Title: Consumer Valuation of Pork Chop Quality Information **- NPB #15-198**

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Industry Summary
Pork quality variation has been well documented and overall eating quality of fresh unenhanced pork chops has been linked to product color and marbling. The National Pork Board is working with USDA to develop a voluntary pork quality grading system that would assign pork chops one of three grades. A well-functioning quality standard could eventually better align pork product flows with consumer demands and ultimately provide opportunities for producers to realize price premiums for hogs exhibiting desirable meat quality. Despite well recognized attributes that affect pork eating experiences, no known research has focused on consumer demand for a retail pork quality labeling system.

The overriding purpose of this project is to determine consumer valuation of pork quality under different labeling situations. This provides the industry guidance on the relative merits of alternative approaches to implementing a pork quality grading system.

In July of 2016, we conducted a national survey of 5,011 U.S. pork consumers. This survey provides a host of information on consumer preferences for pork chops and related pork purchasing and consumption patterns. A split sample, choice experiment was included to compare consumer pork valuations under alternative possible pork quality labeling situations.

The core findings of this study include:
In the absence of quality labels (status quo situation), consumers in aggregate do not differentiate between high, medium, and lower quality pork chops.

This suggests limited awareness of color or marbling as pork quality attributes. It also reflects heterogeneous preferences with some preferring paler, leaner chops.

Across multiple labeling approaches, introduction of quality labels results in consumers on average revealing a stronger preference for higher quality pork chops. While quality grade labels boost willingness-to-pay for higher quality, the results of the study also suggest caution in that willingness-to-pay for chops assigned lower

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quality grades falls relative to the no label scenario. A USDA “Prime,” “Choice,” and “Select” labeling approach appears most viable, potentially increasing revenue to the pork sector.
Evidence of consumer preference heterogeneity highlights a sizeable segment currently prefers paler, leaner chops that would carry the lower quality grade in the new labeling system.

Ultimately our recommendation is for careful progression with a pork quality labeling system. While our research suggests potential promise, more work is needed on the costs associated with implementing a labeling system, finer details of consumer preference heterogeneity, and inner-industry acceptance of any voluntary system before firm conclusions on overall economic viability can be drawn.

Keywords Pork quality; Quality grading; Consumer preferences; Pork demand

Scientific Abstract
Despite ample evidence of pork quality variability, at present there are few signals that would incentivize growers to produce higher quality pork. Using split-sample, choice experiment data from a nationwide survey of pork chop eaters, this research determines changes in pork chop demand in response to potential pork quality grading systems based on color scores. Our simulations include novel short-run projections in which the conditional and latent class logit models are inverted to yield inverse demand curves. The inverse demand curves are used to calculate equilibrium prices and pork revenue given a fixed supply of different pork qualities. We supplement these calculations with a more traditional “long run” analysis in which prices are fixed (at projected marginal cost differences) and quantities of different qualities adjust. Compared to the status quo (control) of no quality grades, we find that two grading systems based on alternative nomenclatures (Select, Choice, Prime vs. Good, Better, Best) both have the potential to increase pork chop sales and revenue to the pork industry; however, we also find that if only the highest quality is labeled, revenue could fall as the increase in demand for the higher quality is offset by the fall in demand for the lower qualities. Results also highlight important heterogeneity in consumer preferences, and although sensory studies strongly suggest redder pork chops are more highly preferred, there remains a non-trivial share of consumers who prefer whiter pork even after quality grade labeling.

Introduction
Pork quality variation has been well documented in recent National Pork Board (NPB) retail product audits. Overall eating quality of fresh unenhanced pork chops has been linked to product color, tenderness, and pH. Consumer taste tests have revealed high correlations with these product attributes and overall eating enjoyment. Despite well recognized attributes that affect pork eating experiences, we are unaware of research determining how existence of a retail pork quality labeling system would impact willingness-to-pay and pork demand.

Developing a product grading system that could identify product attributes known to be associated with eating experiences would provide consumers more information about expected eating quality of pork chops. Furnished with such information, consumers could make more informed purchasing decisions, better tailor product use and preparation, and enjoy more desirable pork eating experiences. More consistently pleasurable eating experiences by pork consumers could increase overall pork demand and enhance pork industry revenue. If cost effective, a well-functioning quality standard could eventually provide opportunities for producers to realize price premiums for hogs exhibiting desirable meat quality.

This situation led NPB to work with broader industry and governmental stakeholders to develop a voluntary, 3-level grading system based upon color and marbling. The grade system being considered consists of:

Grade 1 (highest quality – “Prime” or “Best”) would have color sores of 4 or 5 capturing about 8%–10% of current volume;

Grade 2 (medium quality – “Choice” or “Better”) would apply to about 50%–60% of current volume with a color score of 3;

Grade 3 (lower quality – “Select” or “Good”) would include approximately 20%–30% of chops with a color score of 1 or 2.

Chops outside of this marbling range (those in color score 6) would be excluded. This excluded volume is approximated at less than 1% of current production.

Objectives

The overriding purpose of this project is to determine consumer willingness-to-pay for pork quality and associated labeling. Comparisons of consumer assessments of pork chops under alternative labeling schemes provide the industry guidance on the relative merits of alternative approaches to implementing a pork quality grading system. Consumer demand findings can be used with data on implementation costs to more thoroughly assess the net economic viability of alternative pork quality labeling systems.

Material and Methods

To gather information directly from U.S. consumers we conducted a national survey of pork consumers. The survey was programed by the project directors, delivered to an online panel maintained by Survey Sampling, International, and fielded in July 2016. An initial screener question asked “Do you eat pork?” Individuals responding “no” were directed to the end of survey and were discarded from the sample.

Given the project’s focus on pork chop color and possible concern regarding the color each participant assessed given differences in computer monitors, mobile device screens, etc., three initial screener questions asked individuals to identify the color of three circles (circles were actually purple, red, and pink; multiple choice options included pink, red, purple, orange, and blue). About 88% of the final sample correctly identified the colors of all three circles. Analysis shown below reveals little difference in preferences for chop color by those who could and could not correctly identify all three colors.

As an additional measure to mitigate the impacts of “speeders” or others uninterested in the survey, a “trap” question was also included midway through the survey to check whether respondents were paying attention. The question simply asked respondents to “click strongly disagree” on a 5-point agree/disagree scale. Three-fourths of respondents correctly answered the trap question. Those who missed the trap question were removed from the analysis when estimating the choice experiment models.

In total, 5,011 completed responses were obtained. Of these, 1,820 were identified as “pork enthusiasts” according to the criteria supplied by Ceci Snyder.[1] At the conclusion of the survey, respondents answered questions about demographics. Table 1 summarizes the characteristics of the sample. Overall, the sample demographic characteristics are similar to U.S. Census population data with a few exceptions. Our sample contains a somewhat younger age cohort than Census data. Our sample has 3% of respondents 75 years or older compared to 8% in Census data. Our sample is

[1] “Pork enthusiasts” consumed fresh pork at home at least three times in the past two weeks, enjoyed all pork products (giving an average of at least an 8 out of a 10-point scale), and were not price sensitive according to a couple scale questions.

also more highly educated, with 44% having college degrees compared to 29% in Census data. Our sample has smaller representation of the highest income category of $160K or more, with 5% of sample compared to Census data of 13%.

To estimate demand for pork chops under different labeling conditions, a choice experiment (CE) was created where participants made repeated choices between three pork chop qualities, a beef steak, a chicken breast, and a "none of these" option. The beef, chicken, and non-meat (opt out) options were added to determine whether pork quality labels would change the share of respondents who choose pork vs. non-pork substitutes.

Table 1. Survey Respondent Demographic Summary

Characteristic	All Respondents (N=5,011)	Pork Enthusiasts (N=1,820)	U.S. Census Data
Resides in Northeast Census Region	19.2%	19.6%	17.5%
Resides in Midwest Census Region	20.7%	17.3%	21.1%
Resides in South Census Region	36.6%	39.1%	37.7%
Resides in West Census Region	23.5%	24.0%	23.7%
Female	53.8%	45.8%	51.4%
Age 18–24 years	13.7%	9.3%	12.9%
Age 25–34 years	24.0%	26.4%	17.6%
Age 35–44 years	19.7%	24.2%	17.0%
Age 45–54 years	15.3%	14.2%	18.4%
Age 55–64 years	13.6%	12.3%	16.1%
Age 65–74 years	10.9%	10.7%	10.0%
Age 75 or older	2.8%	2.9%	8.0%
Married	55.6%	64.3%	n/a
Mean % of Meat Buying for Household	35.41%	35.05%	n/a
Mean Household Size (# people)	2.81	2.93	2.58
Children under 12 in Household	36.3%	44.0%	33.4%
SNAP (foodstamp) Participant	19.5%	22.1%	18.4%[a]
Collee Degree	44.0%	50.1%	29.3%
Income less than $20K	13.0%	8.7%	11.7%
Income $20K–$39K	19.3%	17.6%	17.6%
Income $40K–$59K	19.0%	17.6%	15.7%
Income $60K–$79K	17.7%	18.8%	13.5%
Income $80K–$99K	12.2%	15.7%	10.3%
Income $100K–$119K	6.7%	8.0%	8.1%
Income $120K–$139K	3.7%	3.5%	6.1%
Income $140K–$159K	3.6%	4.6%	4.3%
Income $160K or higher	4.8%	5.5%	12.7%
Hispanic[b]	13.0%	12.8%	16.9%
White	78.3%	79.6%	73.8%
Black or African American	10.7%	10.8%	12.6%

[a]Figure reported is household participation rate as reported by the USDA.

[b]Following the Census Bureau, Hispanic origin is asked separate from other race questions; as a result, the percent indicating Hispanic, White, and Black sum to more than 100%.

A split sample design was used to facilitate comparisons of consumer valuations of pork under alternative labeling approaches (Pozo, Tonsor, and Schroeder, 2012; Tonsor, 2011). Given each respondent was randomly assigned to one treatment, identified differences in consumer demand across treatments shed light on the central issue of which labeling approaches may be best suited to meet the industry's goals.

The only difference across choices presented to respondents, within a given CE design and labeling situation, was the price of each meat option. Base prices were established using retail meat prices reported by the Bureau of Labor Statistics. In the year prior to the survey (from June 2015 to May 2016), monthly pork chop, beef steak, and chicken breast prices averaged $3.78/lb, $7.75/lb, and $3.32/lb, respectively. Using these as a guide, the mid-points of the prices used in the choice experiment were $3.75/lb, $7.75/lb, and $3.35/lb for pork chops, steak, and chicken breast, respectively. To these mid-points, $0.50 was added and subtracted to make higher and lower levels. Given five meat cuts and three price levels, there are 3^5=243 possible choices that could be constructed. From this full factorial consisting of all price combinations, 12 were selected so that the standard errors of a multinomial logit model were minimized assuming true parameter estimates equal to those generated by the Food Demand Survey (FooDS) at Oklahoma State University.[2]

Thus, each person answered 12 discrete choice questions regarding which meat product they would buy. Table 2 lists the prices (in $/lb) assigned to the meat products in the 12 choice questions (the order of questions was randomized across respondents).

