

Models of Media Influence on Demand for Animal Products

Allison Smith | Animal Charity Evaluators | August 2016

Abstract

One way animal advocates hope to influence consumers to buy fewer animal products is through media coverage. Animal nonprofits actively pursue this goal by conducting undercover investigations of factory farms in the hopes that media coverage of their findings will convince readers and viewers to eat fewer animal products. Other animal welfare efforts, such as the [California Proposition 2 ballot initiative](#), may garner media attention indirectly. This page discusses two studies which sought to model the influence of media coverage on demand for animal products. After summarizing the findings of each study, we discuss the study's implications for animal advocates.



Table of contents

[Abstract](#)

[Table of contents](#)

[Modeling media influence on demand for eggs](#)

[Understanding the economic model](#)

[Proposition 2 study: data](#)

[Proposition 2 study: findings](#)

[Deriving estimated final equilibrium quantity](#)

[Qualifications](#)

[Causation](#)

[Quantifying media coverage](#)

[Time](#)

[Model adequacy](#)

[Statistical significance](#)

[Elasticity](#)

[Conclusions](#)

[Modeling media influence on demand for meat](#)

[Meat demand study: data and findings](#)

[Qualifications](#)

[Causation](#)

[Model adequacy](#)

[Statistical significance](#)

[Supply and demand elasticity](#)

[Conclusion](#)

[Resources](#)

Modeling media influence on demand for eggs

In 2008, Californians voted on [Proposition 2](#) (“Prop 2”), a ballot proposition that would prohibit some forms of extreme confinement for farmed animals. A major consequence of the measure was that California egg producers would no longer be able to keep their hens in battery cages, which severely restrict hens’ movement, either by increasing the size of the cages or raising them without cages. [Lusk \(2010\)](#) used the media coverage following the introduction of the ballot initiative as an opportunity to study the effects of newspaper articles about Prop 2 on demand for different types of eggs. Lusk presents a statistical model that allows us to estimate the changes in demand for conventional, cage-free, and organic eggs associated with newspaper coverage of animal welfare issues. We present Lusk’s findings and show how these can be used to estimate the relationship of newspaper coverage to the net welfare of egg-laying hens.

Understanding the economic model

We anticipate that media coverage of the animal welfare issues surrounding egg production will cause an increase in demand for more humane (cage-free and organic) eggs, and a decrease in demand for conventional eggs. If this were true, after an increase in media coverage of animal welfare issues, the market would respond such that more hens were raised in relatively humane conditions, and fewer hens were raised in typical conditions of extreme confinement.

Figure 1 shows the effects of a demand increase like what we would expect for cage-free eggs following media coverage. Starting at an initial equilibrium price and quantity **A**, an outside factor (in this case, media coverage) causes the demand curve to shift so that quantity demanded increases to **B**. In response to this increased demand, cage-free egg producers raise their prices, causing the market to settle at a new equilibrium price and quantity **C**. In the Resources section below we provide a tool that uses an estimated shift in egg demand, along with estimates of supply and demand elasticity,¹ to approximate the quantity of eggs supplied at a new equilibrium.

¹ Supply elasticity is a measure of the sensitivity of quantity supplied to a change in price. It is given by the formula $(\% \text{ Change in Quantity Supplied}) / (\% \text{ Change in Price})$. Demand elasticity is a measure of the sensitivity of quantity demanded to a change in price. It is given by the formula $(\% \text{ Change in Quantity Demanded}) / (\% \text{ Change in Price})$.

