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The Effect of Proposition 2 on the Demand for Eggs in California

Jayson L. Lusk

Abstract

Californians recently passed Proposition 2, barring the use of cages in egg production in the state. Because most consumers are unknowledgeable of egg production practices, the appearance of Proposition 2 likely served as an information shock that potentially affected consumer demand. In this paper, we use scanner data to investigate the market effects of Proposition 2 by studying whether and how consumer demand for eggs changed in the months leading up to the vote in San Francisco and Oakland. Results indicate that demand for the types of eggs associated with higher animal welfare standards, cage free and organic, increased over time and in response to articles on the proposition whereas demand for other types of eggs fell. These results coupled with the finding that cage free and organic egg demand was virtually unchanged in a location unaffected by the vote, Dallas, suggests that Proposition 2 had a significant effect on consumer preferences for eggs – increasing demand for cage free and organic eggs by 180% and 20%, respectively.

KEYWORDS: animal welfare, cage free, egg, organic, Prop 2, scanner data

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1. Introduction

On November 4, 2008, Californians went to the polls and 63.5% voted in favor Proposition 2 (Prop 2), which stated that, "a person shall not tether or confine any covered animal, on a farm, for all or the majority of any day, in a manner that prevents such animal from: (a) Lying down, standing up, and fully extending his or her limbs; and (b) Turning around freely." In a sense, Prop 2's passage is not surprising. Who is opposed to the seemingly innocuous issue of giving animals room to turn around? The ramifications of the referendum's passage, however, are far less innocuous as most egg production in the state of California occurs in cage systems where hens cannot fully extend their wings. Thus, the result of Prop 2's passage is that agricultural producers in California can no longer use the so-called battery cages in egg production. Because California is the fifth largest producer of eggs in the U.S., the consequences for California egg layers are projected to be disastrous, although the effect on consumers is likely to be relatively minor (Sumner et al., 2008).

Because of retailers' abilities to import cheaper eggs from out of state, some have argued that Prop 2 will have no real effect on the manner in which laying hens are actually raised. Such arguments, however, fail to recognize the informational aspects associated with Prop 2. Most consumers have very little idea how eggs are produced and have an idealized agrarian notion of agricultural production (Thompson, 1993). For example, when we asked a group of consumers to indicate the percentage of eggs they believed are produced in cage systems in the U.S., on average they said that only 37% of eggs come from cage systems, when in reality over 90% come from cage system (Norwood and Lusk, forthcoming). Moreover, after we gave consumers objective and unbiased information about different types of production systems, over 70% reported being more concerned about the well-being of farm animals (Norwood and Lusk, forthcoming).

One of the consequences of placing Prop 2 on the ballot in the California is that it prompted media attention, which provided consumers with more information on modern agricultural production practices. The supporters of Prop 2 raised about $5.2 million, much of which was spent on publicity campaigns, and as we will document momentarily, numerous editorials and newspaper stories were written on the issue (Sacramento Bee, 2008). Such information is likely to affect people's choices by changing their incorrect beliefs about how eggs are raised and by changing social norms about purchase behaviors.

In this paper, we investigate the market effects of Prop 2 by studying whether and how consumer demand for eggs changed in the months leading up to the vote. We attempt to detect the effect of Prop 2 on consumer demand in two ways. First, for the same time periods, we compare the dynamics of consumer purchasing behavior for cage free, organic, and conventional eggs in two distinct locations, only one of which was exposed to the media surrounding Prop 2: San Francisco / Oakland and Dallas / Ft. Worth. Secondly, we directly investigate how the number of articles published about Prop 2 in a local newspaper affected consumer demand for eggs.

Our work advances the literature in a number of ways. First, most previous studies of consumer demand for improved farm animal welfare have utilized hypothetical surveys (e.g., Bennett and Blaney, 2003; Carlsson et al., 2007; Lusk et al., 2007; Tonsor et al., forthcoming) or small-scale laboratory experiments (e.g., Dickinson and Bailey, 2002; Norwood and Lusk, 2009). Here, we study actual purchase behavior and document how such purchases responded to Prop 2. Second, although several studies *ex ante* projected the effects of Prop 2 on California producers and consumers (e.g., Sumner et al., 2008), this paper provides some *ex post* evidence on one effect of the *introduction of* the legislation. These findings are potentially important as groups like the Humane Society of the United States are targeting other states for similar ballot initiatives.