Table 2. Prices used in the Choice Experiment Questions

Choice situation	Pork, high quality	Pork, medium quality	Pork, low quality	Beef Steak	Chicken breast
1	$3.25	$3.25	$4.25	$7.25	$3.85
2	$4.25	$4.25	$4.25	$7.75	$2.85
3	$3.25	$3.75	$3.75	$8.25	$3.35
4	$3.25	$3.75	$3.75	$7.75	$3.35
5	$3.75	$4.25	$4.25	$8.25	$2.85
6	$4.25	$4.25	$4.25	$8.25	$2.85
7	$4.25	$3.25	$3.25	$7.25	$3.85
8	$3.25	$3.75	$3.25	$7.25	$3.85
9	$3.75	$3.25	$3.25	$7.25	$3.85
10	$3.75	$3.75	$3.25	$7.75	$3.35
11	$3.75	$3.25	$3.75	$7.75	$3.35
12	$4.25	$4.25	$3.75	$8.25	$2.85

In the CE participants were presented with pictures of the meat products they could select from as most preferred. The images of the three pork qualities presented to participants were identical across all surveys and treatments, in accordance with chops that fit the currently proposed 3-level labeling criteria. The pork images were supplied by David Newman, North Dakota State University, and were obtained from Steve Larsen of NPB. The exact three color images shown to respondents were:

[2]The experiment was designed with the software Ngene. The assumed "true" parameter values for the middle pork quality used in creation of the experiment design were set equal to the parameters for the pork chop resulting from analysis of data from FooDS. Roughly 10% was added and subtracted from this middle value to create the assumed true values for the higher and lower quality chops in the creation of the experiment design.

The pork labels used in the CE were of products that would actually be assigned the respective quality grade if they were so labeled. As such, all labeling was "truthful" insofar as being assigned to the images of chops that would actually qualify for such labels. For example, in no case was a Prime label affixed to a chop that would qualify as a lower quality grade.

CE participants were randomly assigned to one of 11 treatments that varied according to which labels were applied to pork and beef products.[3] Table 3 describes each of the treatments.

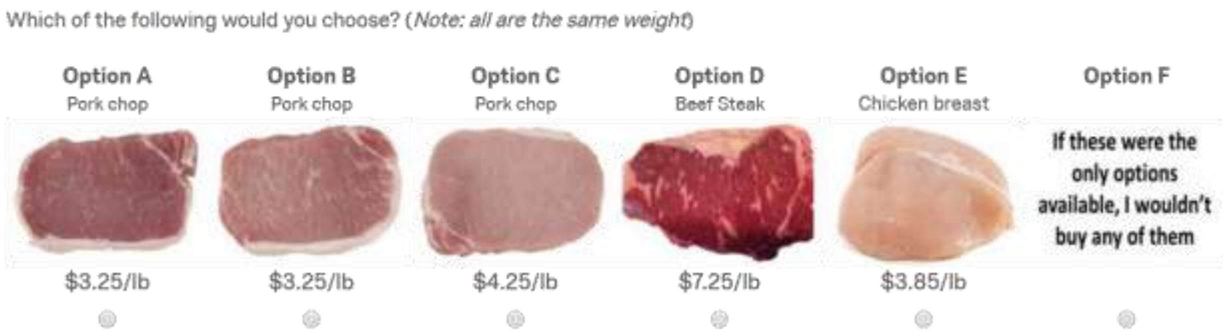
Table 3. Choice Experiment Treatments

Treatment	Pork Labels	Beef Label	Info about labels?	Task	N obs
1 (control)	None	None	No	Choose one	475
2	USDA Prime only	None	No	Choose one	474
3	USDA Prime, Choice, Select	None	No	Choose one	471
4	NPB Prime	None	No	Choose one	452
5	NPB Prime, Choice, and Select	None	No	Choose one	455
6	USDA Prime, Choice, Select	USDA Choice	No	Choose one	456
7	USDA Good, Better, Best	None	No	Choose one	456
8	USDA Prime, Choice, Select	None	Yes	Choose one	452
9	USDA Prime only + "enhanced" on lowest quality	None	No	Choose one	457
10	None	None	No	How many	421
11	USDA Prime, Choice, Select	USDA Choice	No	How many	430

[3] A slightly larger sample size was allocated to the first three treatments to gain more precision in these key treatments of interest.

Treatment 1

Treatment 1 is the control in which none of the meat products presented to the participant contained any labels. This treatment reflects the current, status quo situation of no regular labeling of pork quality grades and serves as the control treatment in our study. An example of one of the 12 choice questions from the control treatment is shown in the following figure.



Treatment 2

The choice questions in the second treatment were the same as the first, control treatment except the USDA Prime logo was affixed to the photo of the Prime pork chop; no other meat products contained labels. An example is below.

Treatment 3

Choices in treatment 3 were the same as treatment 2 except labels were also added for Choice and Select chops, as the following figure illustrates.

Treatments 4 and 5

Treatments 4 and 5 were the same as treatments 2 and 3 except the USDA quality grade label logos were replaced with NPB logos. The following figure is an example from treatment 5 containing all three NPB quality grade labels.

Treatment 6

Treatment 6 was the same as treatment 2 except the USDA Choice label was also affixed to the beef steak. This treatment permits an exploration into the sensitivity of results when quality labels are also used on competing meat products.

Treatment 7

Treatment 7 considered an alternative labeling strategy where the three pork qualities were labeled USDA Good, Better, and Best, as shown in the following figure.

Treatment 8

Treatment 8 was the same as treatment 3 except extra information was provided about the quality grade labels prior to the choices being made. The following information was provided.

The pork chops below have one of three quality labels.

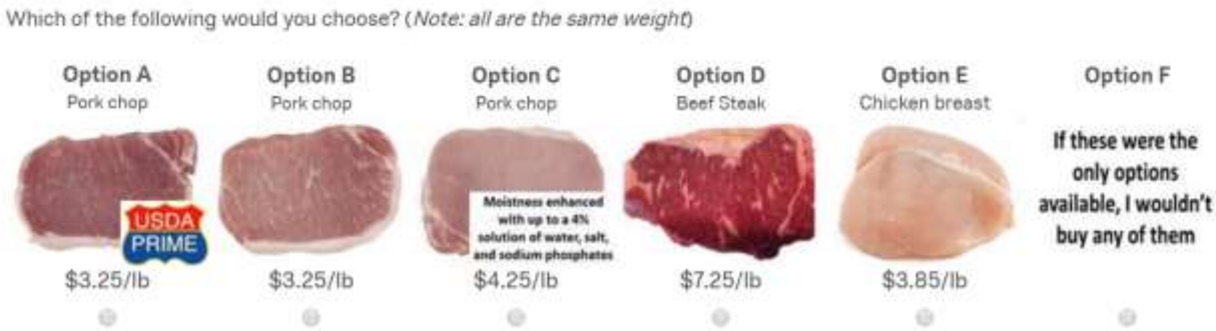
"USDA Prime" represents the highest quality grade and includes chops that are redder in color and have adequate marbling (or intramuscular fat). Taste tests show these chops tend to be among the juiciest and tastiest.

"USDA Choice" represents the middle quality grade and includes chops that are pinkish in color and have adequate marbling (or intramuscular fat). Taste tests show these chops tend to be in the middle in terms of juiciness and tastiness.

"USDA Select" represents the lowest quality grade and includes chops that are less red in color and have low amounts of marbling (or intramuscular fat). Taste tests show these chops tend to be among the least juicy and tasty.

Treatment 9

Treatment 9 explored the sensitivity of results to labels about pork chop enhancement. In particular, the USDA Prime label was affixed to the highest quality pork chop. To the lowest quality pork chop, a label was attached that said, *"Moistness enhanced with up to a 4% solution of water, salt, and sodium phosphates."*



Treatments 10 and 11

Finally, treatments 10 and 11 were the same as treatments 1 and 6, except instead of asking respondents to choose just one product, they were asked how many of each meat product they would buy at the posted prices. An example question from treatment 10 is below.

Data from each treatment were separately analyzed using a multinomial logit (MNL) model. In particular, consumer *i* in treatment *t* is assumed to derive the following utility from choice option *j*: $U_{itj} = V_{tj} + \varepsilon_{itj}$. If the ε_{itj} follow a Type I extreme value distribution and are independently and identically distributed across *i*, *t*, and *j*, then the conventional multinomial logit model (MNL) results:

(1) Prob(*i* chooses *j* in treatment *t*) = $\frac{e^{V_{tj}}}{\sum_{k=1}^{6} e^{V_{tk}}}$.

A basic specification is utilized here for the systematic portion of the utility function:

(2) $V_{tj} = \beta_{tj} + \alpha_t p_j$,

where p_j is the price of alternative *j*, α_t is the marginal utility of a price change in treatment *t*, and β_{tj} is an alternative specific constant indicating the utility of option *j* in treatment *t* relative to the utility of the "no purchase" option, which was normalized to zero for identification purposes. Estimating the parameters of the model is straightforward using maximum likelihood estimation.

When the model is estimated, all respondents who missed the trap question, which simply told the participant to "click strongly disagree" on a 5-point agree/disagree scale, were deleted. Moreover, to ensure that the estimated model reflects market demand, responses were weighted by the frequency of pork chop consumption reported by the respondent. Thus, a respondent indicating that they ate pork chops every day "counts" seven times more than a respondent who indicates they only eat pork chops once a week.

A challenge arises in estimating comparable models using data from treatments 10 and 11 where subjects choose "how many" to purchase instead of "which one." To work these data into the analysis in a comparable fashion, the share of purchases accruing to each option was calculated for each person and choice question; these share values take the place of discrete choice dummy variables in the likelihood function. The underlying assumption with this approach is that the shares represent a series of discrete choices made by the respondent. Because "how many" questions do not have an explicit "none" option, the share of "none" choices is calculated as either zero if any other product is picked at least once in the choice set or one if zero units were selected of all items in the choice set.

The analysis focuses on several metrics of interest that align with the project's objectives. First is willingness-to-pay (WTP) for the three quality pork chops in different treatments. Maximum WTP) for pork chop *k* in treatment *t* compared to "none" is calculated as $WTP_{tk} = -\beta_{tk}/\alpha_t$. This is the price that would make the average or representative consumer indifferent to buying chop quality *k* in treatment *t* and choosing "none." Also of interest is how different labeling schemes change the "spread" in value for different pork qualities. Thus, for each treatment, the difference in WTP for the highest quality chop, *H*, and the lowest quality chop, *L*, is calculated as: $WTP_{tH} - WTP_{tL} = -(\beta_{tH} - \beta_{tL})/\alpha_t$. Because of differences in the way "none" is defined in treatments 10 and 11, it is probably not instructive to compare WTP vs. none across the "choose one" and "how many" treatments, though comparing WTP for high vs. low quality across treatments is informative.

Because labeling may reduce WTP for the lowest quality more than it increases WTP for the highest quality, it is important to analyze how a labeling scheme affects overall demand for pork. To investigate this issue, three additional metrics were calculated: (i) the probability of buying pork regardless of quality, (ii) the expected revenue from all pork sales at a fixed set of prices, and (iii) expected revenue from all pork sales with fixed quantities of each quality pork. Metric (ii) is something like a long-run simulation where prices approach marginal cost and producers respond by adjusting the quantities of different qualities. By contrast, metric (iii) is a more short-run simulation where the quantities of different qualities are fixed and market prices adjust to equate supply with demand.

For the first two simulated outcomes, prices have to be assigned to competing choice options to construct a hypothetical market environment. For medium-quality pork, beef steak, and chicken breast, the median prices employed in the experimental design were used ($3.75/lb, $7.75/lb, and $3.35/lb); prices for the higher quality and lower quality were determined by assigning a 10% premium and discount resulting in a price of $4.125/lb for the high quality and $3.375/lb for low quality chops. Let qt_H, qt_M, and qt_L be the probabilities of buying high, medium, and low quality pork in treatment *t*; the probabilities of purchase are defined as:
$q_{tH} = \frac{e^{\beta_{t1}+\alpha_t(4.125)}}{\sum_{k=1}^{6} e^{V_{itk}}}$, $q_{tM} = \frac{e^{\beta_{t2}+\alpha_t(3.75)}}{\sum_{k=1}^{6} e^{V_{itk}}}$, and $q_{tL} = \frac{e^{\beta_{t3}+\alpha_t(3.375)}}{\sum_{k=1}^{6} e^{V_{itk}}}$.
Thus, the probability of buying pork at the given prices is: $q_{tH} + q_{tM} + q_{tL}$. At fixed prices, the expected revenue ($ per shopper per choice occasion) accruing to pork is $4.125q_{tH} + 3.75q_{tM} + 3.375q_{tL}$.

