition 2 restrictions. Assuming the supply curve for cage-free eggs is horizontal at existing prices, only those consumers who are forced to pay higher prices for their eggs and those who are shut out of the market will experience a welfare loss. The former group of consumers earned positive surplus by purchasing conventional eggs at pre-regulation market prices, but would be willing to pay the premium for the

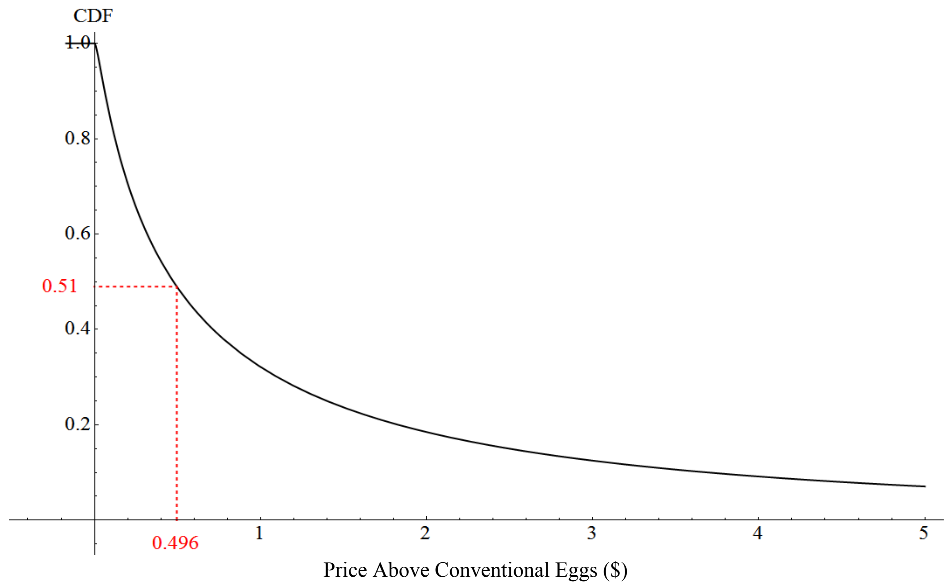

Figure 4. Percentage of California households willing to buy the cage-free attribute

cage-free attribute. The latter were egg consumers, but no longer will be if they only have access to higher-priced cage-free eggs. Defining the change in welfare as the compensating variation between pre- and post-regulation purchases, we find that the implied welfare loss is approximately $106 million, assuming wholesalers pass 100% of their input price increases on to consumers (Sumner, Rosen-Molina, and Matthews, 2008).

Our assumption that prices will rise by the increase in the cost of production clearly assumes perfectly inelastic demand. If the demand elasticity were −1.0, then suppliers and consumers would share the rise in production costs. Assuming a unit elasticity of demand, if retail prices increase by 5%, then the implied welfare loss is $28 million; likewise, if prices rise by 10%, the implied loss is $55 million. However, if regular egg prices increase to the average 2007–2008 cage-free retail prices (i.e., an increase of 87.5%), then the implied welfare loss would be $293 million. Our baseline assumptions therefore imply a loss in consumer welfare that lies on the conservative side of the likely welfare loss, as it lies below the mean of the possible extreme outcomes. In more intuitive terms, our welfare simulations reveal that California egg consumers would need about $106 million in compensation after the initiative goes into effect in 2015 to be as well off as they are now.

Our findings show that California cage-free egg consumers consist of households with fewer individuals and higher incomes. The California households likely most affected by the recent initiative are those with five or more members and/or those with yearly incomes less than $30,000. Furthermore, the overall average WTP calculated for almost every demographic attribute was below the price differential required to buy an egg brand at market prices. This suggests that regardless of income or household size, the average consumer likely would not be willing to buy cage-free eggs at the 2007–2008 market price. Referring back to figure 1, the 20.63% of households willing to buy cage-free eggs appear to be a niche market. For a majority of current egg-consuming California households to be willing to buy a dozen eggs with the cage-free attribute, (i.e., will be egg consumers after January 1, 2015), the price differential above regular eggs would need to be \$0.496 or lower, or approximately \$2.513 per dozen. Figure 4 illustrates this point in general for the price differential of cage-free eggs to regular eggs. We see from this graphic that if the passage of the initiative pushes the price of eggs up, the number of California households buying eggs will significantly decrease.