2. Data and Methods

To investigate this issue, we obtained retail scanner data from the Information Resources Inc. (IRI) InfoScan database for two markets: San Francisco / Oakland (hereafter SFO) and Dallas / Ft. Worth (hereafter DFW). We chose to study a non-California location, DFW, in an effort to determine whether egg consumption is changing as a result of a secular trend occurring nationwide or whether changes might be more attributable to Prop 2, which only occurred in California.[1] The data consist of weekly volume sales, dollar sales, and average price per egg by stock-keeping unit (SKU) aggregated across stores in the respective regions from the time period January 1, 2007 to January 25, 2009. In each location, there were well over 100 SKUs sold in the market. We removed any SKUs from the data set which were not present over the entire two year time period such that we focus only on demand for SKUs that were present before, during, and after Prop 2 activity. For each SKU, we were able to identify labeling claims such as “cage free,” “organic,” “omega 3,” etc. To reduce the dimensionality of the data, we aggregated eggs into one of four types: 1) cage free, 2) organic, 3) conventional (e.g., no “extra” claims were advertised on the package), and 4) other egg types

[1] It might be argued that a better control location would be geographically closer to California; however, it is likely that news of events in California would be more readily available in neighboring states, making it more difficult to isolate the Prop 2 effect. To be sure, there are many differences in the two selected locations, and in no case do we argue that demand for eggs is or should be the same in the two locations. However, what is of interest is the comparison of *changes* in egg demand across time in Dallas and San Francisco.

including claims such as omega 3, vegan fed, pasteurized, and fertile.[2] Only the first two types, cage free and organic, have attributes associated with animal welfare and thus it is of interest to see how demand for these egg types change relative to demand for other types.

Table 1 reports summary statistics. Conventional egg prices are about 58% higher and organic egg prices are about 7% higher in SFO compared to DFW. Cage free and organic eggs sell at significant premiums to conventional eggs, and somewhat surprisingly, the premiums are higher in DFW as compared to SFO. For example organic (cage free) eggs sell at a \$0.164/egg (\$0.104/egg) premium to conventional eggs in SFO but the respective premiums are even higher in DFW: \$0.221/egg (\$0.142/egg). To put these numbers in perspective, they imply that a carton of one dozen organic eggs in DFW sells at a \$2.65 premium to conventional eggs – a 166% premium. Even cage free eggs sell at a more than 100% premium to conventional eggs in DFW – values which are much higher than the estimated 40% cost difference between cage free and cage egg production (Sumner et al., 2008). One must keep in mind that the high *percent* premium in DFW is partially a result of the very low price of conventional in that location. The cage-free and organic premiums, in dollar terms, are more similar in DFW and SFO than are the percent premiums because conventional eggs are, overall, much less expensive in DFW than in SFO. Although cage free and organic eggs are sold at high premiums, their market shares are relatively small. As table 1 shows, conventional eggs account for 82% of egg expenditures in SFO and 92% of egg expenditures in DFW.

In addition to the scanner data, Lexis-Nexis was used to identify the number and timing of articles mentioning the search words "Prop 2" or "Proposition 2" in the *San Francisco Chronicle* – the major newspaper in SFO. These terms were not mentioned at all in a search of the *Dallas Morning News* – the major newspaper in the Dallas / Ft. Worth market. Figure 1 shows the number of articles mentioning the topic in the *San Francisco Chronicle* by week over the study time period. The first mention of Prop 2 occurred in June 2008 and peaked at six articles per week in the months of September and October preceding the vote in early November. Over the study period, 28 articles on Prop 2 were published by the *San Francisco Chronicle*. Following authors such as Brown and Schrader (1990), who studied the impact of articles on cholesterol on egg demand, and Piggott and Marsh (2004), who studied the impact of articles on food safety on meat demand, we created a Prop 2 media index, which was simply a running count of the number of articles published on the topic up to a given date.

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[2] All organic eggs are cage free. Thus, "cage free" includes eggs that are cage free but not organic. If an SKU had a cage free claim but no organic claim, it was placed in the "cage free" category.

Table 1. Summary Statistics on Egg Prices and Consumption (weekly data from January 1, 2007 to January 25, 2009; N=108)

Variable	**San Francisco / Oakland**	**Dallas / Ft. Worth**
Cage Free Price ($/egg)	0.315[a] (0.023)[b] [0.266, 0.354][c]	0.275 (0.011) [0.236, 0.297]
Other Egg Price ($/egg)	0.291 (0.015) [0.258, 0.318]	0.231 (0.008) [0.212, 0.254]
Organic Price ($/egg)	0.378 (0.019) [0.336, 0.411]	0.354 (0.009) [0.324, 0.372]
Conventional Price ($/egg)	0.211 (0.019) [0.177, 0.256]	0.133 (0.016) [0.1, 0.165]
Cage Free Expenditure Share	0.024 (0.006) [0.014, 0.038]	0.013 (0.002) [0.009, 0.020]
Other Expenditure Share	0.063 (0.005) [0.043, 0.079]	0.043 (0.003) [0.036, 0.055]
Organic Expenditure Share	0.091 (0.008) [0.058, 0.107]	0.021 (0.002) [0.015, 0.025]
Conventional Expenditure Share	0.821 (0.014) [0.793, 0.882]	0.923 (0.006) [0.901, 0.937]
Expenditures on Eggs (million $)	1.300 (0.204) [1.001, 2.155]	0.925 (0.16) [0.67, 1.443]
Prop 2 Media Index (# articles)	4.435 (9.455) [0.000, 28.000]	0.000

[a]mean
[b]Numbers in parentheses are standard deviations
[c]Numbers in brackets are the minimum and maximum