The third metric used to evaluate the alternative labeling scenarios is to determine the prices such that the share of each chop quality sold equals the expected share of pork qualities produced in the short run. Stated differently, approach (ii) plugs in a set of prices and then solves for the resulting shares (or quantities), whereas approach (iii) plugs in a set of shares (or quantities) and solves for the resulting set of prices. To make this calculation, equation (1) needs to be inverted to create an inverse demand curve.

Write equation (1) as: $q_{jt} = \frac{e^{V_{tj}}}{\sum_{k=1}^{6} e^{V_{tk}}}$, where q_{jt} is the market share (or quantity) of alternative *j* in treatment *t*. Now, substitute equation (2) and take the natural log of this equation:
$ln(q_{jt}) = \beta_{tj} + \alpha_t p_j - \ln(\sum_{k=1}^{6} e^{V_{tk}})$. Solving partially for price, we have:
$p_j = (ln\left(q_{jt}\right) - \beta_{tj} + \ln(\sum_{k=1}^{6} e^{V_{tk}}))/\alpha_t$. The term $\sum_{k=1}^{6} e^{V_{tk}}$ contains prices for all the alternatives, so the price of alternative *j* is not uniquely identified by this equation. However, the log-sum term can be eliminated from the equation by calculating price differences. In particular, we can identify the price of alternative *j* relative to the price of the sixth "none" option by taking the following difference: $p_j - p_6 = \frac{ln\left(q_{jt}\right) - \beta_{tj} + \ln\left(\sum_{k=1}^{6} e^{V_{tk}}\right)}{\alpha_t} - \frac{ln\left(q_{6t}\right) - \beta_{t6} + \ln\left(\sum_{k=1}^{6} e^{V_{tk}}\right)}{\alpha_t}$. Note that the price of the "none" alternative is zero (i.e., $p_6 = 0$), as is the alternative specific constant for this alternative (i.e., $\beta_{t6} = 0$). Plugging these values in and simplifying uniquely identifies the price. Thus, given market shares (or quantities) for alternative *j* and none, the resulting price of *j* is:
(3) $p_j = (ln\left(q_{jt}\right) - ln\left(q_{6t}\right) - \beta_{tj})/\alpha_t$.

To create a baseline scenario, we look at data from the baseline (no label) treatment 1, which shows at mid-level prices, the shares for pork, steak, chicken, and none are: 0.65, 0.11, 0.20, and 0.05, respectively. If we assume that 10% of the pork is the highest grade, 40% is the middle grade, and 50% is the lowest grade, then the overall probabilities of high, mid, and low quality pork are: 0.065, 0.26, and 0.325, respectively. Plugging these shares into equation (3) generates prices, which can then be used to calculate expected revenue accruing to pork, which is: $0.065\hat{p}_{tH} + 0.26\hat{p}_{tM} + 0.325\hat{p}_{tL}$, where the $\hat{p}$ values are the prices for the high, medium, and low quality chop resulting from equation (3).

Results

The survey began with basic questions about pork consumption habits, beliefs about pork and competing meat products, cooking preferences, expected prices, and so forth. Additionally, questions were asked about perceptions of pork chop images that had different color and marbling scores. All pork images were supplied by David Newman at North Dakota State University as obtained by Steve Larsen of NPB.

Respondents were shown three pork chops associated with three color scores (1, 3, and 5) and were asked, for each, expected taste (-5=very un-tasty; +5=very tasty) and expected healthiness (-5=very unhealthy; +5=very healthy). Respondents were also shown three pork chops associated with three different levels of marbling (1%, 3%, and 5%) and were asked, for each, expected taste (-5=very un-tasty; +5=very tasty) and expected healthiness (-5=very unhealthy; +5=very healthy). The exact photos shown are included in Tables 4 & 5.

On average respondents expect taste improves with pork chops that would carry higher quality grade labels. In particular, color score 5 (Table 4) chops and those with at least 3% marbling (Table 5) have the highest average respondent favorable taste expectation rankings. This is generally consistent with past research by Brewer and McKeith (1999) where consumers on average indicated a much greater likelihood of purchasing darker colored pork chops. However, heterogeneity is also evident among respondent perceptions of taste and healthiness across both color and marbling scores. Specifically, 25% of respondents indicated the paler chop would taste better and 30% expected the least marbled chop would have the best taste. This is important because it indicates respondents associate both color and marbling differently with how it relates to taste as well as with healthiness. *As a result, a quality grade system based upon visible product color and marbling would be counter to a significant number of consumer preconceived perceptions about product taste.*

Table 4. Mean Perceived Taste and Healthiness (on -5 to +5 scale) of Pork Chops with Color Scores 1, 3, and 5.

Chop Image	Expected Taste		Expected Healthiness	
	All Respondents	Pork Enthusiasts	All Respondents	Pork Enthusiasts
	2.116[a] (2.569)[b] {24.9%}[c]	2.794 (2.359) {23.4%}	2.122 (2.509) {31.1%}	2.820 (2.300) {28.1%}
	2.712 (2.147)	3.292 (1.882)	2.255 (2.252)	2.982 (1.933)
	2.765 (2.255) [44.9%][d]	3.375 (1.964) [42.6%]	2.287 (2.416) [33.9%]	3.060 (2.070) [33.6%]

[a]Mean rating on -5 to +5 scale.

[b]Numbers in parentheses ( ) are standard deviations.

[c]Numbers in brackets { } indicate the percent of respondents who gave a higher rating to the whitest chop compared to the rating given to the reddest chop.

[d]Numbers in brackets [ ] indicate the percent of respondents who gave a higher rating to the reddest chop compared to the rating given to the whitest chop; the numbers in the two brackets, { } and [ ], do not sum to 100% because many respondents gave the reddest and whitest chops the same rating.

Note: Among the 12% of respondents (N=577) who did not correctly identify the color of all three circles in the screener questions, the mean expected taste of the three chops was 2.393, 2.833, and 2.944, and expected health was 2.308, 2.445, and 2.613.

Table 5. Mean Perceived Taste and Healthiness (on -5 to +5 scale) of Chops with Marbling Scores 1%, 3%, and 5%.

Chop Image	Expected Taste		Expected Healthiness	
	All Respondents	Pork Enthusiasts	All Respondents	Pork Enthusiasts
	2.076[a] (2.493)[b] {30.0%}[c]	2.798 (2.297) {28.5%}	2.141 (2.415) {41.7%}	2.885 (2.190) {39.0%}
	2.415 (2.286)	3.075 (2.032)	1.904 (2.426)	2.701 (2.155)
	2.412 (2.405) [41.1%][d]	3.116 (2.148) [39.8%]	1.716 (2.596) [27.8%]	2.568 (2.355) [27.4%]

[a]Mean rating on -5 to +5 scale.
[b]Numbers in parentheses ( ) are standard deviations.
[c]Numbers in brackets { } indicate the percent of respondents who gave a higher rating to the least marbled chop compared to the rating given to the most marbled chop.
[d]Numbers in brackets [ ] indicate the percent of respondents who gave a higher rating to the most marbled chop compared to the rating given to the least marbled chop; the numbers in the two brackets, { } and [ ], do not sum to 100% because many respondents gave the lowest and highest marbled chops the same rating.
Note: Among the 12% of respondents (N=577) who did not correctly identify the color of all three circles in the screener questions, the mean expected taste of the three chops was 2.352, 2.740, and 2.652, and expected health was 2.421, 2.221, and 2.154.

After the choice experiment questions, respondents were asked to rank labels (by clicking a label with the mouse and moving it up or down in the list) according to likelihood of purchase, assuming products holding the labels were the same price and package size. The order of appearance of labels was randomized across respondents. The question appeared as follows.

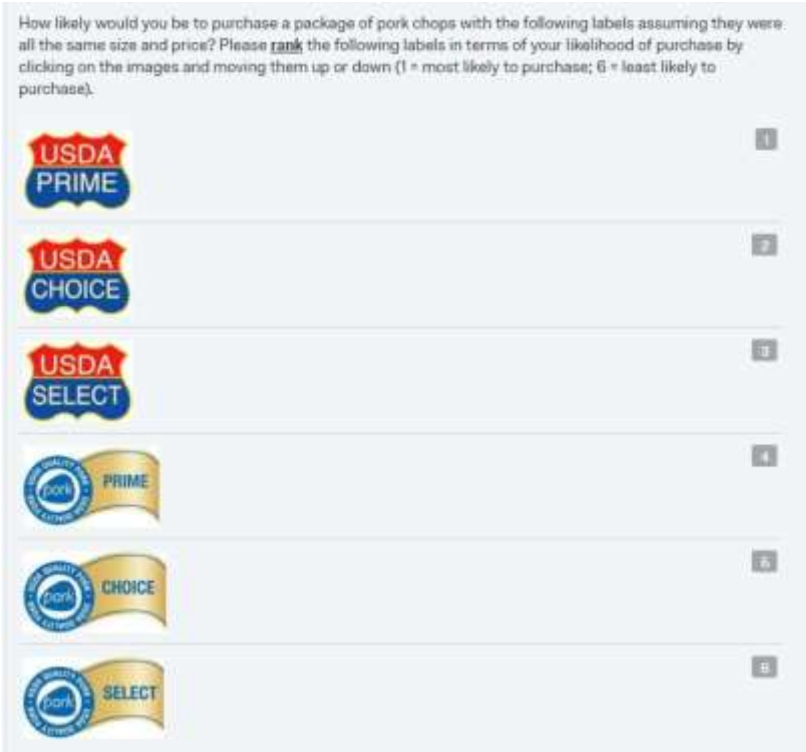


Table 6 summarizes respondent rankings of different potential quality labels (1 = most likely to purchase; 6 = least likely to purchase). More than 40% of respondents rank USDA Prime highest as the product label they would most likely purchase (assuming prices were all the same). Overall, this indicates a USDA rather than NPB labeling approach may be generally preferable. However, this is not definitive given the heterogeneity present as over 30% of respondents indicated the NPB Prime, Choice, or Select labels would most impact purchasing decisions. We did not offer an option containing both labels, but this might be an interesting alternative.

Table 6. Respondent Quality Grade Labeling Rankings

Label	All Respondents	Pork Enthusiasts
USDA PRIME	2.489[a] [42.3%][b]	2.566 [40.2%]
USDA CHOICE	3.366 [13.5%]	3.402 [12.8%]
USDA SELECT	3.576 [11.2%]	3.599 [12.4%]
pork PRIME	3.187 [19.2%]	3.154 [19.4%]
pork CHOICE	4.106 [7.0%]	4.062 [8.2%]
pork SELECT	4.276 [6.8%]	4.217 [7.0%]

[a]Average rank (1 = most likely to purchase; 6 = least likely to purchase).
[b]Number in brackets [ ] are the percent of respondents ranking the label first as most likely to purchase.

Table 7 provides basic summary statistics associated with several consumption and belief questions for the entire sample and for the sub-sample identified as pork enthusiasts.

Table 7. Responses to Specific Consumption Questions

How often do you eat pork chops?

