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Impact of Hormone Use Perceptions on Consumer Meat Preferences

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U.S. consumers see retail beef products with "no added hormones" (NAH) labels. However, similar labels appear on pork and chicken products, even though hormone use in their production is prohibited. This study assesses consumer perceptions of hormone use in different livestock species. Using choice experiment data, we then examine the impact of these perceptions on preferences for unlabeled meat products and willingness to pay for NAH-labeled meat products. Results suggest that consumer perceptions of hormone use in production are incorrect. Further, perceptions influence consumer preferences and willingness to pay for unlabeled products versus those with NAH labels.

Key words: food labeling, meat demand, willingness to pay

Introduction

The U.S. Department of Agriculture (2013) estimates that more than 90% of U.S. feedlot cattle are injected with hormones to improve growth rates and feed efficiency.[1] However, federal regulations do not allow hormone use in poultry (chickens, turkeys, ducks) or pork production (U.S. Department of Agriculture, 2015).[2] Given the prevalence of media attention regarding hormone use in meat animals (e.g., Organic Consumers Association, 2007; Storrs, 2011), consumers may perceive hormone use to be high across all meat animal species. Consumers may also be uninformed or skeptical regarding regulations, prevalence, or safety of chemical technologies in food production (Hayes et al., 1995). While growth-promoting hormones are used extensively in beef production, research indicates that such use does not pose a risk to human beings or to the environment (e.g., Jeong et al., 2010; Capper and Hayes, 2012; Payne, 2012; U.S. Food & Drug Administration, 2015). Despite these research findings and U.S. Food & Drug Administration (FDA) approval, many consumers still express concerns about the impacts of hormone use in meat animals (Rimal et al., 2001; Brewer and Rojas, 2008; Tonsor et al., 2009; Lusk, Schroeder, and Tonsor, 2014).

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[1] Six kinds of steroid hormones are currently approved by the U.S. Food & Drug Administration (FDA) for use in beef production: estradiol, progesterone, testosterone, zeranol, trenbolone acetate, and melengestrol acetate (U.S. Food & Drug Administration, 2015).

[2] Nonhormone growth promotants are used in poultry and swine production. Beta-agonists (e.g., ractopamine) are widely used in swine to enhance lean muscle gain and feed conversion. These promotants work at a cellular level without affecting an animal's hormone levels (Dilger, 2015). An estimated 60% to 80% of U.S. feedlot cattle received beta-agonists, such as ractopamine and zilpaterol hydrochloride, in 2013 (Micik, 2013). Zilpaterol was pulled from the market in 2013 to further examine its impact on animal welfare, but other beta-agonists are still in use.

While food labels can inform consumer choice, they may also create further uncertainty and influence beliefs about the quality or claim status of unlabeled products (Dannenberg, Scatasta, and Sturm, 2011). In the case of meat, consumers observe selected retail beef products labeled as produced with no added hormones (NAH). Although no added hormones are used in pork and poultry production, consumers may also see similar labels on pork and poultry products in the retail meat case. This may mislead consumers to believe that hormones may also be used in pork and poultry production, though the NAH claim is actually valid for both labeled and unlabeled product in these species.

What percentage of beef, pork and poultry meat animals do consumers perceive to be treated with hormones? Does consumer perception of hormone use rates affect demand or willingness to pay for beef, pork, or chicken products? These questions are of interest to meat producers, consumers and policy makers. This study provides important information for policy makers to consider when regulating labels that may lead to inaccurate product perceptions. Poultry and pork producers who market products using "no added hormones" (NAH) labels may be unaware of the externality imposed on the sector as a whole if overall demand is dampened by consumer perceptions of nonzero hormone use. While NAH label claims on poultry and pork products may increase sales for some market participants, the disparity in labeling is likely not an efficient way to grow demand for the sector as a whole in the long run.