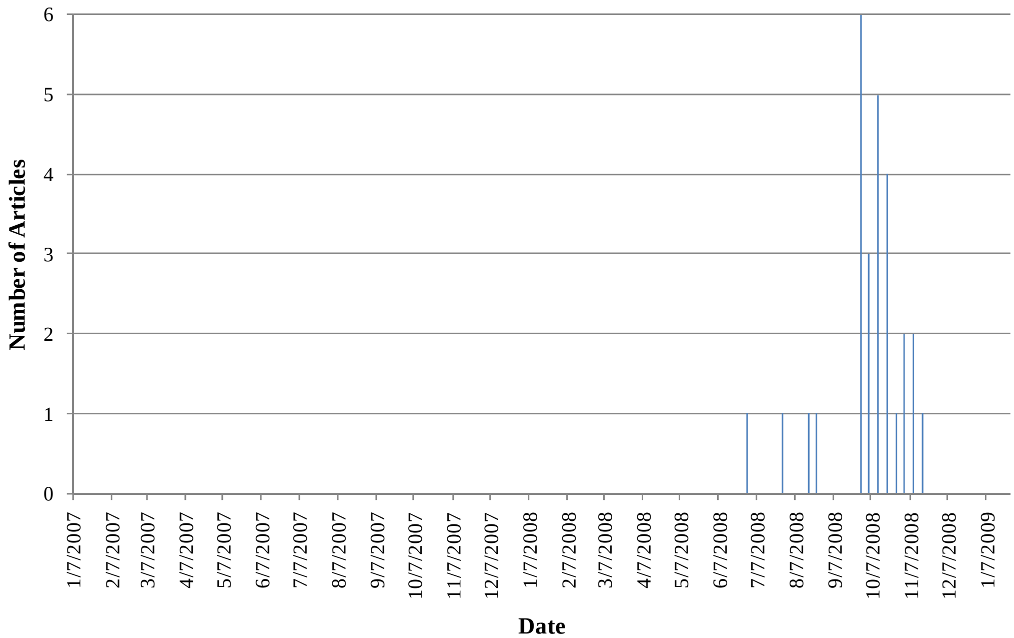

Figure 1. Number of Stories Mentioning Prop 2 in the *San Francisco Chronicle*

2.1 Demand Model

To study consumer preferences for eggs, the widely used Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) was employed. Because the model has been used extensively in previous research, only a briefly description is provided here. Assuming seperability between egg and other food purchases, the expenditure share ($w_i = x_i p_i / X$) for egg type i is:

(1) $$w_i = \alpha_i + \delta_i T + \sum_{j=1}^{J} \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{X}{P}\right)$$

where X is total expenditure on eggs, p_j is the price of the j^{th} egg type (given a total of J types), and P is a price index defined by:

(2) $$\ln(P) = \alpha_0 + \sum_{j=1}^{J} \ln(p_j)(\alpha_j + \delta_j T) + 0.5 \sum_{i=1}^{J} \sum_{j=1}^{J} \gamma_{ij} \ln(p_i) \ln(p_j).$$

Homogeneity, adding-up, and symmetry restrictions are imposed:
$\sum_{j=1}^{J} \gamma_{ij} = 0$, $\sum_{j=1}^{J} \alpha_j = 1$, $\sum_{j=1}^{J} \delta_j = 0$, and $\gamma_{ij} = \gamma_{ji}$.

The variable T is included to determine whether preferences for each type of egg change over the study period in response to information provided by Prop

2.[3] In our first approach, we simply specify T as a time trend variable. A finding that expenditure shares are affected by a time trend is not conclusive evidence alone that Prop 2 affected egg demand; however, a finding that cage free and organic eggs (but not conventional eggs) are positively affected by the trend in SFO (but not DFW) would provide more conclusive evidence that Prop 2 is the driver of preference change. To provide further empirical support, we also specify T as the Prop 2 media index, which measures cumulative articles about Prop 2 in the *San Francisco Chronicle*.[4]

2.2 Estimation Issues

Empirical estimation involves adding an error term to each equation (1). We study demand for four egg types, and to avoid a singularity, one good (other egg types) is dropped from the estimation. Following common practice, the restriction $\alpha_0 = 0$ is imposed during estimation.[5] Diagnostic tests revealed the presence of autocorrelation, and as such, a one-period lag autoregressive term was added to the three share equations.[6] Specification tests suggest that model parameters differed by location, and as such, the demand systems were separately estimated for SFO and DFW.

Given the arguments of LaFrance (1991) that expenditure is likely endogenous and given the additional possibility of price endogeneity, we followed Dhar et al. (2003) and estimated the three share equations given in (1) as

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[3]Alston et al (2001) argue that the AIDS model is not invariant to scaling unless the parameter α_0 also varies with T. To investigate this issue, we estimated a model specifying α_0 as $\alpha_0 T$. In this specification, the estimate for α_0 was not significantly different from zero, suggesting little concern with the scaling invariance.