Response Category	All Respondents	Pork Enthusiasts[a]
Never	2.0%	0.2%
2–3 Times a Year	18.2%	6.8%
Once a Month	21.5%	13.5%
2–3 Times a Month	29.4%	30.9%
Once a Week	15.7%	23.4%
2–3 Times a Week	11.7%	22.2%
Daily	1.5%	2.9%

[a]A few pork enthusiasts report a low level of pork chop consumption. This arises because enthusiasts are defined by *total* fresh pork consumption not just consumption of chops.

Which types of pork chops do you normally buy?

Response Category	All Respondents	Pork Enthusiasts
Boneless	52.1%	52.5%
Bone-in	44.2%	46.3%
I don't know	3.7%	1.2%

When you buy pork chops, what types of packages do you normally buy?

Response Category	All Respondents	Pork Enthusiasts
a package with a single chop	3.5%	3.8%
a package with 2–3 chops	28.1%	22.1%
a package with 4–5 chops	32.3%	32.8%
a package with 6 chops or more	28.5%	36.0%
I buy a loin that I cut into my own chops at home	4.4%	4.9%
I don't know	3.2%	0.4%

When you buy pork chops, do you typically eat them right away or freeze them?

Response Category	All Respondents	Pork Enthusiasts
almost always eat them right away	21.4%	25.1%
mostly eat them right away, sometimes freeze them	37.6%	40.9%
sometimes eat them right away, mostly freeze them	28.3%	25.8%
almost always freeze them	12.7%	8.1%

Table 7. Continued

Have you ever bought pork chops on-line?

Response Category	All Respondents	Pork Enthusiasts
Yes	11.8%	17.6%
No	86.7%	81.3%
I don’t know	1.5%	1.1%

When you buy beef steaks, what USDA quality grade do you typically buy?

Response Category [a]	All Respondents	Pork Enthusiasts
Prime	32.9%	41.8%
Branded Choice	16.7%	20.2%
Choice	22.9%	20.9%
Standard	8.5%	6.7%
I don’t know	19.0%	10.4%

[a]The category “Select” was inadvertently omitted from the response categories on the survey.

When you buy fresh pork, how do you assess quality and the likelihood of the product will be flavorful, juicy, tender? (check all that apply)

Response Category	All Respondents	Pork Enthusiasts
Store I buy from	58.3%	63.3%
Meat counter attendant advice	19.8%	25.1%
Brand name	26.4%	32.7%
USDA quality grade on label	38.6%	44.7%
Visual color	59.8%	61.3%
Visual marbling	32.9%	35.3%

Note: total does not sum to 100% because respondents could pick more than one category.

Table 7. Continued

What price ($/lb) would you expect to pay for pork chops at the grocery store you normally shop at?

Response Category	All Respondents	Pork Enthusiasts
less than $2.00/lb	10.6%	8.1%
$2.00/lb	13.6%	11.4%
$2.50/lb	17.0%	16.4%
$3.00/lb	18.3%	16.9%
$3.50/lb	13.1%	14.2%
$4.00/lb	10.7%	12.4%
$4.50/lb	5.9%	6.4%
$5.00/lb	4.9%	5.4%
$5.50/lb	2.0%	3.3%
$6.00/lb	2.2%	3.0%
more than $6.00/lb	1.7%	2.5%
Average price	$3.15	$3.34

What is the *maximum* price ($/lb) you would be willing to pay for pork chops at the grocery store you normally shop at?

Response Category	All Respondents	Pork Enthusiasts
less than $2.00/lb	3.4%	1.5%
$2.00/lb	5.9%	4.0%
$2.50/lb	9.4%	7.1%
$3.00/lb	14.7%	12.9%
$3.50/lb	12.6%	11.9%
$4.00/lb	13.2%	12.5%
$4.50/lb	6.9%	7.9%
$5.00/lb	10.0%	10.1%
$5.50/lb	3.8%	4.8%
$6.00/lb	5.8%	6.0%
$6.50/lb	2.1%	3.0%
$7.00/lb	2.9%	3.9%
$7.50/lb	1.6%	2.1%
$8.00/lb	1.9%	3.1%
$8.50/lb	1.0%	1.2%
$9.00/lb	1.1%	1.7%
$9.50/lb	0.5%	0.9%
$10.00/lb	1.8%	2.8%
More than $10.00/lb	1.5%	2.8%
Average maximum WTP	$4.35	$4.84

One of the initial questions asked respondents, “Over the past five years, has your consumption of pork chops increased or decreased?” 32.9% indicated consumption had increased, 57.5% responded “stayed the same,” and the remaining 9.6% indicated consumption had decreased.

Respondents indicating an increase or decrease were given a conditional question asking why.

Why has consumption of pork chops increased? (N=1,651)

Reason	% Indicating Reason
Pork chops have become tastier	42.4%
Pork chops have become more convenient to cook	42.1%
Pork chops have become juicier	35.7%
The price of pork chops has fallen	33.3%
Pork chops have become leaner	32.0%
Pork has become safer to eat	27.0%
My household income has changed	25.0%
Other meat options have become less attractive	19.6%
My health status has changed	16.3%
Hog welfare has improved	15.5%
Other	4.8%

Note: total does not sum to 100% because respondents could pick more than one category.

Why has consumption of pork chops decreased? (N=480)

Reason	% Indicating Reason
Other meat options have become more attractive	40.0%
My health status has changed	23.3%
The price of pork chops has increased	20.8%
Pork chops have become less tasty	19.4%
Pork chops have become less convenient to cook	16.7%
Pork has become less safe to eat	16.3%
My household income has changed	15.6%
Other	14.4%
Pork chops have become drier	11.9%
Hog welfare has fallen	5.8%
Pork chops have become leaner	4.2%

Note: total does not sum to 100% because respondents could pick more than one category.

Beliefs about taste and health of competing meat products (mean responses on five-point scale 1 = strongly disagree to 5 = strongly agree)

Statement	All Respondents	Pork Enthusiasts
Pork chops are tasty	4.332 (0.981)	4.708 (0.717)
Beef steaks are tasty	4.298 (0.943)	4.512 (0.777)

Chicken breasts are tasty	4.263 (0.927)	4.417 (0.847)
Pork chops are healthy	3.809 (1.029)	4.184 (0.911)
Beef steaks are healthy	3.547 (1.032)	3.888 (0.987)
Chicken breasts are healthy	4.300 (0.849)	4.492 (0.748)

Note: numbers in parentheses are standard deviations.

Beliefs about affordability, ease of cooking, and consistency of competing meat products (mean responses on five-point scale 1 = strongly disagree to 5 = strongly agree)

Statement	All Respondents	Pork Enthusiasts
Pork chops are affordable	3.975 (0.985)	4.382 (0.809)
Beef steaks are affordable	3.187 (1.117)	3.536 (1.144)
Chicken breasts are affordable	4.051 (0.920)	4.291 (0.819)
Pork chops are easy to cook	4.209 (0.928)	4.560 (0.693)
Beef steaks are easy to cook	4.031 (0.970)	4.337 (0.829)
Chicken breasts are easy to cook	4.284 (0.878)	4.518 (0.731)
One pork chop tastes about the same as another	3.043 (1.215)	3.143 (1.313)
One steak tastes about the same as another	2.734 (1.257)	2.950 (1.366)
One chicken breast tastes about the same as another	3.315 (1.233)	3.452 (1.297)

Note: numbers in parentheses are standard deviations.

How do you typically cook the following meats? (check all that apply). All Respondents

	Braise	Broil	Grill/ Barbecue	Microwave	Roast	Sauté	Stew	I don't know
Pork chop	16.3%	32.2%	52.3%	5.9%	34.5%	48.7%	11.5%	2.8%
Ham	10.7%	13.7%	13.6%	9.2%	54.7%	27.0%	9.3%	9.3%
Bacon	7.6%	15.4%	13.7%	23.5%	10.6%	63.8%	5.0%	3.6%
Pork Roast	11.9%	14.2%	15.9%	4.3%	66.8%	10.5%	17.5%	6.8%
Beef steak	12.6%	26.0%	58.5%	4.4%	17.1%	34.6%	11.8%	5.0%
Beef Roast	11.7%	13.0%	14.6%	3.9%	65.5%	11.0%	23.7%	6.1%
Chicken Breast	19.5%	32.8%	56.5%	6.8%	40.2%	49.5%	21.3%	2.7%

Note: Total do not sum to 100% because respondents could pick more than one cooking method for each meat.

How do you typically cook the following meats? (check all that apply). Pork Enthusiasts

	Braise	Broil	Grill/ Barbecue	Microwave	Roast	Sauté	Stew	I don't know
Pork chop	22.4%	37.8%	60.1%	7.4%	39.3%	53.0%	14.5%	0.7%
Ham	14.7%	18.0%	18.3%	11.7%	56.0%	32.0%	12.3%	4.6%
Bacon	11.0%	19.0%	18.0%	23.9%	15.2%	65.2%	7.2%	1.6%
Pork Roast	16.5%	19.7%	23.7%	6.8%	68.7%	14.9%	20.7%	1.8%
Beef steak	17.4%	30.0%	61.0%	6.4%	23.8%	38.7%	14.6%	2.0%
Beef Roast	16.5%	19.1%	20.3%	5.7%	66.8%	15.5%	26.3%	2.0%
Chicken Breast	25.1%	37.0%	59.3%	8.7%	42.5%	50.8%	25.2%	1.3%

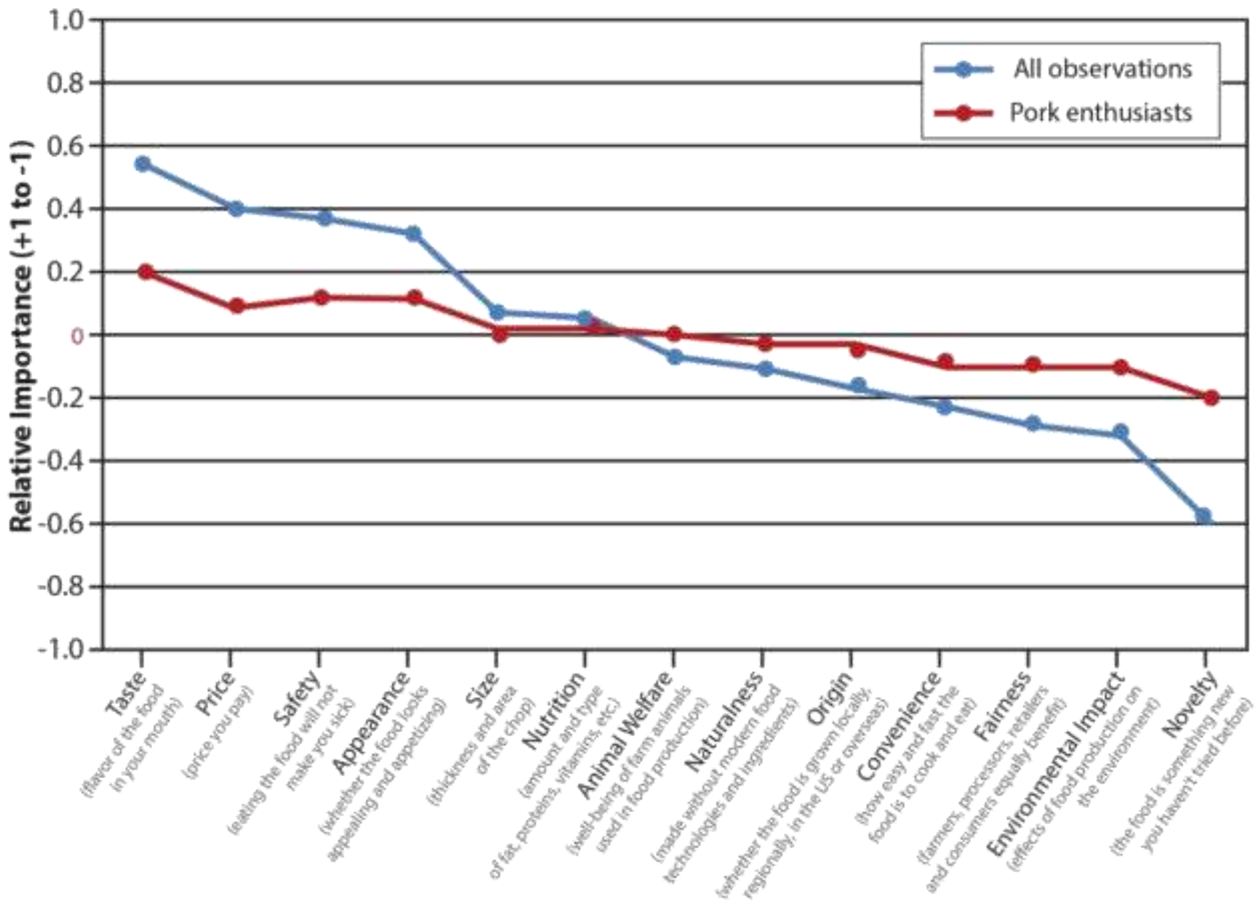
Note: Total do not sum to 100% because respondents could pick more than one cooking method for each meat.