Consumer beliefs regarding the extent of hormone use in different livestock species can impact consumer choice for various meat products. Since consumer beliefs affect choice,[3] Lusk, Schroeder, and Tonsor (2014) suggest willingness to pay (WTP) can be better understood by distinguishing beliefs from preferences in food choice. Econometric approaches that do not account for differences in beliefs or perceptions across individuals may also yield misleading estimates of welfare changes (Marette, Roe, and Teisl, 2012). This previous research suggests that including consumers' perceptions of hormone use rates across different livestock species in consumer utility models should result in improved WTP estimates for meat products.

This paper identifies the impact of consumer perceptions of hormone use rates in meat animal production on consumer preferences for meat products. Specifically, we measure consumer perceptions of hormone use rates in meat animal production for beef, pork and chicken. We estimate and compare a conditional logit model under three specifications to assess whether consumer perceptions of hormone use rates affect choices for unlabeled meat products. Finally, we analyze the effect of perceived rates of hormone use on stated WTP premiums for NAH-labeled meat products using different specifications of a Tobit model.

Background

Economists have conducted many studies about the impact of hormone use in fed cattle production on beef demand. Lusk, Roosen, and Fox (2003) found that French consumers value ribeye steaks from nonhormone-treated cattle (NHTC) more highly than U.S consumers do, while valuations of NHTC ribeyes for consumers from Germany, the United Kingdom, and the United States were not statistically different. Platter et al. (2003) reported that consumer ratings of beef palatability are affected by the use of hormonal implants on cattle. They found that steaks from nonimplanted steers were rated as more desirable for overall eating quality than steaks from implanted steers. Capper and Hayes (2012) quantified that withdrawing growth-enhancing technologies (GET), including hormone implants, from the U.S. beef production system would reduce both the economic and environmental sustainability of the industry. The common thread among these studies is the focus

[3] The words "perception" and "belief" regarding hormone use are equivalent in this article. Specifically, these phrases in the context of hormone use in livestock production refer to the consumer's belief about the specific percentage of meat animals within the species that are administered hormone treatments during the production phase. The phrases are not intended to capture how the consumer feels about hormone use but rather to measure their belief about the extent of hormone use in meat production.

on beef, which is not unexpected, since growth hormones are not used in U.S. pork and poultry production. Implicitly, previous meat demand research has presumed that consumer knowledge of hormone use in meat animals is accurate. As such, previous studies regarding U.S. consumer preferences for NAH products have been limited to beef. An exception is Heng, Peterson, and Li (2016), who found that survey respondents were willing to pay a premium for many attribute labels in eggs, including hormone-free, even though growth hormones are not used in egg production. This suggests that differences between consumer perceptions of hormone use in production and actual use in production may impact WTP for NAH-labeled pork or chicken products. To date, the accuracy of consumer perceptions regarding the prevalence of hormone use in cattle, hogs, and chicken production has not been examined.

Many studies elicit consumer WTP for various beef products and for health and environmental outcomes (Adamowicz, 2004; Dannenberg, 2009; Grunert et al., 2009; Lagerkvist and Hess, 2011). However, this large body of applied work often does not explicitly separate WTP estimates into components attributable to consumer beliefs or perceptions and preferences for product attributes. Most WTP studies are constructed such that attributes are assumed to be known with certainty and beliefs across people are the same. However, Lusk (2011) illustrated that a consumer's purchase behavior for organic milk and eggs is impacted by the degree of importance they place on certain food values as measured by Lusk and Briggeman's (2009) food values scale.[4] Similarly, Malone and Lusk (2018) found that differences in perceived taste substantially affects consumer brand choice in beer.