[4] One could include both a time trend and the Prop 2 index in the model, but in practice the two variables are highly correlated (correlation of about 0.7), making it difficult to separately identify the two effects. In practice, when both variables are included in the model only the time trend variables are statistically significant and the parameters are of the same sign as what is reported later in the results. We also considered adding quarterly dummy variables to capture seasonal variation in demand, but these variables were not statistically significant in any of the share equations, and thus were omitted. Rather than a time trend or media index, we have also analyzed specifications include a dummy variable for all time periods after the initial news stories appear. This specification generates very similar results to that for the time trend or media index.

[5] We attempted to estimate this parameter, but the model would not converge when α_0 was allowed to freely vary. This finding suggests the likelihood function is flat for the parameter, and thus setting the parameter equal to zero is probably not too tenuous an assumption.

[6] The key results related to the time trend or media index variables are insensitive to the inclusion of the autoregressive term.

a system along with the following five equations using full information likelihood using the SUR estimates as starting values.[7]

$$(3)\qquad \ln(X_t) = \theta_0 + \theta_1 \ln(CPI_{t,r}) + \theta_2 \ln(wage_{t,r}) + \theta_3 t + \theta_4 qt_1 + \theta_5 qt_2 + \theta_6 qt_3 + \varepsilon_t$$

$$(4)\qquad \ln(p_{jt}) = \pi_{j0} + +\pi_{j1} \ln\left(wegg_{p_t}\right) + \pi_{j2} \ln(FMCI_t) + \pi_{j3} \ln\left(corn_{p_t}\right) + \pi_{j4} \ln(soy\_p_t) + \pi_{j5} qt_1 + \pi_{j6} qt_2 + \pi_{j7} qt_3 + \varepsilon_{jt} \quad \text{for } j = 1 \text{ to } 4$$

where $CPI_{r,t}$ is the consumer price index and $wage_{t,r}$ is the average weekly wage of manufacturing workers in region *r* (either SFO or DFW) in time *t*, as reported by the Bureau of Labor Statistics. Quarterly dummy variables are represented by qt_k. Retail egg prices are regressed on variables influencing the costs of eggs: wholesale prices of eggs ($wegg\_p_t$) and the nearby Chicago Mercantile Exchange futures prices for corn ($corn\_p_t$) and soybeans (soy_p_t), data on all three of which were obtained from the Livestock Marketing Information Center. In addition, we included food marketing cost index ($FMCI_t$) data which was obtained from the USDA, Economic Research Service.

3. Results

Table 2 reports summary statistics by location before and after the first appearance of an article on Prop 2. The data reveal that cage free, other, and organic egg prices trended upward over the time period in SFO, whereas conventional egg prices were relatively constant. Despite the price increases for cage free and organic eggs, the data also reveal that both egg types *gained* expenditure share, a fact strongly suggestive of an outward demand shift for cage free and organic eggs in SFO. Table 2 shows that cage free and organic expenditure shares also increased in DFW. However, the increase in cage free and organic expenditure shares is not nearly as pronounced in DFW as in SFO. Indeed, calculating difference in differences indicates that expenditure shares for organic (cage free) eggs increased by 0.01 (0.009) *more* in SFO than in DFW after the first appearance of a Prop 2 article. This is in spite of the fact that organic (cage free) egg prices increased by \$0.018/egg (\$0.037/egg) *more* in SFO than in DFW after the first appearance of a Prop 2 article. Taken together, the statistics in table 2 provide strong circumstantial evidence of an outward shift in organic and cage free egg demand in SFO in general and in relation to DFW. Table 2 also shows that total egg expenditures were approximately flat in both SFO and DFW before and after the appearance of the first Prop 2 article.

[7] Hausman specification tests suggest the presence of endogeneitiy, and as such, we utilize this maximum likelihood approach, however, it should be noted that the key results related to the time trend and media index variables are invariant to whether the AIDS share equations are estimated in isolation or with the inclusion of equations (3)-(4).

Although the appearance of Prop 2 might have affected *which* eggs were purchased, it appears overall egg expenditures were relatively unaffected.

Table 2. Changes in Egg Prices and Expenditures Before and After First Appearance of Articles on Proposition 2

Variable	Before[a]	After[b]	Change	Percent Change	P-value[c]
San Francisco/Oakland					
Cage Free Price ($/egg)	$0.305	$0.340	$0.035	11.35%	0.001
Other Egg Price ($/egg)	$0.285	$0.305	$0.019	6.79%	0.001
Organic Price ($/egg)	$0.371	$0.394	$0.022	5.99%	0.001
Conventional Price ($/egg)	$0.211	$0.210	-$0.001	-0.36%	0.819
Cage Free Expenditure Share	0.021	0.032	0.011	51.08%	0.001
Other Expenditure Share	0.063	0.062	-0.002	-2.39%	0.184
Organic Expenditure Share	0.088	0.100	0.012	13.26%	0.001
Conventional Expenditure Share	0.827	0.806	-0.021	-2.54%	0.001
Expenditures on Eggs (million $)	$1.286	$1.335	$0.050	3.89%	0.215
Dallas/Ft. Worth					
Cage Free Price ($/egg)	$0.276	$0.273	-$0.002	-0.81%	0.359
Other Egg Price ($/egg)	$0.227	$0.240	$0.012	5.46%	0.001
Organic Price ($/egg)	$0.352	$0.356	$0.004	1.11%	0.041
Conventional Price ($/egg)	$0.133	$0.133	$0.000	-0.02%	0.993
Cage Free Expenditure Share	0.012	0.015	0.002	18.65%	0.001
Other Expenditure Share	0.043	0.043	-0.001	-1.64%	0.312
Organic Expenditure Share	0.020	0.022	0.002	9.09%	0.001
Conventional Expenditure Share	0.924	0.921	-0.003	-0.37%	0.004
Expenditures on Eggs (million $)	$0.924	$0.927	$0.004	0.39%	0.917