How important are the following items to you when deciding whether to buy pork chops? Figure 1, on a +1 to -1 scale, indicates relative importance calculated as the proportion of times an item was placed in the most important category minus the proportion of times the same item was placed in the least important category.[4] If all respondents placed an issue in the most important category, the score for the issue would be +1; by contrast if all respondents placed an issue in the least important category, the score for the issue would be -1. Complete random assignment of items to importance categories would result in a score of zero for each item. A score of zero could imply that no one put an item in the most or least important categories or that equal frequencies of respondents put an item in the most important category as did the frequency of respondents putting an item in the least important category.

The general population and pork enthusiasts generally agree on the relative ordering of issue importance. However, the flatter line for pork enthusiasts is indicative of more dispersion among this group in terms of which issue they consider most important.

The most important overall attribute of those considered is "taste." This is followed next by price, safety, and appearance, all of which are nearly identical in relative rank to each other.

Figure 1. Relative Importance of Product Attributes in Pork Chop Purchase Decisions



[4] The same data is included in table form in the Appendix.

Before presenting the results from the model estimation, it is instructive to first look at a comparable segment of the raw choice experiment data. Recall from Table 2 that the sixth choice situation was one in which all three pork qualities had the same price ($4.25/lb), the beef steak was priced at $8.25/lb, and the chicken breast was $2.85/lb. Table 8 shows the percentage of respondents who selected each option in each treatment (results are weighted by volume of pork chop consumption and omit individuals who missed the trap question).

Table 8. Summary Statistics Associated with Choice Scenario 6, where all Chops were Identically Priced

Treat	Description	Chop, High	Chop, Middle	Chop, Low	Any Chop[a]	Steak	Chicken Breast	"None"
1	No labels	13.9%	14.6%	15.4%	43.9%	9.1%	42.1%	4.9%
2	USDA Prime only	28.2%	9.7%	2.2%	40.2%	9.8%	44.7%	5.3%
3	All 3 USDA labels	17.1%	13.3%	14.9%	45.3%	9.2%	42.2%	3.2%
4	NPB Prime only	35.2%	8.1%	10.4%	53.7%	5.3%	37.4%	3.6%
5	All 3 NPB labels	18.0%	13.4%	11.0%	42.4%	6.8%	46.6%	4.3%
6	All 3 USDA labels + steak label	26.7%	13.8%	8.2%	48.6%	5.6%	39.7%	6.1%
7	USDA Good, Better, Best	24.6%	11.2%	15.3%	51.1%	6.7%	39.6%	2.6%
8	All 3 USDA labels + info	30.3%	9.0%	11.0%	50.3%	6.6%	37.9%	5.2%
9	USDA Prime + enhanced label	28.0%	11.7%	8.5%	48.2%	4.4%	41.7%	5.7%
10	No labels (how many)	13.9%	12.0%	13.1%	39.1%	11.1%	42.6%	7.3%
11	All 3 USDA labels (how many)	16.7%	13.8%	15.3%	45.8%	12.9%	38.6%	2.7%

[a]Figures in this column represent the percent or respondents who chose any pork chop—they are the sums of the figures in the three previous columns.

In the no label treatment (Treatment 1), where all the respondent saw was the pictures of the products, and in the absence of a price signal that might suggest a quality difference, participants were evenly split across the three pork chops with about 14%–15% selecting each chop picture (Treatment 10, with no labels but with the ability to select more than one product, had the same general conclusion). If anything, they have a slight preference for the paler, leaner chop in Treatment 1. This data suggests that consumers are currently uninformed about visual pork quality attributes relative to how they relate to product taste.

In Treatments 2 and 4 where a Prime-only label was introduced, participants shifted quite dramatically to the label that helped them identify the higher quality chop. This shift corroborates with the results from Treatment 1 and suggests participants are confused about what constitutes quality and will respond strongly to a decision aid (i.e., a label) that helps them do this.

The introduction of three labels, especially in Treatments 3 and 5, and somewhat 6, resulted in a more balanced pattern across the three chops. Remember that in this choice situation there was no price difference across the chops. In these circumstances, the relatively large proportion who chose the Choice and Select chops indicates that many, but not all, consumers are confused about whether "Prime," "Choice," or "Select" is the best quality reference. Perhaps surprisingly, some participants had a similar problem differentiating among “Good,” “Better,” and “Best” in Treatment 7. We also cannot rule out that pork quality preference heterogeneity, rather than quality label “confusion” per se underlies these findings. That is, the fact that product color signals different eat quality to participants might suggest some participants were still using the product visual characteristics of color or marbling rather than the labeled grade to make choices.

The introduction of additional information to inform the quality selection in Treatment 8 resulted in a shift to the Prime chop that rivaled that observed in Treatments 2 and 4. Treatment 9 reveals that including enhancement information on the lower quality chop leads to a shift towards USDA Prime similar to Treatment 2. Treatments 10 and 11 provide similar insights to Treatments 1 and 3, respectively.

The data in the Table 9 below report results of the MNL model estimation where preference homogeneity is assumed.[5] The first three columns show estimated WTP for the higher, medium, and lower quality chops. The data shown directly below these values in brackets shows the 95% confidence interval for each measure. While random allocation to treatment was used to help mitigate such effects, because different participants participated in different treatments, it is possible that differences reflect sampling variability. Therefore, it is advisable to draw inferences from only these results where the difference lies outside of the confidence intervals. This table also reports the difference between the WTP for the highest and lowest quality chops, the probability of choosing any one of the three pork chops, and the expected revenue from these chops. In these latter two calculations the highest quality chop is assumed to be sold at a 10% premium and the lowest quality chop is presumed to be sold at a 10% discount.

[5] Coefficient estimates of underlying MNL models are provided in the Appendix.

Table 9. WTP Estimates from Choice Experiment (Results are Weighted by Volume of Pork Chop Consumption and Omit Individuals who Missed the Trap Question)

Treat	WTP_H	WTP_M	WTP_L	$WTP_H - WTP_L$	Prob[Pork][a]	E[Rev][a]
1. No labels	$5.10 [4.87, 5.32]	$5.13 [4.90, 5.35]	$5.00 [4.78, 5.22]	$0.10 [-0.01, 0.21]	0.66 [0.64, 0.68]	$2.41 [2.34, 2.48]
2. USDA Prime only	$5.62 [5.37, 5.87]	$4.68 [4.47, 4.88]	$4.31 [4.11, 4.52]	$1.30 [1.13, 1.48]	0.62 [0.60, 0.64]	$2.37 [2.30, 2.45]
3. All 3 USDA labels	$5.76 [5.48, 6.05]	$5.33 [5.06, 5.59]	$5.54 [5.26, 5.81]	$0.23 [0.13, 0.32]	0.71 [0.69, 0.72]	$2.59 [2.52, 2.65]
4. NPB Prime only	$5.87 [5.60, 6.14]	$4.97 [4.74, 5.19]	$4.74 [4.52, 4.96]	$1.13 [0.99, 1.28]	0.70 [0.68, 0.71]	$2.65 [2.59, 2.72]
5. All 3 NPB labels	$5.39 [5.15, 5.63]	$4.99 [4.77, 5.21]	$4.88 [4.67, 5.1]	$0.51 [0.39, 0.62]	0.66 [0.64, 0.68]	$2.46 [2.40, 2.53]
6. All 3 USDA labels + steak label	$5.38 [5.15, 5.62]	$4.80 [4.60, 5.00]	$4.68 [4.48, 4.88]	$0.70 [0.58, 0.83]	0.65 [0.63, 0.67]	$2.42 [2.36, 2.49]
7. USDA Good, Better, Best	$6.26 [5.90, 6.62]	$5.53 [5.22, 5.84]	$5.34 [5.04, 5.64]	$0.92 [0.77, 1.08]	0.67 [0.65, 0.68]	$2.52 [2.45, 2.58]
8. All 3 USDA labels + info	$5.49 [5.24, 5.75]	$4.36 [4.17, 4.56]	$4.30 [4.10, 4.49]	$1.19 [1.01, 1.37]	0.65 [0.63, 0.66]	$2.46 [2.39, 2.53]
9. USDA Prime + enhanced label	$5.69 [5.42, 5.95]	$4.97 [4.74, 5.19]	$4.31 [4.09, 4.52]	$1.38 [1.19, 1.57]	0.63 [0.61, 0.65]	$2.41 [2.34, 2.48]
10. No labels (how many)	$5.32 [4.91, 5.72]	$5.16 [4.78, 5.55]	$5.10 [4.72, 5.48]	$0.22 [-0.01, 0.44]	0.52 [0.50, 0.54]	$1.94 [1.87, 2.02]
11. All 3 USDA labels (how many)	$9.30 [7.97, 10.63]	$9.04 [7.76, 10.33]	$8.79 [7.55, 10.03]	$0.51 [0.22, 0.8]	0.58 [0.56, 0.59]	$2.15 [2.09, 2.21]

[a] Calculated values are at fixed prices, where it is assumed the high and low quality chops are priced at a 10% premium an discount to the mid-quality chop.

The model results are consistent with the raw data in the Scenario 6 summary. In the absence of a cue in Treatment 1, on average, participants do not differentiate among the three quality levels. The introduction of a single Prime label for the highest quality chop in Treatments 2 and 4 results in a dramatic increase in the WTP for the chop that would carry the highest quality grade. The shift is so dramatic in Treatment 2 that the reduction in WTP for the medium and lower quality chops more than offsets the increase in WTP for the highest quality chop and as a result total revenue is slightly (but not significantly) lower.