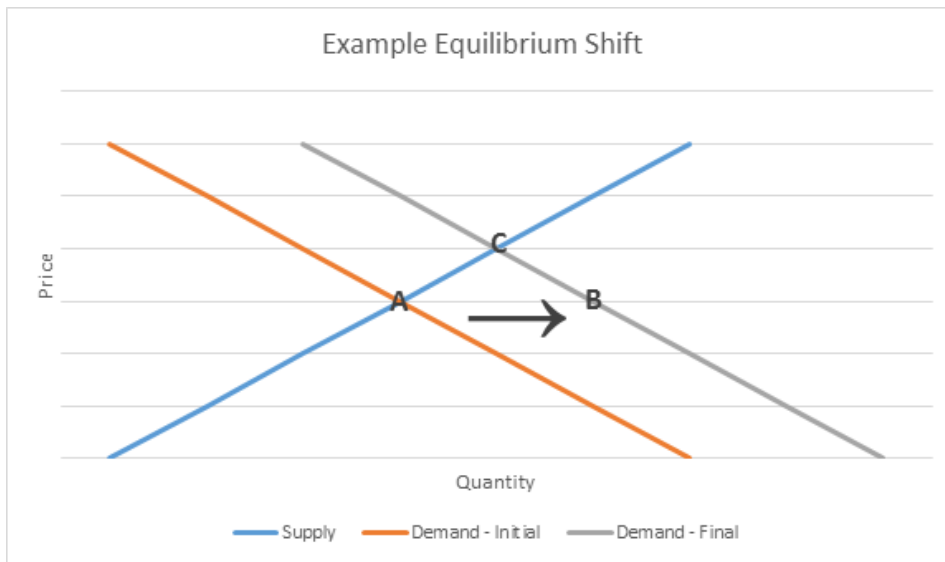


Figure 1: Effects of an increase in demand on equilibrium price and quantity supplied.

Proposition 2 study: data

In order to be more confident that observed demand changes were partly attributable to Prop 2 coverage, Lusk analyzed data from two regions: San Francisco / Oakland (SFO) and Dallas / Fort Worth (DFW), which was not affected by the Prop 2 initiative and whose major newspaper (*Dallas Morning News*) did not cover Prop 2 during the study period². Data consisted of volume sales, dollar sales, and average egg prices for each week in the time period January 1, 2007 to January 25, 2009. Eggs were grouped into 1) cage free, 2) organic, 3) conventional, and 4) other. The “other” category includes, for example, omega 3, vegan fed, pasteurized, and fertile eggs; according to Lusk, all egg types in this category are unrelated to hen welfare. The number of articles mentioning Prop 2 published weekly in the *San Francisco Chronicle*, SFO’s major newspaper, was also recorded. The purpose of the study was to examine how expenditures on each type of egg varied with the number of articles about Prop 2 which were published, as compared to DFW, which saw no Prop 2 media coverage in its major newspaper.

Proposition 2 study: findings

As expected, Lusk found that expenditure shares for cage-free and organic eggs significantly increased, and that of conventional eggs in SFO significantly decreased over the study period. In DFW, expenditure shares for each egg type showed significantly less change than in SFO, suggesting the trend was more

² In a personal communication, Lusk explained that he chose DFW because it was unlikely to be affected by Prop 2 coverage, but not any other characteristics.

pronounced in areas affected by the media coverage. Lusk reports a model for the weekly expenditure share of each type of egg as a function of the total number of Prop 2 articles published in the *San Francisco Chronicle* up until that week. From these models, we can find the estimated change in weekly quantity of eggs demanded for each egg type associated with the publication of a given number of additional Prop 2 articles.

For example, Lusk reports the average prices per egg and total weekly expenditures on eggs in SFO over the study period, as shown in Table 1. Using the demand model, we can estimate the change in the quantity of each type of egg demanded in a market with these egg prices.

Lastly, while Lusk found statistically significant changes in expenditures on conventional, cage-free, and organic eggs, there was not a decrease in *total* expenditures on eggs over the study period. In fact, total weekly expenditures increased from an average of \$1.286 million before Prop 2 media coverage appeared to an average of \$1.335 million after (though this was not a statistically significant difference). This lack of a significant increase in total egg expenditures does not seem to be driven by consumers buying fewer but more expensive eggs, given that the more expensive categories of eggs—cage free and organic—saw very small absolute increases in their expenditure shares (1.2% and 1.1%, respectively). Thus we conclude that the media coverage surrounding Prop 2 did not cause a decrease in demand for eggs in general.

Table 1: Example estimated change in quantity demanded, using model and average expenditures and prices from Lusk (2010).