[a]Summary statistics before June 28, 2008, when first article on Prop 2 appeared in San Francisco Chronicle (N=77)
[b]Summary statistics on or after June 28, 2008 (N=31)
[c]P-value from t-test that means are the same before and after June 28, 2008

Table 3 reports the AIDS demand estimates for SFO. For sake of brevity, only those parameter estimates associated with the share equations are reported; coefficients associated with equations (3) and (4) are available from the authors upon request.[8] Overall, the models appear to fit the data well with R^2 values ranging from 0.57 to 0.87. Results are similar across the two model specifications, but results indicate lower AIC and BIC values for model specification 1 as compared to specification 2, suggesting model 1 is the preferred specification. Specification 1 reveals that expenditure shares for cage free and organic eggs (the two types associated the production methods targeted in Prop 2) significantly increased over the study period whereas shares for conventional and other eggs fell. Specification 2 reveals a similar result: increasing the number of articles on Prop 2 increased expenditure shares for cage free and organic eggs but decreased expenditure shares for conventional and other eggs.

Although the results in table 3 alone are not necessarily conclusive in so far as establishing that Prop 2 is the sole driver affecting the dynamics of egg demand, the results become more compelling when compared to the AIDS demand estimates for DFW, which are reported in table 4. In stark contrast to the results for SFO, expenditure shares are virtually unchanged over time in DFW. Although there are several differences in SFO and DFW, one key difference between the two locations is that Prop 2 occurred in California and not in Texas. Although it is possible that some consumers in DFW were aware of Prop 2, search results on Lexis-Nexis indicate *no* mention of the ballot initiative in the major regional newspaper, suggesting that unlike SFO consumers, DFW consumers experienced no general “information shock” that would have caused a shift in egg purchasing behavior.[9]

[8]While the specific parameter estimates from equations (3) and (4) are largely uninteresting in relation to the present inquiry, one exception relates to θ_3 in equation (3), which shows how total egg expenditures change over time. For SFO, the estimated value for this parameter is 0.004 (p-value=0.006) indicating an increase in total egg expenditures from the beginning to the end of the study period in SFO. A similar, though less pronounced result, is also found in DFW; the estimated value for the parameter is 0.002 (p-value=0.07).

[9] It is important to note that the significances of the time trend variables does *not* result from the adding up conditions which dictate that a change in time must have a net positive effect on some goods and a negative effect on others. It is true that the time trend/media coefficients have to sum to zero across goods, but this fact does not guarantee the sign of any of the coefficients in any particular equation nor does it imply that the coefficients will be statistically significant (as demonstrated in the case of DFW).

Table 3. AIDS Demand Model Estimates for San Francisco/Oakland

Variable	Model Specification 1				Model Specification 2			
	Cage Free	Other Share	Organic Share	Conv. Share	Cage Free	Other Share	Organic Share	Conv. Share
Intercept	0.103*	0.273	0.641*a	-0.018	0.167**	0.348**	0.805**	-0.319
	(0.100)b	(0.164)	(0.183)	(0.283)	(0.053)	(0.139)	(0.196)	(0.227)
Time Trend	0.00021**	-0.00007**	0.00014**	-0.00028**				
	(0.00003)	(0.00003)	(0.00005)	(0.00007)				
Prop 2 Media Index					0.00051**	-0.00013	0.00041**	-0.00078**
					(0.00019)	(0.00017)	(0.00017)	(0.00028)
Cage Free price	-0.031*	0.023	0.001	0.007	-0.005	0.005	-0.001	0.001
	(0.017)	(0.018)	(0.02)	(0.01)	(0.010)	(0.009)	(0.013)	(0.008)
Other price	0.023	-0.048*	0.027	-0.002	0.005	-0.052**	0.029	0.018
	(0.018)	(0.029)	(0.027)	(0.015)	(0.009)	(0.02)	(0.028)	(0.016)
Organic price	0.001	0.027	-0.035	0.006	-0.001	0.029	-0.060	0.033
	(0.02)	(0.027)	(0.041)	(0.025)	(0.013)	(0.028)	(0.044)	(0.026)
Conventional price	0.007	-0.002	0.006	-0.011	0.001	0.018	0.033	-0.052
	(0.01)	(0.015)	(0.025)	(0.038)	(0.008)	(0.016)	(0.026)	(0.036)
Expenditure	-0.006	-0.014	-0.036**	0.056**	-0.010**	-0.019	-0.046**	0.075**
	(0.006)		(0.012)	(0.018)	(0.003)		(0.013)	(0.015)
R^2	0.83		0.60	0.66	0.87		0.57	0.68