Studies that examine the impact of consumer perceptions on preferences and behavior are prevalent in consumer behavior literature. Harper and Makatouni (2002) examined consumer perceptions of organic food production using focus groups. "Perception" in their study related to consumers' understanding of the definition of organic food, including whether organic food contained pesticides, hormones, and genetic modified (GM) ingredients. Lee and Yun (2015) investigated how consumers' perceptions of organic food attributes influence intentions to purchase organic products. Our study presumes that consumers' stated perceptions of hormone use rates in meat animal production also reflect consumers' attribute uncertainty with respect to hormone use for unlabeled meat products. This attribute uncertainty ultimately represents the likelihood that an unlabeled product was produced with added hormones.

Data and Methods

Data were collected through Oklahoma State University's monthly Food Demand Survey (FooDS) in May 2016. The Food Demand Survey is an online survey conducted by Oklahoma State University using Qualtrics and Survey Sampling International (SSI) (Lusk, 2017b). The requisite sample of at least 1,000 consumers is weighted to reflect the U.S. population in terms of age, gender, education, and region of residence.[5] Consumers receive an email invitation and opt in to the survey panel. They receive points worth approximately $1.50, which can be accumulated and redeemed for various goods or for cash. The monthly survey contains a standard set of questions regarding consumer preferences and WTP for a set of meat products, including choice questions as well as questions designed to gauge the degree of consumer concerns on various topics. In addition, standard questions about subjects' demographic information are asked, including farm experience, age, household income, education level, regions, and presence of children in the household. A total of 1,023 consumers responded to the May 2016 survey, yielding a 3% sampling error with a 95% confidence interval for dichotomous choice questions.

[4] Lusk and Briggeman (2009) developed a Food Values Scale that measures core underlying values that may motivate consumer decisions, including naturalness, taste, price, safety, convenience, nutrition, tradition, origin, fairness, appearance, and environmental impact.

[5] Regional definitions are consistent with those of the U.S. Bureau of Economic Analysis.

Figure 1. Example of Choice Questions

Table 1. Food Products and Price Level ($/lb) Used in Choice Experiment

Food Item	Price Level ($/lb)	Food Item	Price Level ($/lb)
Beef hamburger	2.00	Chicken breast	1.75
	3.50		3.25
	5.00		4.75
Beef steak	5.00	Chicken wing	0.75
	6.50		1.75
	8.00		3.25
Pork chop	2.25	Beans and rice	0.50
	3.75		2.00
	5.25		3.50
Pork deli ham	1.15	Pasta	2.50
	2.65		4.00
	4.15		5.50

In the standard monthly FooDS survey, respondents participate in a choice experiment in which the choice set contained nine discrete choices. In each choice (see example in Figure 1), subjects choose from eight types of food products: beef hamburger, beef steak, pork chop, pork deli ham, chicken breast, chicken wings, beans and rice, and pasta and red sauce. A "no purchase" option is also included as a ninth choice in each question. Respondents answer nine choice questions, each identical to that in Figure 1, except that prices for each of the eight food products vary across the nine questions, as shown in Table 1. Respondents are randomly assigned to one of three question blocks from an orthogonal fractional factorial design. Questions specific to this study were appended to the standard monthly survey.

Perceived Rates of Hormone Use

In addition to the standard choice experiment questions, subjects were asked to indicate their perception of the prevalence of hormone use in beef cattle, pigs, and broiler chickens by choosing a percentage along a scale from 0% to 100%, indicating what they believe best represents the percentage of meat animals in that species treated with hormones during the production cycle (Figure 2). The percentage chosen for each meat animal species represents the individual consumer's perception of hormone use rates for that species and measures the extent to which the consumer believes that hormones are used in meat animal production for that species. Standard *t*-tests are used to examine whether consumer perception of hormone use rates in meat production across cattle, hogs, and chicken differ from actual use in production. Since hormone use perceptions in