Total Weekly Expenditures on Eggs (\$)	\$1.3 million			
	Cage Free	Other	Organic	Conventional
Average Price per Egg (\$)	\$0.314	\$0.291	\$0.378	\$0.211
Effect of One Additional <i>San Francisco Chronicle</i> Story on Number of Eggs Demanded per Week	2127.38	-536.58	1423.27	-4688.23

Deriving estimated final equilibrium quantity

How does the demand shift associated with Prop 2 media coverage translate into a change in animal welfare? We can extend Lusk’s work and use the estimated demand change, along with estimates of the supply and demand elasticity of eggs, to estimate a new equilibrium quantity of eggs supplied. This in

turn will give us an idea of how many more hens are raised in relatively less miserable (cage-free or organic, as opposed to conventional) conditions, as well as the total decrease in the number of hens raised for their eggs.

Figure 2 displays graphs of how the estimated change in long-run equilibrium numbers of conventional and cage-free eggs per week vary with supply and demand elasticity.³⁴ These calculations use the average expenditure and price values from Lusk's 2007 - 2009 study period displayed in Table 1. The *Resources* section at the end of this article provides a link to a tool that allows users to input values for number of articles, weekly expenditures, egg prices, and supply and demand elasticities to estimate initial change in demand and final change in egg quantity.

While changes in demand associated with the publication of animal welfare-related newspaper articles are statistically significant, they are quite small. For instance, the decrease of 4688.23 conventional eggs demanded per week reported in Table 1 is very small compared to the approximately 5 million conventional eggs consumed each week over the course of Lusk's study period.

³ See [this link](#) for an explanation of how elasticities and initial demand change are used to estimate the final equilibrium numbers of eggs.

⁴ See the *Elasticity* subsection below for remarks on what elasticity values are reasonable.

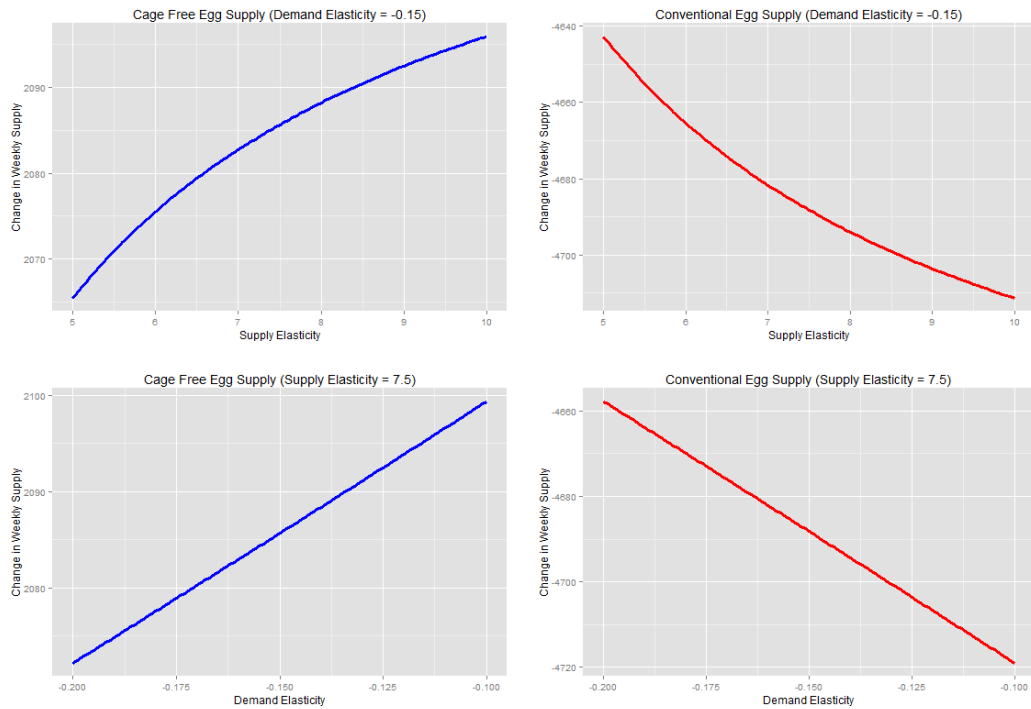


Figure 2: Change in weekly quantity of conventional and cage free eggs supplied, as a function of supply and demand elasticity. Computed using a total weekly expenditure of \$1.3 million, a conventional egg price of \$0.211, and a cage-free egg price of \$0.314.