[a]One (*) and two (**) asterisks represents significance at the 0.10 and 0.05 levels, respectively.; [b]Numbers in parentheses are standard errors
Note: the models were estimated as a system using full information maximum likelihood including autoregressive terms in each share equation and including five additional equations to account for potential price and expenditure endogeneity. An index of food marketing costs, wholesale egg, corn, and soybean prices, quarterly dummy variables, and a time trend were used as instruments in the price equations and the location-specific CPI, average weekly earnings of manufacturing workers, quarterly dummy variables, and a time trend were used as instruments in the expenditure equation.

Table 4. AIDS Demand Model Estimates for Dallas / Ft. Worth

Variable	Cage Free Share	Other Share	Organic Share	Conv. Share
Intercept	0.014	-0.076	0.100**	0.962**
	(0.069)	(0.104)	(0.041)	(0.178)
Time Trend	0.000004	0.000008	0.000021	-0.00003
	(0.00001)	(0.00003)	(0.00002)	(0.00004)
Cage Free price	-0.026**	0.020	0.008	-0.002
	(0.010)	(0.011)	(0.008)	(0.004)
Other price	0.020*	-0.039*	0.014	0.004
	(0.011)	(0.020)	(0.016)	(0.008)
Organic price	0.008	0.014	-0.011	-0.011**
	(0.008)	(0.016)	(0.014)	(0.004)
Conventional price	-0.002	0.004	-0.011**	0.009
	(0.004)	(0.008)	(0.004)	(0.012)
Expenditure	-0.0001	0.007	-0.005**	-0.002
	(0.004)		(0.003)	(0.012)
R^2	0.56		0.56	0.21

[a]One (*) and two (**) asterisks represents statistical significance at the 0.10 and 0.05 levels, respectively.
[b]Numbers in parentheses are standard errors
Note: the models were estimated as a system using full information maximum likelihood including autoregressive terms in each share equation and including five additional equations to account for potential price and expenditure endogeneity. An index of food marketing costs, wholesale egg, corn, and soybean prices, quarterly dummy variables, and a time trend were used as instruments in the price equations and the location-specific CPI, average weekly earnings of manufacturing workers, quarterly dummy variables, and a time trend were used as instruments in the expenditure equation.

Overall, it would be difficult to explain the patter of results reported in tables 2, 3, and 4 if Prop 2 were not affecting demand. Indeed, it would be highly coincidental that only the two options associated with arguable higher levels of animal welfare (cage free and organic) are the two that “happen” to experience positive increases in demand over time and only in the location in which Prop 2 occurred.

Table 5 reports the uncompensated elasticities of demand. The elasticity estimates are of reasonable sign and magnitude, and except for the effect of time, are also quite similar across location. Own-price elasticities of demand range from -2.99 for cage free eggs to -0.99 for conventional eggs in DFW and from -2.26 for cage free eggs to -1.01 for conventional eggs in SFO. Expenditure elasticities are slightly lower for cage free and organic eggs relative to conventional eggs. Although this result is perhaps somewhat counter-intuitive, it is consistent with previously published research. For example, Dhar and Foltz (2005) find a *lower* expenditure elasticity on demand for organic milk as compared to conventional milk and Hsieh et al. (2009) find *lower* expenditure elasticities on demand for organic potatoes as compared to conventional potatoes. The key results are in the last column, which indicate that whereas demand for cage free and organic eggs (the egg types with arguably higher animal welfare standards) increased over time in SFO, demand for conventional and other eggs (those with arguable lower animal welfare standards) fell.

Table 5. Uncompensated Elasticities of Demand for Eggs

Variable	Cage Free Price	Other Price	Organic Price	Conv. Price	Expenditure	Time
San Francisco / Oakland						
Cage Free Quantity	-2.264*[a]	1.007	0.207	0.285	0.766*	0.474*
	(0.679)[b]	(0.772)	(0.803)	(0.390)	(0.263)	(0.060)
Other Quantity	0.390	-1.700*	0.576	-0.038	0.772*	-0.059*
	(0.297)	(0.479)	(0.398)	(0.211)	(0.168)	(0.026)
Organic Quantity	0.059	0.406	-1.125*	0.055	0.605*	0.084*
	(0.215)	(0.277)	(0.414)	(0.233)	(0.129)	(0.029)
Conv. Quantity	0.001	-0.022	-0.036	-1.012*	1.068*	-0.020*
	(0.010)	(0.015)	(0.025)	(0.037)	(0.023)	(0.004)
Dallas / Ft. Worth						
Cage Free Quantity	-2.992*	1.566	0.593	-0.163	0.996*	0.016
	(0.762)	(0.818)	(0.637)	(0.362)	(0.336)	(0.05)
Other Quantity	0.470	-1.889*	0.315	-0.060	1.165*	0.010
	(0.245)	(0.459)	(0.366)	(0.184)	(0.158)	(0.033)
Organic Quantity	0.373	0.670	-1.518*	-0.271	0.745*	0.055
	(0.397)	(0.758)	(0.677)	(0.182)	(0.126)	(0.058)
Conv. Quantity	-0.002	0.004	-0.011*	-0.989*	0.998*	-0.002
	(0.004)	(0.008)	(0.004)	(0.015)	(0.012)	(0.002)