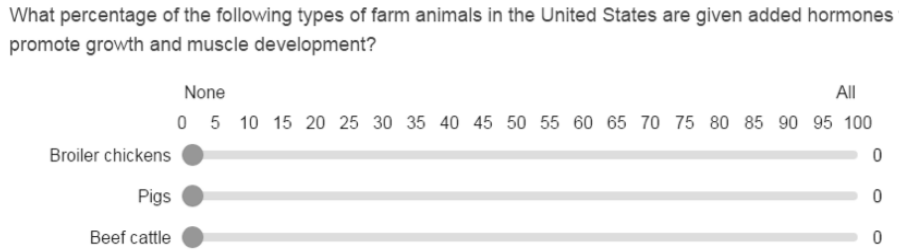

Figure 2. Survey Question about Perceived Hormone Use

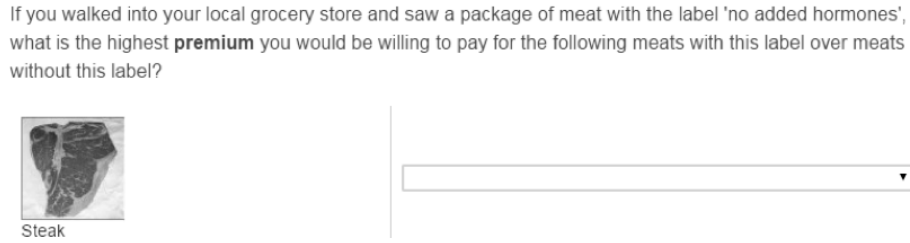

Figure 3. Sample Willingness-to-Pay Question for "No Added Hormones" Labeled Meat Products.

Notes: Possible premiums range from $0/lb to $5/lb.

all livestock species may be affected by some common factors, we also examine the extent to which an individual's perceptions of hormone use rates are correlated across species. This employs the simple linear regression

$$B_{ij} = \alpha_0 + \alpha_k B_{ik} + \alpha_g B_{ig} + \mu_{ij}, \tag{1}$$

where B_{ij} is subject i's perceived rate of hormone use in livestock species j, k and g are other livestock species, and μ_{ij} is a normally distributed error term.

Stated WTP premiums were solicited for NAH-labeled meat products in the survey. Possible premiums were based on previous surveys and ranged from $0/lb to $5./lb (see the example question presented in Figure 3). Each respondent was asked to state a WTP premium for the NAH label on each of six meat products, including beef hamburger, beef steak, pork chop, pork deli ham, chicken breast, and chicken wings. While we recognize that solicitation of stated WTP may be subject to hypothetical bias resulting in overstated values (see Loomis, 2011), it provides a useful tool for comparison of behavioral choices across groups. Food studies on WTP (Yiridoe, Bonti-Ankomah, and Martin, 2005; Norwood and Lusk, 2011) often use choice experiments to calculate premiums based solely on food attributes. Those premiums can be affected by many factors, including consumer demographics as well as beliefs regarding the attributes and demographics. In the case of hormone use, WTP premiums for NAH labels may be influenced by the perceived cost of giving up hormone use in production or by the consumer's trust in the enforcement of hormone-free production, in addition to the individual consumer's preference for hormone use in production. Thus, we ask a WTP premium for NAH labels rather than for the NAH attribute.

Alternative Specifications of Expected Utility

The choice experiment data are analyzed using expected utility models under three specifications, which differ in how utility derived from the presence or absence of hormone use in production is incorporated into the model. The perceived likelihood of purchasing a meat product produced using added hormones is equivalent to the consumer's perceived hormone use rate, B_{ij}, and is the subjective probability of that outcome. It is true that B_{ij} may include noise. For some consumers, it

may be difficult to separate belief about the prevalence of hormone use in meat animal production from aversion to potential hormone residues. It is also possible that a strong preference for a specific product type could skew the consumer's perception of hormone use rates as they endogenously update their beliefs to rationalize choices. Such behavior could over- or under-state the resulting WTP estimates. While B_{ij} is not immune to potential measurement error, it is a reasonable proxy for the consumer's subjective probability of procuring an unlabeled meat product that has been obtained from meat animals treated with added hormones during the production phase. In specification 1, the impact of hormone use rate perceptions and preferences on utility are implicit in model parameters but are not explicitly included. Specification 2 explicitly incorporates consumer hormone use rate perceptions but assumes that consumer preference for NAH products is stable across species and thus across products. Finally, specification 3 unrestricts consumer preferences to allow relative preference for NAH products to vary across products.