Qualifications

Causation

The above calculations assume that the relationship between cumulative media coverage and egg demand is causal. But did Prop 2 media coverage *cause* a demand shift for the different types of eggs studied? Or did the market just happen to change in the same time period as the ballot initiative happened?

While it's impossible to establish a causal relationship with any certainty, comparison of SFO and DFW egg markets over the study period provides some evidence that demand changes in SFO were at least partly due to increased media attention to animal welfare issues during the Prop 2 initiative. First of all, the observed conjunction of (1) a rise in the prices of cage-free, organic, and "other" eggs and (2) an *increase* in the expenditure share of each of these egg types is good evidence that demand for non-conventional eggs increased after the beginning of the Prop 2 campaign. And changes in expenditure shares for non-conventional eggs in DFW were also positive but much smaller than the changes in SFO, supporting the hypothesis that the demand shift was partly due to Prop 2-related media coverage.

Quantifying media coverage

Lusk's model estimates the change in egg demand associated not with *any* media coverage of Prop 2 in SFO, but with articles published in the *San Francisco Chronicle* only. Given the high likelihood that other news outlets in SFO also covered Prop 2 during the study period, the number of Prop 2 articles published in the *San Francisco Chronicle* should be seen as a *proxy* for total Prop 2 media coverage in SFO. This makes extrapolation of the model particularly difficult, as the major newspapers of different locations probably vary widely in their representativeness of all media coverage in that area.

Time

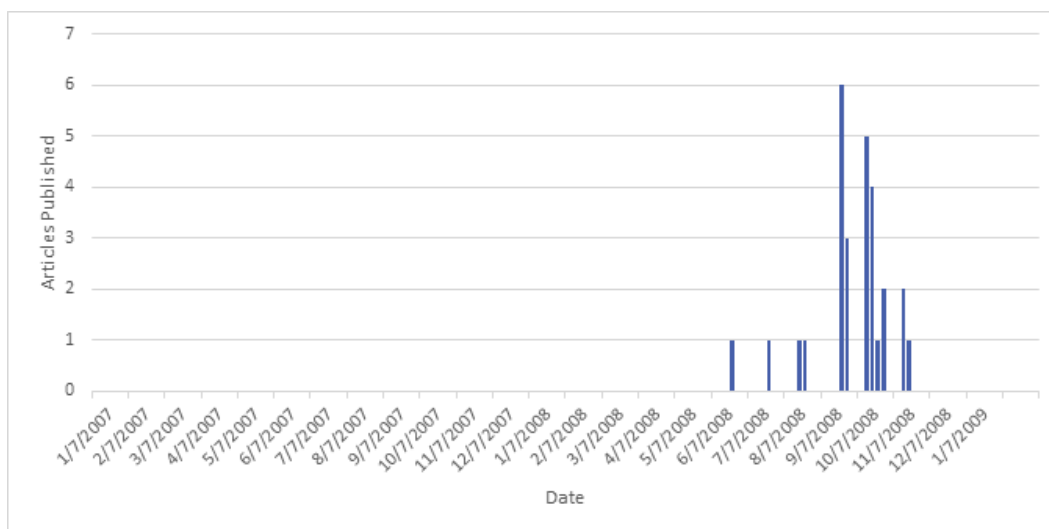


Figure 3: Number of stories mentioning Prop 2 in the *San Francisco Chronicle*. Reproduced from Lusk (2010).