[a]One asterisk (*) represents statistical significance at the 0.05 level or lower
[b]Numbers in parentheses are standard errors determined by the delta method

Table 6 reports the compensated (Hicksian) elasticities of demand which, by construction, sum to zero across each row. The compensated elasticities suggest more pronounced substitution relationships between conventional eggs and the other egg types. Table 6 shows that in 1% increase in the price of conventional eggs causes a 0.91%, 0.60%, and 0.55% increase in the consumption of cage free, other, and conventional eggs in SFO. Likewise, changes in cage free, other, and organic egg prices have statistically significant (but relatively small) effects on conventional egg demand. The compensated own-price elasticities of demand for conventional eggs are highly inelastic at -0.13 in SFO and -0.07 in DFW, values which are similar to estimates previously reported in the literature. For example, Schmit and Kaiser (1998) find an own-price elasticity of demand for eggs of -0.08, Huang and Lin (2000) estimate the figure at -0.06, You et al. (1996) find an estimate of -0.12, and Brown, and Schrader (1990) estimate the own-price elasticity of egg demand at about -0.17.

Table 6. Compensated Price Elasticities of Demand for Eggs

Variable	Cage Free Price	Other Price	Organic Price	Conv. Price
San Francisco / Oakland				
Cage Free Quantity	-2.246*[a]	1.054	0.279	0.913*
	(0.680)[b]	(0.767)	(0.808)	(0.341)
Other Quantity	0.408	-1.650*	0.647	0.596*
	(0.297)	(0.477)	(0.400)	(0.196)
Organic Quantity	0.074	0.444	-1.070*	0.551*
	(0.215)	(0.275)	(0.40)	(0.221)
Conv. Quantity	0.027*	0.046*	0.061*	-0.134*
	(0.010)	(0.015)	(0.025)	(0.037)
Dallas / Ft. Worth				
Cage Free Quantity	-2.979*	1.609*	0.613	0.756*
	(0.764)	(0.812)	(0.637)	(0.298)
Other Quantity	0.484*	-1.839*	0.339	1.016*
	(0.244)	(0.460)	(0.365)	(0.176)
Organic Quantity	0.383	0.702	-1.502*	0.417*
	(0.397)	(0.756)	(0.677)	(0.192)
Conv. Quantity	0.011*	0.047*	0.009*	-0.067*
	(0.004)	(0.008)	(0.004)	(0.013)

[a]One asterisk (*) represents statistical significance at the 0.05 level or lower
[b]Numbers in parentheses are standard errors determined by the delta method

To put the magnitude of the demand changes over time in perspective, we used the AIDS model estimates (specification 1) to calculate the predicted expenditure share for each egg type at mean prices and expenditure. Figure 2 shows how the expenditure shares for cage free and organic eggs were predicted to change over time in SFO (arguably as a result of Prop 2) holding prices constant. Figure 2 shows that at constant prices, the expenditure share of cage free eggs is estimated to increase from 1.28% to 3.58% from the beginning to the end of the study period – a 180% increase. Similarly, the expenditure share of organic eggs is estimated to increase from 8.35% to 9.99% from the beginning to the end of the study period – a 20% increase.

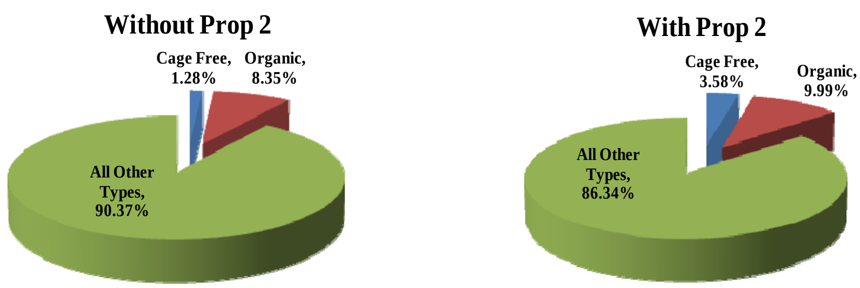

Figure 2. Predicted Expenditure Shares for Cage Free and Organic Eggs with and without Prop 2 in San Francisco/Oakland at Constant Prices

Figure 3 further illustrates the potential effect of Prop 2 on organic egg expenditures in SFO by plotting actual and predicted expenditure shares. The dashed line reports predicted expenditure shares for organic eggs under the assumption that no articles on Prop 2 were published, whereas the solid line reports predicted shares for organic eggs given what actually happened. As can be seen at the end of the study period, the model estimates suggest that the articles published on Prop 2 caused a significant shift in demand as compared to what is predicted to have occurred without Prop 2. Whether such preference changes are only temporary or persist is a question that can only be answered in the future.