Specification 1

The random utility model from McFadden (1974) represents the consumer's expected utility simplistically as

$$EU_{ij} = \gamma_j - \alpha Price_{ij}, \tag{2}$$

where EU_{ij} is subject i's expected utility from product j, γ_j is the fixed effect of product j which implicitly incorporates beliefs about hormone use in food product j, and $Price_{ij}$ is the price of product j chosen by consumer i.[6]

Specification 2

The subjective expected utility model (SEU) by Savage (1954) is the standard model employed to determine how consumers assess the desirability of a choice. In the SEU model, individual i evaluates prospect j as follows:

$$EU_{ij} = \sum_{k=1}^{K} p_{ijk} U\left(x_k\right), \tag{3}$$

where p_{ijk} is the probability of individual i receiving attribute x_k from option j and is a utility function that describes the desirability of attaining attributes. Attribute x_k can denote a dollar amount, a variable indicating the presence/absence of a discrete attribute (e.g., organic or hormone free), or a continuous quantity of some attribute (e.g., fat or sodium content). Although most WTP studies are constructed such that attributes are assumed to be known with certainty, uncertainty is prevalent in the real world. In most real-world applications, the probabilities, p_{ijk}, are typically subjective and individual specific.

In the SEU framework, the consumer's expected utility from a product has two components: (i) the desire to obtain the attributes provided by the product, given by $U(x_k)$ in equation (3); and (ii) the consumer's subjective beliefs that the product will actually deliver the attribute, given by p_{ijk} in equation (3). In choice data analyses, a choice of option A over option B reveals that $SEU_{iA} > SEU_{iB}$.

This concept can be incorporated into the random expected utility model used to identify relative preferences for hormone added meat products over NAH meat products, resulting in

$$EU_{ij} = \gamma_j + B_{ij} UH - \alpha Price_{ij}, \tag{4}$$

[6] The complete random utility model is $EU_i = \sum_{j=1}^{8} \gamma_j I_{ij} - \alpha Price_{ij}$, where EU_i is subject i's expected utility from each choice question and I_{ij} is an indicator for different meat products. Since subjects can only choose one option, the first right-side term collapses to γ_j and the complete model can be presented as equation (2). Similarly, the first right-side terms in the full representation of the random expected utility model and modified random expected utility model also collapse to γ_j, as presented in equations (4) and (5).

where B_{ij} is subject i's belief that product j is hormone added and UH is the relative preference for hormone-added product over NAH product. Here, consumer i's perception of hormone use rate in the species source of product j also represents the likelihood that an unlabeled product was produced using added hormones in the production process, where B_{ij} is a continuous variable ranging from 0 to 1. In this case, it is this consumer perception of hormone use rates in meat animal production that is subjective and individual specific. The preference for NAH, UNH, has implicitly been normalized to 0. As a result, in the context of this study, UH represents the difference in utilities for meat products where hormones are used in the production process and meat products where no added hormones are used. UH is the same across products and is expected, though not restricted, to be nonpositive. This allows the relative contributions of added hormones to be isolated from the overall preference for product j.

Specification 3

An additional consideration is that consumers' relative preference for NAH meat products may vary across products. That is, UH—the level of utility derived from the NAH attribute—may be dependent on the product j. The random expected utility model then becomes

$$EU_{ij} = \gamma_j + B_{ij}UH_j - \alpha Price_{ij}, \tag{5}$$

where UH_j is relative preference for hormone-added product j over NAH product j and other variables are as previously defined. This modification unrestricts the model to allow relative preferences for hormone added meat products to differ from each other. The -2 log-Likelihood and Aikake information criterion (AIC) model selection criteria are both used to test whether random expected utility models incorporating consumer perceptions of hormone use rates (equations 4 and 5) fit the data better than the conventional model (equation 2).