The above model estimates a new weekly average quantity of eggs produced given an increase in the number of news stories. In Lusk's model, demand for eggs in a given week is a function of the cumulative number of articles published up to that week, so the effect of the publication of an article on demand is indefinite. Clearly this assumption is unrealistic for time periods much longer than Lusk's study period. An analysis by Tonsor and Olynk (2010) of the relationship between media coverage and *meat* demand finds evidence that the effects of the publication of an article regarding animal welfare on meat demand are significant up to one fiscal quarter later, so this might be used as a more reasonable estimate of the duration of the demand shift for eggs. Otherwise, there is little evidence about the time periods over which egg demand changes due to animal welfare media coverage.

Lusk's analysis says nothing about the amount of time it takes for egg suppliers to change the supply of eggs in response to a demand shift, and there is little evidence elsewhere as to what a reasonable estimate of this time period might be.

Model adequacy

Lusk's models of expenditure shares for each egg type show moderate to high skill in predicting the study data (technically, they have R^2 values ranging from 0.57 to 0.87), providing some confidence in their accuracy. However, we have no measures of the models' *external* predictive skill (i.e. their ability to predict *new* data). Whatever their accuracy on the study data, the models were estimated for one state, during a short and unusual time period (in which an animal-welfare related proposition was part of public discourse), using a very specific type of media coverage (newspaper articles mentioning Proposition 2).

Moreover, the models were estimated for cumulative counts of 0 to 28 newspaper articles. This means we can expect them to be much less accurate when applied in another context, such as other states (whose populations may be more or less responsive to animal welfare coverage), locations which are not undergoing public discussion of a highly specific animal welfare issue (such as Prop 2), or those in which many more than 28 articles have been published on the topic in question.

Finally, the above estimation of the change in quantity demanded associated with a change in number of media stories assumes that prices of each egg type and total expenditures on eggs are the same before and after the additional stories appear. The worse the violation of this assumption, the less trustworthy the models will be.

Statistical significance

The authors' evidence for a significant relationship between egg expenditures and media coverage is the result of a null-hypothesis significance test. This methodology is highly controversial, and many statisticians believe it actually provides little or no evidence for the hypothesis in question. See the [Wikipedia page on statistical hypothesis testing](#) for an overview of the methodology and criticisms.

Elasticity

Previous studies have estimated the retail demand elasticity of eggs to be between -0.15 and -0.3 (Sumner et al. 2011). Lusk reports somewhat lower-magnitude demand elasticities for conventional eggs (-0.134 in SFO and -0.067 in DFW), and much higher-magnitude elasticities for cage-free, organic, and "other" eggs (from -1.07 to -2.979). Sumner et al. (2011) propose half of the retail demand elasticity as a reasonable

value for final (farm) demand elasticity⁵; Carman (2012) uses a range of -0.1 to -0.2⁶. These authors do not, however, differentiate between types of eggs. While getting an exact estimate of final demand elasticity for eggs is difficult, we do know that, under certain assumptions, retail demand is always at least as elastic as farm demand.⁷ On the supply side, recent econometric estimates of supply elasticity are not available, but Sumner et al. (2011) use values of 5 and 10 in their models (again, without differentiating between egg types). Chavas and Johnson (1981), however, estimate considerably lower supply elasticity values, placing long run supply elasticity at 0.942.⁸ This discrepancy indicates the large uncertainty surrounding the supply elasticity of eggs.

Unless the user is confident in particular demand and supply elasticity values, we recommend using our tool with different combinations of values in these ranges to establish an interval of plausible final equilibrium values.

Conclusions

Given the dearth of studies on the subject, we take the above figures as the best current quantitative picture of the causal effect of Prop 2 coverage on California egg demand—and extrapolate to the effects of media coverage on egg demand in general—while acknowledging the huge uncertainties involved. With moderately more certainty, we can conclude that Prop 2 media coverage resulted in slight increases in demand for cage-free and organic eggs, and a slight decrease in demand for conventional eggs, but did not cause a decrease in demand for eggs in general.

Modeling media influence on demand for meat

To test for the effects of media coverage on consumer behavior, [Tonsor and Olynk \(2010\)](#) modeled the quarterly demand for beef, pork, and poultry as a function of the number of animal welfare-related articles published in the United States each quarter. They found a statistically significant relationship between the

⁵ According to Sumner et al. (2011) this is what farm demand elasticity should be if retail price is a fixed markup of farm price, initially equal to twice the farm price.