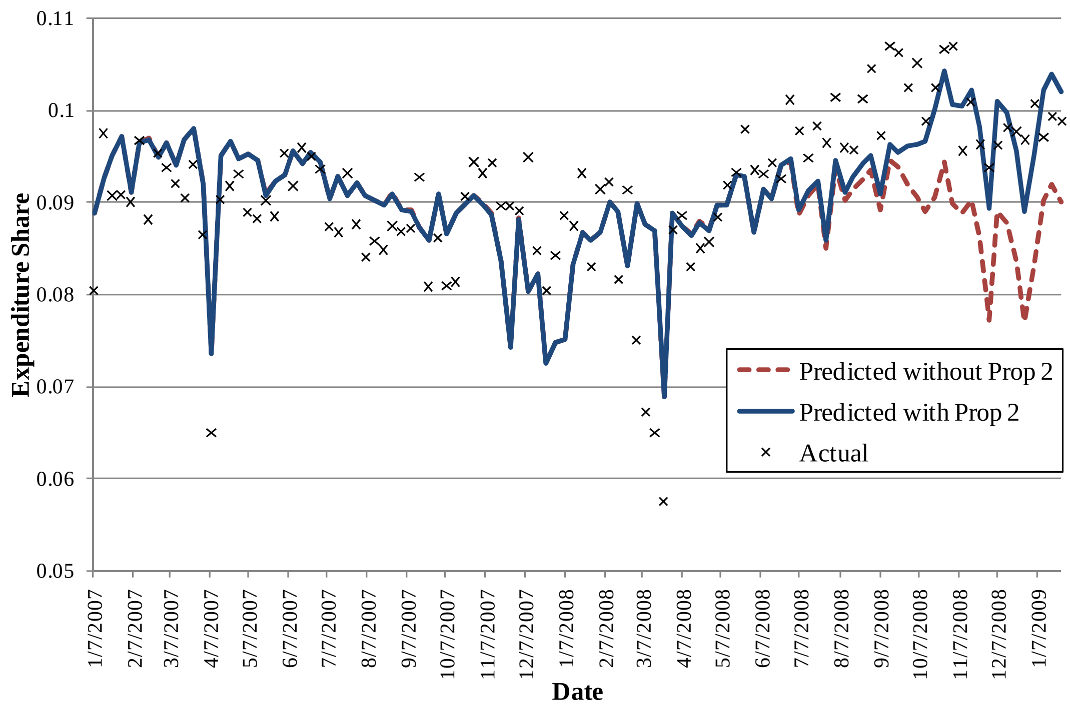

Figure 3. Actual and Predicted Expenditure Shares for Organic Eggs in San Francisco/Oakland over Time

4. Conclusions

Given the increasingly controversial nature of animal welfare and the prospect that several states may soon witness ballot initiatives like Prop 2 in California, there is a need to better understand consumer preferences and behavior for products produced under differing standards of animal care.

Using scanner data of actual consumer purchases, we find evidence suggestive of the notion that Prop 2 significantly increased demand for cage free and organic eggs in SFO. We cannot conclusively say that what is being picked up by our time trend estimates is solely attributable to Prop 2 activity; however, the fact that only those egg types associated with arguably higher standards of animals care increased expenditure share whereas other egg types did not suggests the main driver of change over time was Prop 2. This argument is further bolstered by the finding that preferences for eggs were essentially constant over time in DFW, a location in which Prop 2 was not present or much discussed.

These findings have potentially important implications. The results suggest that the very act of putting an issue like Prop 2 on the ballot affects consumers' preferences – likely because consumers are largely unaware of and have incorrect beliefs about modern agricultural production practices. That our results suggest Prop 2 increased demand for cage free and organic eggs while reducing demand for conventional eggs may explain why agricultural producer groups in other states the Humane Society has targeted for ballot initiatives (e.g., Michigan and Ohio) appear willing to work with state law makers to enact similar laws rather than having to publically fight a ballot initiative. Agricultural producers faced with the prospect of a rise in production costs and a downward shift in demand for conventional products are unlikely to welcome the publicity surrounding a ballot initiative. Our results also suggest that total egg expenditures were either constant or slightly increasing in San Francisco/Oakland over the study period suggesting that while Prop 2 may have changed *which* eggs consumers chose to buy, the information contained in Prop 2 did not cause a decline in total egg expenditures (although total egg expenditures might still rise if consumers shift to purchasing fewer but more expensive organic and cage free eggs).

The results of this analysis indicate that even if the passage of Prop 2 leaves open the possibility for retailers to import cage eggs from other states, the fact that consumers are now more informed about the eggs they eat influences what they want and thus what retailers will procure. Thus, although many California egg consumers are likely to continue buying cage eggs even when Prop 2 takes effect, our estimates indicate some people decided, at least for the time being, to make a different choice.

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