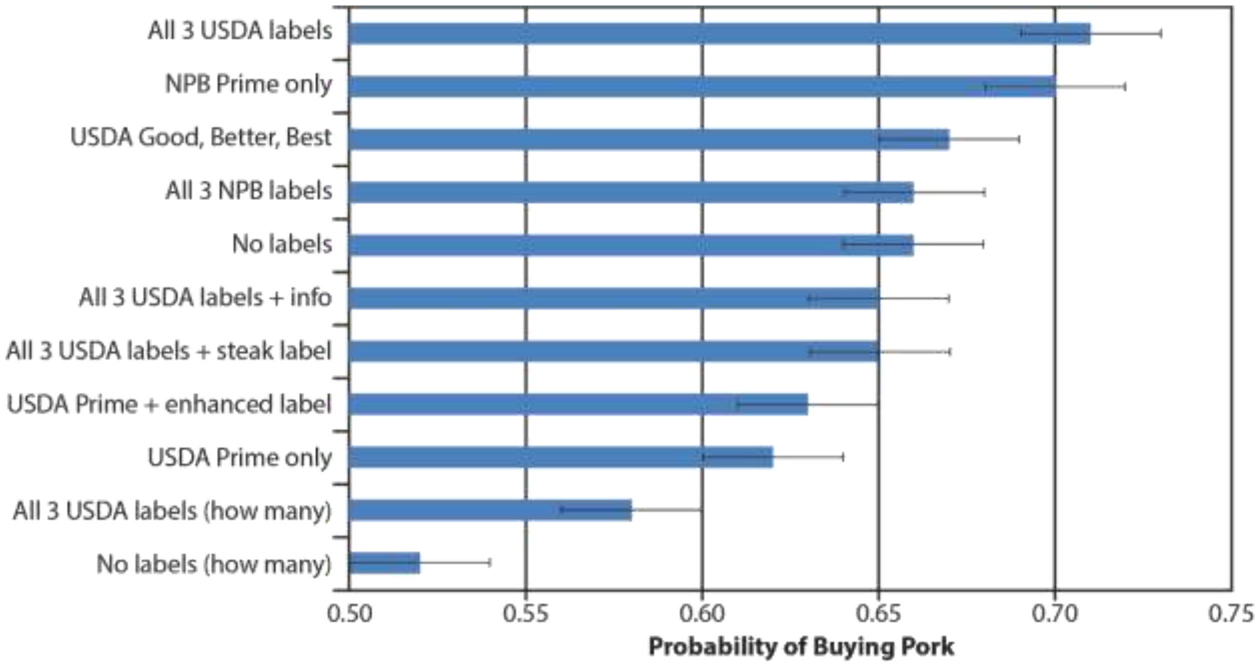
Total revenue increases for the NPB Prime in Treatment 4 and the three USDA labels in Treatment 3 relative to the control situation (Treatment 1). Point estimates of total revenue are also higher for Treatments 5 (all three NPB labels), 7 (USDA Good, Better, Best), and 8 (all three USDA labels plus information) but the increase is not significant.

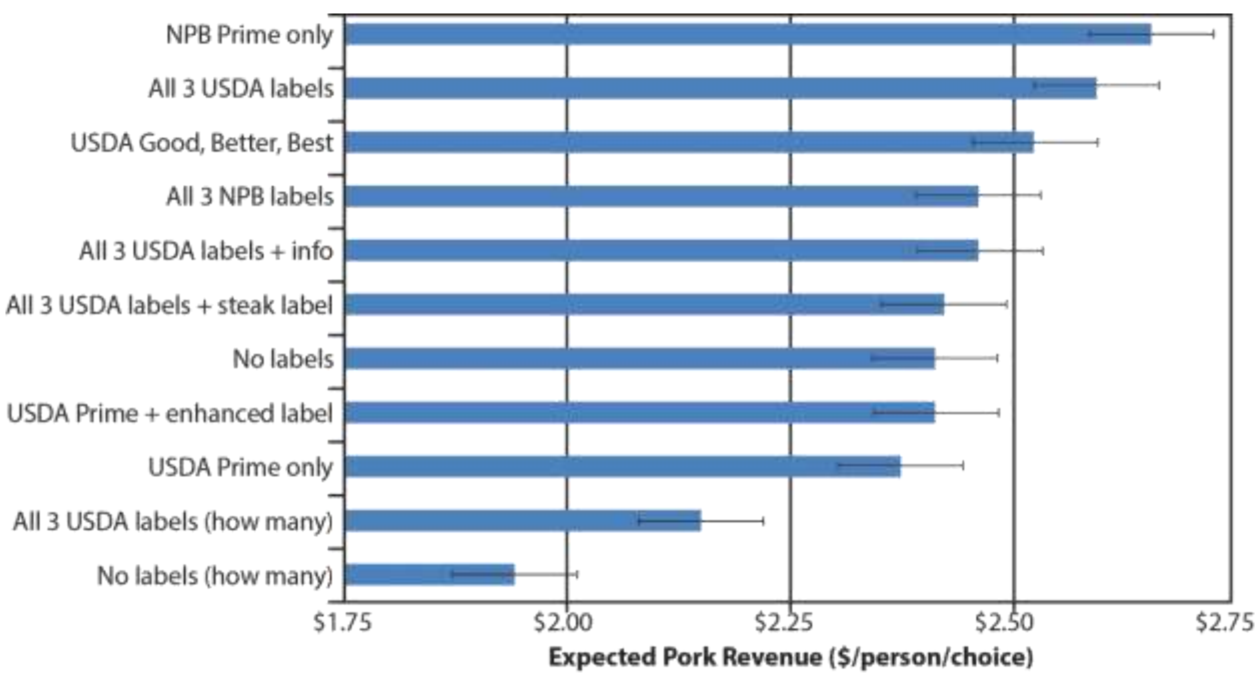
The introduction of quality labels results in large WTP premiums between high and medium as well as between medium and low in almost all cases. One aberration can be seen in Treatment 3 where overall participants either appear to be confused about the terms “Choice” and “Select” or they have mixed opinions. Again, this could also be a result of some participants relying on visual preference cues that prefer the lighter less marbled product and thus not responding to the quality grade labels. The introduction of the term “enhanced” in Treatment 9 results in a low value for the enhanced product and overall revenue in line with Treatment 1.

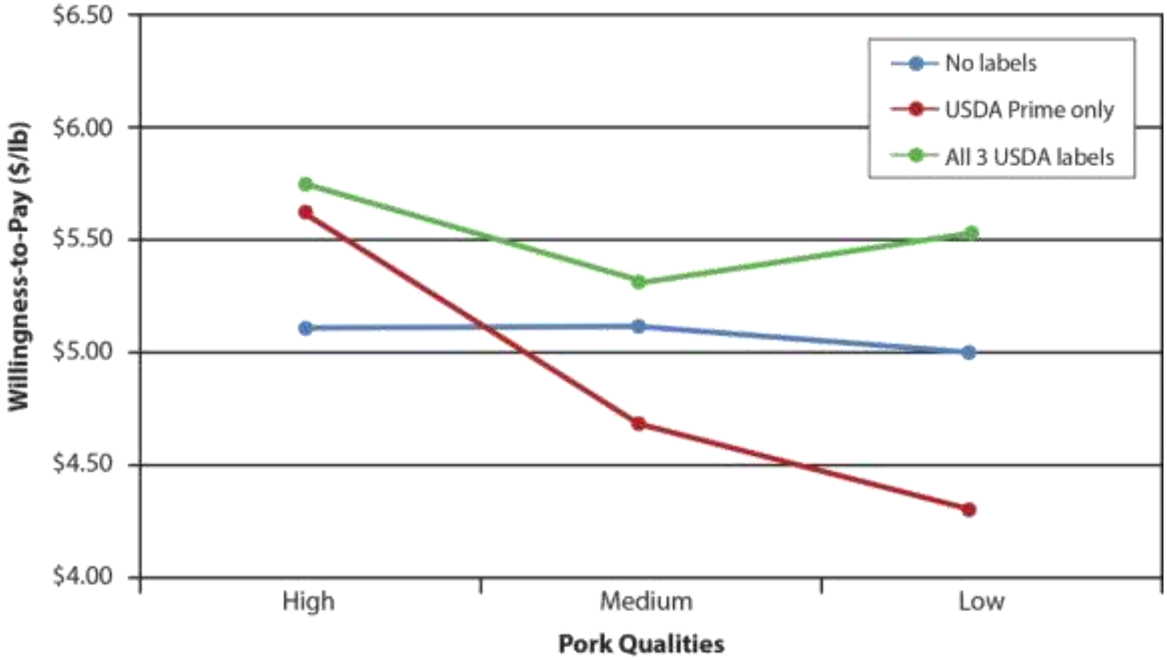
The results suggest that consumers do not currently understand how to use color or marbling to identify quality. Once a label is introduced, they react strongly and are willing to pay a significant premium for a chop where the label suggests better quality. Comparing Treatments 3 and 5 (USDA labels versus Pork Board labels) the results are more favorable towards the USDA labels. But this preference for the USDA label is reversed in Treatments 2 and 4 where a single Prime label is used. These contradictory results preclude us from predicting whether the USDA or Pork Board label would be most effective. The ranking preference results presented in Table 6 suggested more would prefer USDA labels over NPB labels, but the WTP results make this less clear.

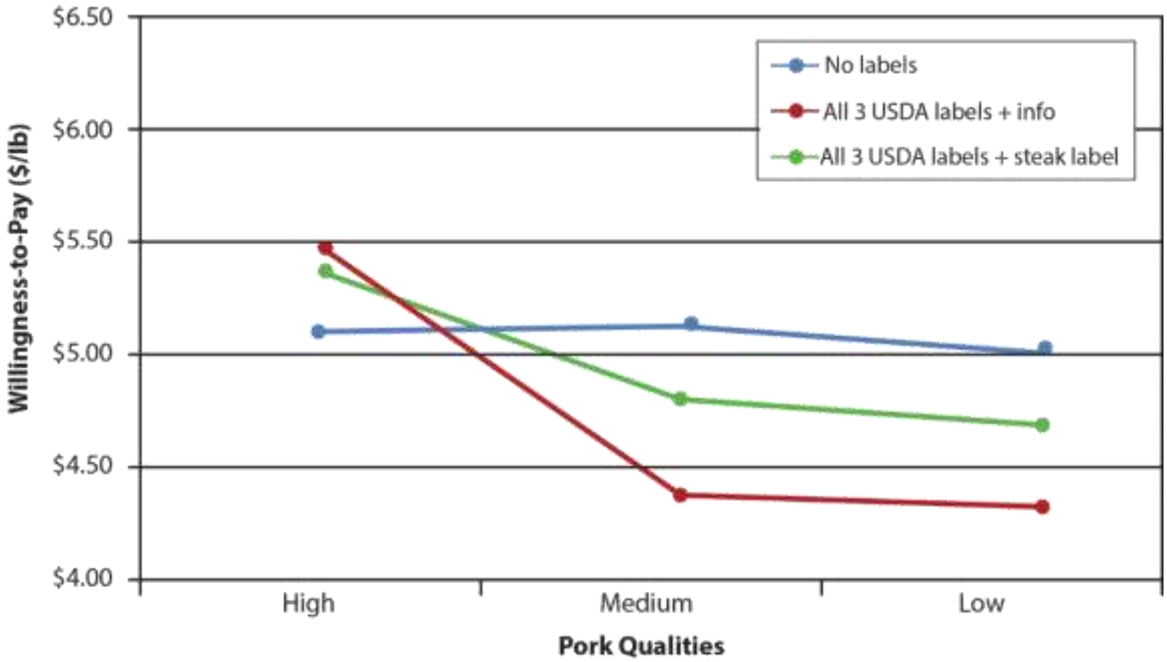
In general, results suggest introduction of pork quality labels along the lines of Treatments 3 or 4, in conjunction with an informational campaign that explained importance and use of these labels would initially support large premiums and an overall increase in pork industry revenue.