⁶ Retail demand elasticity is the sensitivity of consumer demand to a change in retail prices. Farm demand elasticity is the sensitivity of retailer demand to a change in farm prices.

⁷ In particular, retail demand elasticity is less than or equal to (i.e. more elastic) than farm demand elasticity when retail price = A*(farm price) + B, where A and B are positive numbers. See Carman (2012)'s discussion of the relationship between farm and retail elasticity.

⁸ Chavas and Johnson (1981) point out that these estimates are dependent on the shifter used to compute elasticity; in this case the price of beef was used as the demand shifter, but the estimate may differ for other shifters.

number of animal welfare-related articles and the demand for pork and chicken. We discuss the implications of this study for animal activists and its limitations.

Meat demand study: data and findings

Tonsor and Olynk's data consisted of quarterly prices and per capita consumption of beef, pork, and poultry in the U.S., and quarterly media indices for each type of farmed animal, which measured the number of American news articles mentioning that animal in the context of animal welfare from 1982 through 2008.⁹

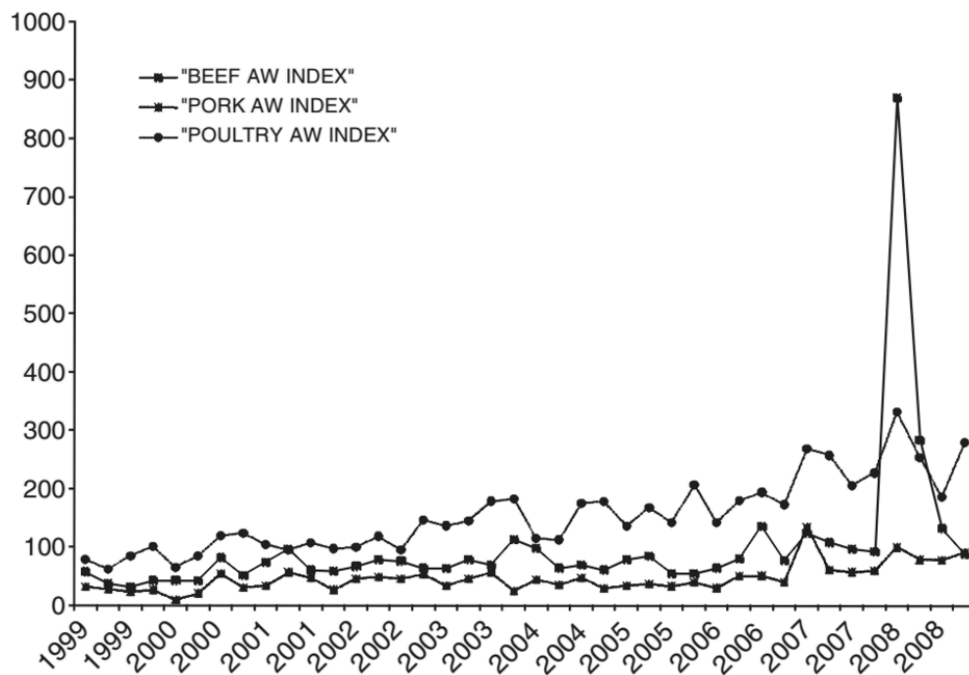


Figure 4: Animal welfare media indices over the period 1999 - 2008. Originally in Tonsor and Olynk (2010). The spike in the beef index in 2008 corresponds to an event relating to the handling of downer cattle, which triggered significant media coverage of animal welfare and food safety issues (Wald 2008).

The authors tried a range of models allowing for a long-term effect of media coverage on meat demand lasting zero to four quarters after the quarter in which the change in media coverage takes place; they

⁹ The media index for a particular animal is the number of articles which resulted from the following search of the LexisNexis Academic database's *U.S. Newspapers and Wires* source option: '{(animal welfare) or (animal well-being) or (animal friendly) or (animal care) or (animal handling) or (animal transportation)} AND (food or diet or meat)', appended with 'AND (beef or cattle)', 'AND (pork or swine or hogs)' or 'AND (poultry or turkey or chicken)'. This search was conducted in May 2010; the list of newspapers in LexisNexis Academic has changed significantly since then.

found evidence that the effect lasts up to one quarter after the publication of an animal welfare-related article. They also tested for spillover effects (i.e. media coverage about one type of animal affecting the demand for the meat of a different animal) but found no evidence of these.