Stated Willingness-to-Pay Analysis

Since WTP is a censored dependent variable, we used a Tobit model to analyze the marginal effects on stated WTP for NAH-labeled meat products from product type, perceived hormone use rate, and sociodemographic variables (Wooldridge, 2002). The likelihood function of the Tobit model can be represented as

$$L(\boldsymbol{\beta},\sigma) = \prod_{WTP_i>0}\left[\left(2\pi\sigma^2(z_i\eta)\right)^{\frac{-1}{2}}\exp\left(\frac{-1}{2\sigma^2(z_i\eta)}\left(WTP_i - \boldsymbol{x_i}'\boldsymbol{\beta}\right)^2\right)\right]\prod_{WTP_i=0}\left[1-\Phi\left(\frac{\boldsymbol{x_i}'\boldsymbol{\beta}}{\sigma^2(z_i\eta)}\right)\right], \tag{6}$$

where, in our case, WTP_i is the dependent variable, $\boldsymbol{x_i}$ is the vector of explanatory variables, z_i contains explanatory variables that affect the variance, Φ is the normal cumulative distribution function (CDF), and

$$\boldsymbol{x_i}'\boldsymbol{\beta} = f(\textit{Perceived hormone use rate, meat product type, sociodemographic factors}). \tag{7}$$

The effects of explanatory variables on the observed variable are explained by the marginal effects computed as

$$\begin{aligned}\frac{\partial \mathrm{E}(WTP|x)}{\partial x} &= \mathrm{Prob}(WTP>0)\frac{\partial \mathrm{E}(WTP|x,WTP>0)}{\partial x} \\ &+ \mathrm{E}(WTP|x,WTP>0)\frac{\partial \mathrm{Prob}(WTP>0)}{\partial x}\end{aligned} \tag{8}$$