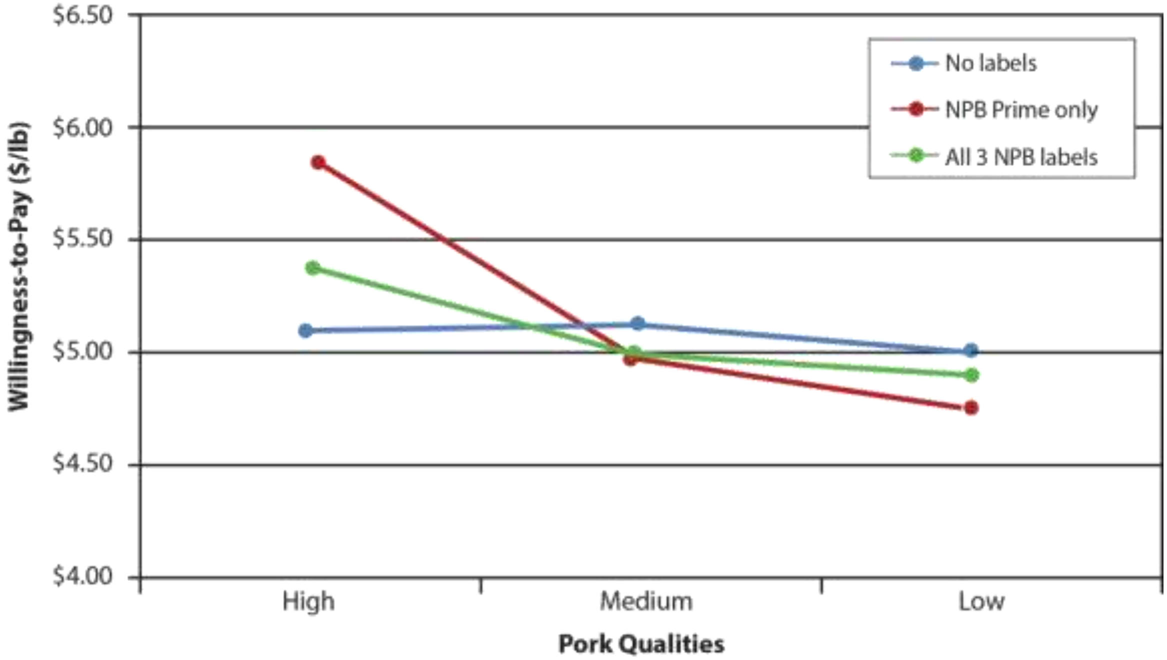
To aide visual comparison across treatments the probability of buying pork, expected revenue, and WTP estimates are provided in the following figures.

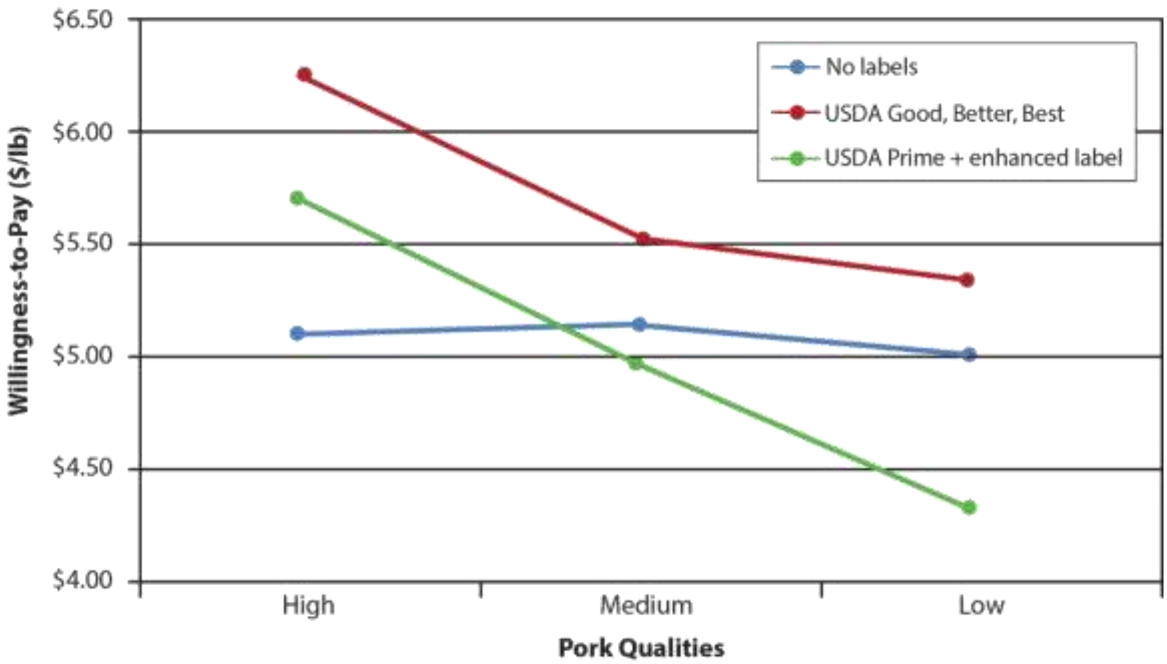

All 3 USDA labels
NPB Prime only
USDA Good, Better, Best
All 3 NPB labels
No labels
All 3 USDA labels + info
All 3 USDA labels + steak label
USDA Prime + enhanced label
USDA Prime only
All 3 USDA labels (how many)
No labels (how many)
0.50
0.55
0.60
0.65
0.70
0.75
Probability of Buying Pork


NPB Prime only
All 3 USDA labels
USDA Good, Better, Best
All 3 NPB labels
All 3 USDA labels + info
All 3 USDA labels + steak label
No labels
USDA Prime + enhanced label
USDA Prime only
All 3 USDA labels (how many)
No labels (how many)
$1.75
$2.00
$2.25
$2.50
$2.75
Expected Pork Revenue ($/person/choice)

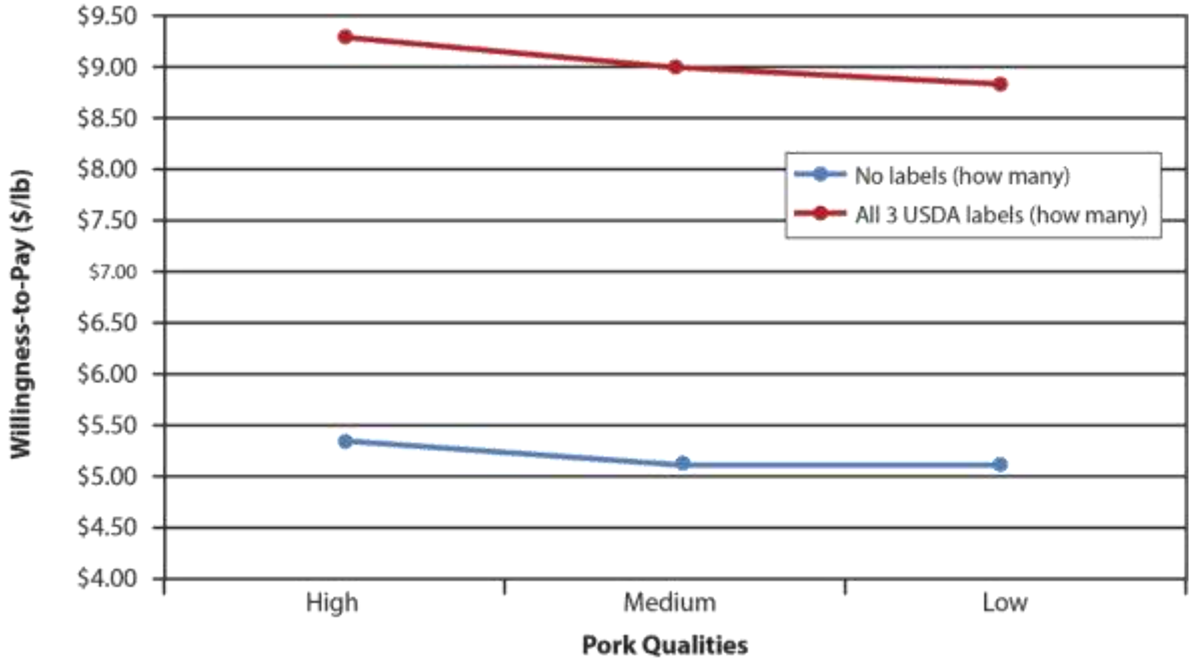

$6.50
$6.00
$5.50
$5.00
$4.50
$4.00
Willingness-to-Pay ($/lb)
No labels
USDA Prime only
All 3 USDA labels
High
Medium
Low
Pork Qualities


$6.50
$6.00
$5.50
$5.00
$4.50
$4.00
Willingness-to-Pay ($/lb)
No labels
All 3 USDA labels + info
All 3 USDA labels + steak label
High
Medium
Low
Pork Qualities


$6.50
$6.00
$5.50
$5.00
$4.50
$4.00
Willingness-to-Pay ($/lb)
No labels
NPB Prime only
All 3 NPB labels
High
Medium
Low
Pork Qualities


$6.50
$6.00
$5.50
$5.00
$4.50
$4.00
Willingness-to-Pay ($/lb)
No labels
USDA Good, Better, Best
USDA Prime + enhanced label
High
Medium
Low
Pork Qualities

The following figure compares WTP estimated using the “how many” approach of treatments 10 and 11 (note the change in scale of the vertical axis to accommodate the higher WTP).



As noted in the Methods and Procedures, the short-run situation where quantities of pork in each quality grade category are fixed initially warrants direct assessment. Presuming 10%, 40%, and 50% of graded pork is initially in the highest, middle, and lowest quality grades, the prices of each quality can be estimated. Furthermore, the expected revenue can be estimated for comparison with earlier calculations presuming quality-specific supplies are less constrained. Table 10 presents these inverse demand estimates assuming fixed quantities (results are weighted by volume of pork chop consumption and omit individuals who missed the trap question).

A key point highlighted by this assessment is the duration of assessment and consideration of relative availability of pork eligible for specific quality grades is critical. Only in one case (Treatment 3) is the expected revenue in the short-run expected to increase relative to the baseline situation (Treatment 1). In other cases, expected revenue is not statistically different (Treatments 4, 5, 7) or is actually significantly lower (Treatments 2, 6, 8, 9) than in the control situation. *This suggests that any economic gains from introducing a pork quality grading system are likely to be longer-run in nature.*

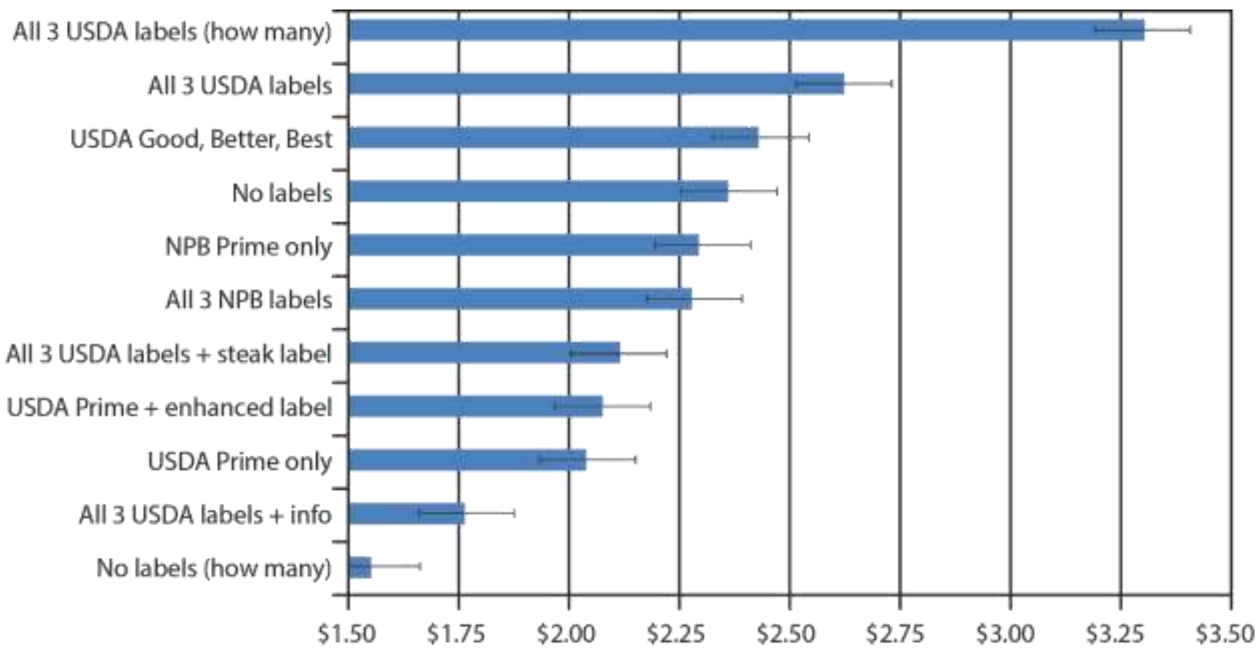
Table 10. Expected Prices and Revenues In Short Run with Fixed Quantities