Tonsor and Olynk found a statistically significant negative relationship of demand with the pork media index in the short-run (i.e. demand changing in the same quarter as the publication of a newspaper article), and with the pork and poultry media indices in the long-run (i.e. demand changing in the quarter following the publication of a newspaper article). This indicates that the publication of news stories about animal welfare was associated with decreases in demand for, and therefore consumption of, pork and poultry products. The short- and long-run relationships between demand and the beef media index, and the short-run relationship for poultry, were statistically insignificant.

Tonsor and Olynk’s estimates of the elasticity of demand for pork and poultry with respect to media index are reported in Table 2.¹⁰ Following Schmit and Kaiser (2004), Tonsor and Olynk estimate the percentage contribution to the change in meat demand due to a given change in the media index by multiplying the percentage change in media index by the elasticity. For instance, a 150% increase in the pork media index is associated with an estimated 2.19% decrease in long-run pork demand, since $1.5 \times -0.0146 = -0.0219$.

Tonsor and Olynk assert that these effects are small but economically significant. They report that without the 181.3% increase in the pork media index from 1999 through 2008, the increase in demand for pork over that period would have been 2.65% greater (holding all else constant). Similarly, without the 253.2% increase in the poultry media index over that period, the increase in poultry demand would have been 5.01% greater.

Table 2: Elasticities of demand for pork and poultry with respect to media indices. Only statistically significant elasticities are shown.

Meat Product	Media Elasticity of Demand
Pork (short run)	-0.0066
Pork (long run)	-0.0146
Poultry (long run) ¹¹	-0.0198

¹⁰ These elasticity values measure the responsiveness of meat demand to changes in the media index. Short-run elasticity measures the effect of a change in the media index on meat demand in the present quarter, and long-run elasticity measures the effect of a change in the media index on meat demand in the following quarter.

¹¹ The authors deemed the long-run poultry media index elasticity statistically significant only at the 0.1-level, whereas the typical maximum cutoff value for a statistically significant p-value is 0.05.

How might this change in demand translate into a change in animal welfare? We can estimate the change in the percentage quantity of meat supplied - and therefore (roughly) the percentage change in the number of animals bred in factory farms - associated with these demand changes. For example, using 2007 USDA estimates of the price elasticity of pork demand (-0.636) and long-run supply elasticity (0.99), along with the estimate of a 2.65% decrease in pork demand from 1999 to 2008, we obtain an estimated 1.61% decrease in the amount of pork supplied per quarter associated with a 181.3% increase in the pork media index. Similarly, using 2006 USDA estimates of poultry demand elasticity (-0.43) and supply elasticity (0.22), and the estimate of a 5.01% decrease in poultry demand, we obtain an estimated 1.7% decrease in the amount of poultry supplied per quarter associated with a 253.2% increase in the poultry media index¹².¹³ According to USDA slaughter totals, 9.35 billion chickens and turkeys were slaughtered for food in the U.S. in 2008. Using these numbers, a 1.7% decrease in poultry supplied each quarter would mean 39.7 million fewer poultry animals slaughtered each quarter (and therefore more than 39.7 million prevented from being bred, since many birds bred for slaughter die before slaughter).

Qualifications

Causation

The above calculations assume that the relationship between quarterly media coverage and meat demand is causal. But did media coverage *cause* a demand shift for the different types of meat studied? Or did meat demand track with media coverage as the result of another factor, perhaps changing attitudes toward meat which affected both meat demand and media coverage? Or did meat demand affect media coverage? There is simply no way to know given the design of this study. However, it seems unlikely that the relationship between the number of animal welfare-related newspaper articles published and meat demand is *wholly* due to the former causing the latter. The fact that it seems more likely that external variables (e.g. public attitudes towards farmed animals) would cause a negative than a positive relationship between media coverage and meat demand suggests the effects reported by Tonsor and Olynk are more likely to be overestimates (i.e. suggesting that media coverage decreases meat demand more than it actually does)

¹² See [this link](#) for an explanation of how elasticities and initial demand change are used to estimate the final equilibrium supply of meat.