Conclusion and Implications

Caged eggs will be banned from sale as of January 1, 2015 (Sumner, Rosen-Molina, and Matthews, 2008). Eggs sold in California using cage-free methods will cost approximately 20% more than regular eggs, so consumers who are not willing to pay the premium for cage-free eggs will be effectively excluded from the market. This study estimates the number and type of households likely to be most impacted by the standards for confining farm animals initiative, and estimates the implied welfare losses imposed by higher egg prices. The demand for eggs by California consumers is modeled using a random coefficient logit model, which allows us to recover household-specific estimates of the WTP for cage-free eggs.

We find that at 2007–2008 prices, 79% of California households would not buy cage-free eggs. Indeed, many California households will no longer purchase eggs at the new prices. The WTP estimates also suggest that cage-free egg consumers are largely still a niche market, generally consisting of households with a higher income and/or fewer individual members. Aggregate welfare losses are estimated at \$106 million, assuming a 20% increase in retail prices (Sumner, Rosen-Molina, and Matthews, 2008). Finally, we find that as the per dozen price of cage-free eggs increases, households will drop out of the market at an exponential rate in the price range of about \$1.80 to \$3.79. Taken together, these results appear to confirm that the higher prices required for cage-free eggs will impose high and regressive costs on California egg consumers.

The implications of our findings are many. First, under California legislation signed into law in July 2010 (AB 1437), we assume conventional egg imports will not be allowed. However, without this restriction, egg imports into California would have increased substantially. In this scenario, quality would suffer, particularly in the summer months, as the lag between production and sale increases. Second, under the current law, California egg production will fall dramatically, which has somewhat obvious and adverse implications for the state economy. Third, consumer groups are likely to call for labeling requirements as an alternative to regulating cage-free eggs. If consumers are aware of the credence attribute embodied in the eggs they are purchasing, they will be able to decide whether to support cage-free egg practices or not.

Other animal welfare initiatives are likely to have similar welfare impacts. For example, Proposition 204 in Arizona, which requires the stall-free production of pork, is expected to drive pork production out of the state. While imports are allowed in this case, pork prices will surely rise as a result of the increased transportation costs and inefficient production practices for any producers who remain. Beyond animal welfare, many other production practices impose negative externalities on the environment; these exist now as credence goods in the products people buy. Regulating these credence attributes will raise prices, reduce choice, and impose welfare losses on consumers as a cost of achieving social goals.

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References

Allender, W. J., and T. J. Richards. "Market Diversion and Market Power: California Eggs." *Rev. Indust. Org.* 38(2010):37–58.

American Egg Board. "Home of the Incredible Edible Egg." AEB, Park Ridge, IL, 2008. Online. Available at http://www.aeb.org/. [Accessed September 29, 2010.]

Andersen, L. M. "Animal Welfare and Eggs—Cheap Talk of Money on the Counter?" Work. pap., AKF, Danish Institute of Governmental Research, 2008.

Appleby, M. C., J. A. Mench, and B. O. Hughes. *Poultry Behaviour and Welfare*. Cambridge, MA: CABI Publishing, 2004.

Bell, D. D., and W. D. Weaver. *Commercial Chicken Meat and Egg Production*, 5th ed. New York: Springer Publishing, 2002.

Bennett, R. M. "Farm Animal Welfare and Food Policy." *Food Policy* 22(1997):281–288.

Bhat, C. R. "Simulation Estimation of Mixed Discrete Choice Models Using Randomized and Scrambled Halton Sequences." *Transportation Research Part B: Methodological* 37(2003):837–855.

Bucklin, R. E., and S. Gupta. "Brand Choice, Purchase Incidence, and Segmentation: An Integrated Modeling Approach." *J. Marketing Res.* 29(1992):201–215.