Treatment	$\widehat{p}_H$ [a]	$\widehat{p}_M$ [a]	$\widehat{p}_L$ [a]	E[Rev] [b]
1. No labels[c]	$4.86 [4.65, 5.08]	$3.67 [3.49, 3.84]	$3.34 [3.16, 3.52]	$2.36 [2.25, 2.47]
2. USDA Prime only	$5.38 [5.15, 5.62]	$3.20 [3.01, 3.38]	$2.63 [2.42, 2.85]	$2.04 [1.92, 2.15]
3. All 3 USDA labels	$5.53 [5.26, 5.8]	$3.86 [3.64, 4.07]	$3.87 [3.66, 4.08]	$2.62 [2.49, 2.75]
4. NPB Prime only	$5.65 [5.39, 5.9]	$3.54 [3.35, 3.73]	$3.12 [2.92, 3.32]	$2.30 [2.19, 2.42]
5. All 3 NPB labels	$5.15 [4.93, 5.38]	$3.50 [3.32, 3.68]	$3.19 [3.00, 3.37]	$2.28 [2.17, 2.39]
6. All 3 USDA labels + steak label	$5.13 [4.92, 5.35]	$3.23 [3.05, 3.4]	$2.89 [2.7, 3.08]	$2.11 [2.01, 2.22]
7. USDA Good, Better, Best	$5.97 [5.64, 6.31]	$3.73 [3.5, 3.97]	$3.30 [3.06, 3.54]	$2.43 [2.29, 2.58]
8. All 3 USDA labels + info	$5.21 [4.98, 5.44]	$2.60 [2.38, 2.82]	$2.30 [2.06, 2.53]	$1.76 [1.64, 1.89]
9. USDA Prime + enhanced label	$5.44 [5.2, 5.69]	$3.42 [3.24, 3.61]	$2.55 [2.32, 2.78]	$2.07 [1.96, 2.19]
10. No labels (how many)	$4.87 [4.51, 5.22]	$2.36 [1.99, 2.73]	$1.92 [1.49, 2.34]	$1.55 [1.33, 1.78]
11. All 3 USDA labels (how many)	$8.68 [7.46, 9.89]	$5.12 [4.45, 5.79]	$4.33 [3.71, 4.96]	$3.30 [2.88, 3.73]

[a]Prices of high, medium, and low quality chops required to obtain a fixed quantity (or market share) for high, medium, and low quality pork.

[b]Calculated values are at fixed quantities, where it is assumed the high, medium and low quality chops have overall market shares of 0.065, 0.26, and 0.325.

[c]Without labels, it would likely be difficult to charge different prices for different chops. Assuming all three chops are priced identically at $3.75 in the "no label" treatment would produce market shares of 0.22, 0.23, and 0.20 for high, medium, and low (for an overall pork share of 0.65), which would yield an expected revenue of $2.43 [2.36, 2.50].



So far, this analysis has outlined findings of CE models estimated presuming U.S. consumers are homogeneous in their preferences. Given concerns with some consumers preferring paler, less marbled pork chops (Tonsor and Schroeder, 2013) and related findings in this survey's base perception and preference questions, it is important to directly assess preference heterogeneity. Latent class logit models (LCM) were estimated to examine (a) the existence of preference heterogeneity, (b) the magnitude of divergence in preferences across groups, and (c) the relative size of groups preferring pork chops deemed lower quality in the 3-level grading system being considered. In short, LCMs identify the number of heterogeneous classes (or segments) where consumers within a given class are presumed to have homogeneous preferences.

Likelihood ratio tests regularly reject the assumption of preference homogeneity indicating a better in-sample fit of LCMs than MNL models. Rather than show results for every treatment, we use the findings from above to highlight a few key Treatments (1, 3, 6, and 7) worthy of additional focused assessment of heterogeneity. In each case, three class models are used to reflect the situation of one class "correctly" preferring chops that would carry the higher quality grade, a second class with reversed pork preferences, and a third class where all meat and price parameters are set at zero. Table 11 provides estimates of these models.

Table 11. Three-Class Latent Class Models for Selected Treatments

	Class 1 Prefer Lighter Color		Class 2[a] Prefer Darker Color
Treatment 1 – No labels			
WTP_H	\$5.27		\$7.92
WTP_M	\$5.61		\$7.86
WTP_L	\$6.59		\$6.59
WTP_H- WTP_L	-\$1.31		\$1.33
Prob[pork][b]	0.72		0.78
E[Rev][b]	\$2.46		\$2.99
Class probability[c]	0.28		0.45
Conditional Class probability[c]	0.39		0.61
Overall Prob[pork][b]		0.76	
Overall E[Rev][b]		\$2.78	
Treatment 3 – All 3 USDA labels			
WTP_H	\$5.01		\$6.86
WTP_M	\$5.26		\$6.37
WTP_L	\$6.60		\$5.40
WTP_H- WTP_L	-\$1.58		\$1.46
Prob[pork][b]	0.81		0.77
E[Rev][b]	\$2.76		\$2.97
Class probability[c]	0.30		0.50
Conditional Class probability[c]	0.38		0.62
Overall Prob[pork][b]		0.78	
Overall E[Rev][b]		\$2.89	
Treatment 6 – All 3 USDA labels + steak label			
WTP_H	\$4.61		\$6.14
WTP_M	\$5.73		\$4.89
WTP_L	\$5.79		\$4.04
WTP_H- WTP_L	-\$1.18		\$2.10
Prob[pork][b]	0.77		0.76
E[Rev][b]	\$2.71		\$3.04
Class probability[c]	0.34		0.41
Conditional Class probability[c]	0.45		0.55
Overall Prob[pork][b]		0.77	
Overall E[Rev][b]		\$2.89	

Table 11. Continued

Treatment 7 – USDA Good, Better, Best			
WTP_H	\$6.19		\$5.01
WTP_M	\$6.40		\$3.85
WTP_L	\$6.50		\$2.30
WTP_H- WTP_L	-\$0.31		\$2.71
Prob[pork][b]	0.73		0.78
E[Rev][b]	\$2.60		\$3.15
Class probability[c]	0.40		0.28
Conditional Class probability[c]	0.58		0.42
Overall Prob[pork][b]		0.75	
Overall E[Rev][b]		\$2.83	

[a]The model also has a third class in which all parameters all restricted to equal zero—this segment corresponds to random responses.

[b] Calculated values are at fixed prices where it is assumed the high and low quality chops are priced at a 10% premium and discount to the mid-quality chop.

[c] Overall class probabilities to not sum to one because of the third class (with all parameters restricted to zero); the conditional probabilities sum to one and are calculated as the share of all non-random responses.

Across treatments, a clear and key finding is that a sizeable (at least 28%) segment of consumers reveal a preference for the lower quality pork chops. Going further to compare preferences of class 1 (preferring chops that would carry the lower quality labels) with class 2 (preferring chops that would possess higher quality labels), we observe expected revenue to be larger for class 2. This assessment of preference heterogeneity highlights the key importance of better understanding of which consumers are most likely to be in class 2 as target markets for any implemented pork quality grade labeling system. Equally important is better understanding the underlying knowledge and preference set of class 1 consumers to mitigate any adverse impacts that may be involved in rolling out a labeling system that conveys information that clashes with their current preferences. These issues warrant focused additional assessment given aggregate economic impact implications of implementing any pork quality grading and labeling system.

Discussion

Consumers find pork chops tasty. Survey respondents ranked pork chops tastier than beef steaks and chicken breasts. Taste was ranked as the most important product attribute to consumers among 13 options when they consider whether to buy pork chops. More than 75% of consumers indicated that they had increased pork chop consumption over the last five years for a variety of reasons. *These are promising results as they indicate pork chops are a product consumers want, they find them tasty, taste is what matters most, and they indicate they are purchasing more regularly. As such, momentum is present to capitalize further on this popular product.*

Pork color is an important factor consumers use to gauge fresh pork chop quality. About 60% of respondents indicated pork chop color and the store where they purchase from were used to assess likelihood the product would be flavorful, juicy, and tender. Only about a third used marbling as part of this assessment. *Pork color is a worthwhile attribute to focus attention on because it is an important signal influencing consumer expectations about quality. However, since a notable percentage of consumers (we estimate around 30%–40%) perceive lighter, lower quality pork chops to be of higher* *quality, an opportunity is present for consumer pork-color quality education to better align consumer perceptions with product quality—quality labeling is one possible strategy.*

The choice experiment data analysis suggests that a USDA grade using Prime, Choice, and Select labels (Treatment 3) would be most likely to increase expected pork revenue and the probability of purchasing pork. This is the strategy we recommend NPB pursue. However, additional important opportunities are present within this strategy. *Foremost is that even with quality labels on the pork chops, some 20%–30% of consumers preferred lower quality than Prime, even when the three quality products were priced the same.* Such consumers either do not understand the quality grade rankings of Prime, Choice, and Select (though results were similar for Best, Better, Good, which should be less prone to confusion), or this group of consumers were ignoring the quality grade labels and relying on product color to influence their choices.

Direct examination of preference heterogeneity suggests that if a USDA approach using Prime, Choice, and Select labels were implemented, a segment representing about 38% of pork purchasers may initially have perceptions or preferences not well aligned with the new quality labeling scheme. This is consistent with past work (and responses to several survey questions in this project) noting a sizeable segment of the population currently prefers paler, less marbled pork chops. This suggests net economic gains from those consumers recognizing and valuing pork chops quality labeling would have to be large enough to offset any adverse impacts on other consumers. Furthermore, this highlights a substantive opportunity for NPB if pork grading were implemented to potentially bring a significant portion of pork consumers to recognize the higher quality pork chops which could increase demand for pork chops.

When quality information on competing meats (USDA Choice on beef steaks in Treatment 6) was included, estimated revenue gains relative to the control baseline were not different. This is important given beef steaks carry quality grades already. However, we did not conduct scenarios where pork chops had no grading labels and beef had a Prime, Choice, or Select label so we do not know how pork revenue would fare under such scenarios relative to Treatment 3.

In the short-run when higher pork quality items have a relatively fixed availability, a USDA grade approach using Prime, Choice, and Select labels actually reduces expected pork revenue relative to no labeling. This suggests net economic gains from instituting a pork chop grading system would likely be realized over a longer-period of time.

Combining findings of this study with recognition that any system will also have implementation costs that must be considered. While we would be cautious in proceeding with implementing a pork quality grading system at this time, there is demand for it among an important segment of consumers and substantial educational/information sharing opportunities regarding quality for a significant portion of consumers. A final point to consider is that this study focused on consumer preferences relative to a pork quality labeling system. Likely a pork quality grading system would be used by food service and branded products to source desired pork quality. Such use could drive larger premiums for high quality product and larger discounts for lower quality product than what is revealed in consumer WTP studies.