¹³ The USDA reports use these elasticity values as estimates of farm-level (as opposed to retail-level) elasticity, which measures the responsiveness of the amount of meat supplied by/demanded from farms to changes in price.

than underestimates. So we cannot conclude, for instance, that the 253.2% increase in the poultry media index *caused* 39.7 million fewer birds to be bred in factory farms each quarter.

Model adequacy

Tonsor and Olynk's models of demand for each category of meat show moderate to high ability to predict the study data (technically, they have R^2 values ranging from 0.683 to 0.836), providing confidence in their accuracy; however, the authors provide no direct measures of the models' ability to predict *new* data.

In fact, using the model to predict new data is very difficult given the irreproducibility of the media indices. These were constructed using searches of the LexisNexis Academic database in May 2010, and the list of sources in that database has changed considerably since then. It is unclear how accurately percentage changes in these media indices predict percentage changes in subsequent versions of the LexisNexis Academic database, or media coverage in general. This introduces considerable uncertainty into predictions using measures of media coverage other than a search of the LexisNexis Academic database as it was in May 2010, which is no longer available.

Statistical significance

The authors' evidence for a significant relationship between meat consumption and media coverage is the result of a null-hypothesis significance test. This methodology is highly controversial, and many statisticians believe it actually provides little or no evidence for the hypothesis in question. See the [Wikipedia page on statistical hypothesis testing](#) for an overview of the methodology and criticisms.

Supply and demand elasticity

The estimated final equilibrium quantities of meat are subject to considerable uncertainty due to variability in estimates of supply and demand elasticity. For instance, the USDA reports cited above report large ranges of elasticities for pork supply (0.007 to 0.42), pork demand (-1.234 to -0.07), poultry supply (0.07 to 0.4), and poultry demand (-1.25 to -0.01). The uncertainties in the elasticity estimates compound to create even greater uncertainty in the supply change estimates for which they are used.

Conclusion

Tonsor and Olynk's study demonstrates that there was a negative relationship between media coverage related to pig and chicken welfare and demand for pork and poultry over the period 1982 through 2008. While this is consistent with the hypothesis that media coverage of animal welfare causes a decrease in

demand for meat, their evidence is not sufficient to substantially increase our confidence in this hypothesis.

Resources

Carman, H. (2012). [Economic Aspects of Alternative California Egg Production Systems](#).

Chavas, J. P. and Johnson, S. R. (1981). [An Econometric Model of the US Egg Industry](#). Applied Economics, 13(3), 321-35.

Lusk, J. (2010). [The Effect of Proposition 2 on the Demand for Eggs in California](#). Journal of Agricultural & Food Industrial Organization, 8(1), 1-20.

Meekhof, Ronald L., et al. (2007). [Pork Slaughter and Processing Sector Facility-Level Model](#).

Meekhof, Ronald L., et al. (2006). [Poultry Slaughter and Processing Sector Facility-Level Model](#).

Schmit, T. M. and Kaiser, H. M. (2004). [Decomposing the Variance in Generic Advertising Response over Time](#). American Journal of Agricultural Economics, 86(1), 139-153.

D. A. Sumner et al. (2011). [Economic and Market Issues on the Sustainability of Egg Production in the United States: Analysis of Alternative Production Systems](#). Poultry Science, 90(1), 241-50.

Tonsor, G. and Olynk, N. (2010). [Impacts of Animal Well-Being and Welfare Media on Meat Demand](#). Journal of Agricultural Economics, 62(1), 59-72.

Wald, M. (2008). [Meat Packer Admits Slaughter of Sick Cows](#). *New York Times*, 3(13), 08.

[Egg quantity change calculator](#). (xlsx version)