California State Senate. "Assembly Bill No. 1437." [Last modified July 6, 2010.] Online. Available at http://leginfo.ca.gov/pub/09-10/bill/asm/ab_1401-1450/ab_1437_bill_20100706_chaptered.pdf.

Chintagunta, P. K. "Investigating Category Pricing Behavior at a Retail Chain." *J. Marketing Res.* 39(2002): 141–154.

Chintagunta, P. K., E. Kyriaziduo, and J. Perktold. "Panel Data Analysis of Household Brand Choices." *J. Econometrics* 103(2001):111–153.

Erdem, T. "A Dynamic Analysis of Market Structure Based on Panel Data." *Marketing Sci.* 4(1996):359–378.

Honoré, B. E., and E. Kyriazidou. "Panel Data Discrete Choice Models with Lagged Dependent Variables." *Econometrica* 68(2000):839–874.

Hosken, D., and D. Reiffen. "Multiproduct Retailers and the Sale Phenomenon." *Agribus.: An Internat. J.* 17(2001):115–137.

List, J. A., and C. A. Gallet. "What Experimental Protocols Influence Disparities Between Actual and Hypothetical Stated Values?" *Environ. and Resour. Econ.* 20(2001):214–254.

Lusk, J. L. "The Effect of Proposition 2 on the Demand for Eggs in California." *J. Agr. and Food Indust. Org.* 8(2010):Article 3.

MacDonald, J. M. "Demand, Information, and Competition: Why Do Food Prices Fall at Seasonal Demand Peaks?" *J. Indust. Econ.* 48(2000):27–45.

McFadden, D. L., and K. Train. "Mixed MNL Models for Discrete Response." *J. Appl. Econometrics* 15(2000):447–470.

National Hog Farmer. "California's Proposition 2 Passes by Wide Majority." [Last modified November 5, 2008.] Online. Available at http://nationalhogfarmer.com/behavior-welfare/news/1105-california-proposition2/.

Nevo, A. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand." *J. Econ. and Mgmt. Strategy* 9(2001):513–548.

Rahn, A. P. "Caged Laying Hen Well-Being: An Economic Perspective." Work. pap., Dept. of Animal Sci. and Agr. Econ., Michigan State University, 2001.

Richards, T. J. "A Nested Logit Model of Strategic Promotion." *Quant. Marketing and Econ.* 6(2007):63–91.

Richards, T. J., P. M. Patterson, and A. Tegene. "Obesity and Nutrient Consumption: A Rational Addiction?" *Contemp. Econ. Policy* 25(2007):309–324.

Roy, R., P. K. Chintagunta, and S. Haldar. "A Framework for Investigating Habits, 'the Hand of the Past,' and Heterogeneity in Dynamic Brand Choice." *Marketing Sci.* 15(1996):280–299.

Seetharaman, P. B. "Modeling Multiple Sources of State Dependence in Random Utility Models: A Distributed Lag Approach." *Marketing Sci.* 23(2004):263–271.

Smith, R. "Eggs: What We Buy, Pay, Want." *Feedstuffs* 82(2010). Online. Available at http://www.feedstuffs.com/ME2/dirmod.asp?sid=&nm=&type=Publishing&mod=Publications%3A%3AArticle&mid=AA01E1C62E954234AA0052ECD5818EF4&tier=4&id=11D20F02341340BCBA329ADD94CA0136.

Sumner, D. A., J. T. Rosen-Molina, and W. A. Matthews. "Economic Effects of Proposed Restrictions on Egg-Laying Hen Housing in California." Work. pap., Agricultural Issues Center, University of California, Davis, 2008.

Thunström, L. "Preference Heterogeneity and Habit Persistence: The Case of Breakfast Cereal Consumption." Work. Pap. No. 738, Umeå U. SE-901 87 Umeå, Sweden.

Train, K. E. "Recreation Demand Models with Taste Differences over People" *Land Econ.* 74(1998):230–239.

———. *Discrete Choice Methods with Simulation*. New York: Cambridge University Press, 2003.

U.S. Department of Agriculture. "2007 Census of Agriculture Report, State Profile: California." USDA, Washington, DC, 2007. Online. Available at http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/index.asp. [Accessed September 29, 2010.]