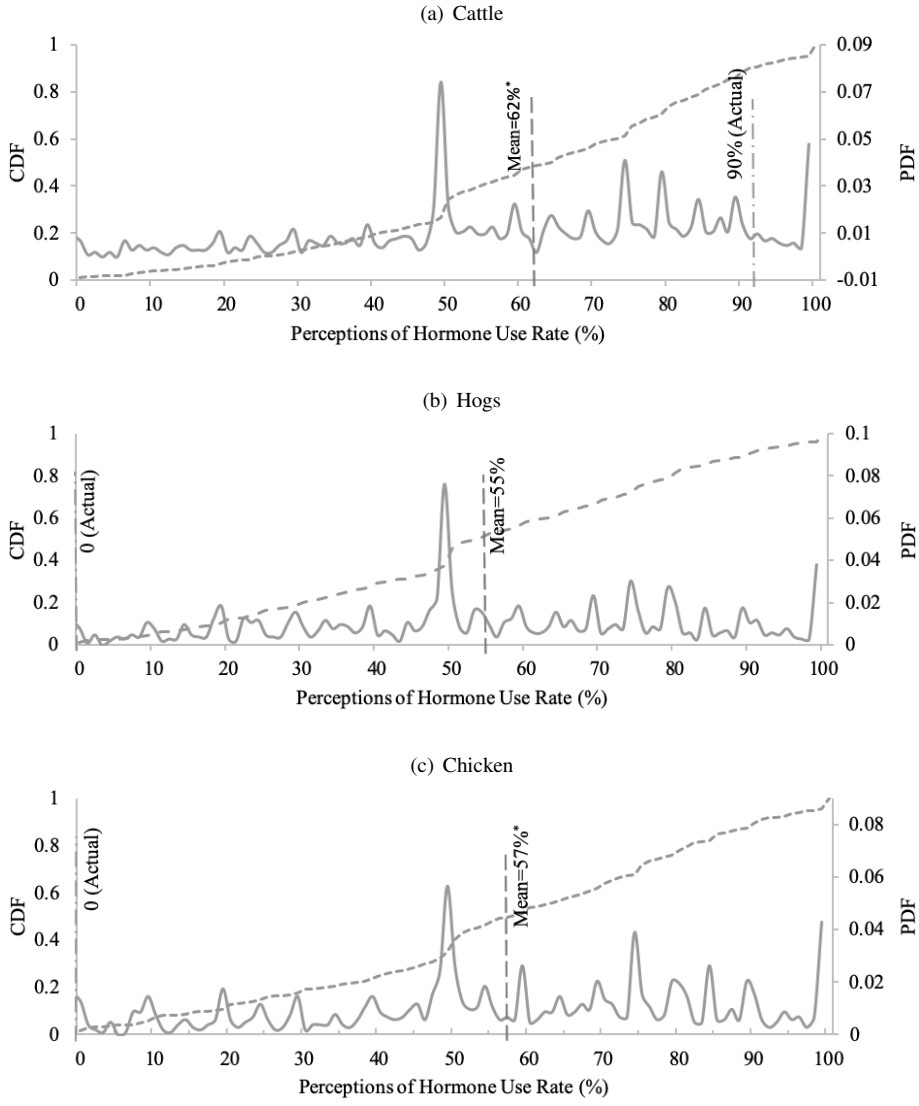

Figure 4. Distribution of Consumer Perceptions of Hormone Use Rate in Cattle, Hogs, and Chicken

Notes: Single asterisk (*) denotes statistical significance at 1% level. Dashed lines indicate the cumulative distribution functions (CDF) of consumer perceptions of hormone use rate. Solid lines indicate the probability density functions (PDF) of consumer perceptions of hormone use rate. Vertical dashed lines indicate actual hormone use rate and the average perceived hormone use rate.

Table 2. Multivariate Correlation Estimates for Hormone Use Perceptions (N = 1,023)

Species	Intercept	Cattle	Hogs	Chickens	R	R^2
Cattle	0.171***		0.515***	0.285***	0.78	0.615
	(0.012)		(0.027)	(0.026)		
Hogs	0.025*	0.576***		0.363***	0.80	0.643
	(0.013)	(0.027)		(0.025)		
Chickens	0.083***	0.370***	0.471***		0.75	0.565
	(0.015)	(0.034)	(0.032)			

Notes: Single, double, and triple asterisks (*,**,***) denote statistical significance at the 10%, 5%, and 1% level, respectively. Numbers in parentheses are standard errors.

The Tobit model is estimated in the following three versions: Model 1 includes no sociodemographic variables, Model 2 incorporates sociodemographic variables, and Model 3 includes linear sociodemographic variables as well as the interaction of perceived hormone use rate and individual sociodemographic variables.

Results

Consumer perception of hormone use prevalence in production ranged from 0% to 100% for each species considered (Figure 4). Perception patterns are similar across species, with peaks near 50% and near 100% for each species. The average perceived hormone use rate is approximately 62% for cattle, 55% for hogs, and 57% for chickens. Based on standard *t*-tests, consumers' perceived hormone use rates are significantly different from actual hormone use rates at the 1% level. On average, consumers underestimate hormone use in beef production and overestimate hormone use in pork and poultry production.

Table 2 displays the multivariate correlation estimates for hormone use rate perceptions from the regressions represented by equation (1). All parameter estimates are significant, and R^2 values range from 0.643 to 0.565. The multivariate correlation estimates (R) are 0.78, 0.80, and 0.75 for cattle, hogs, and chickens, respectively, indicating a significant correlation among hormone use perceptions in different livestock species. Parameter estimates across individual species vary in magnitude, but all are positive and statistically significant, indicating that the average consumer's belief regarding the rate of hormone use in one species has a positive influence on their perception of hormone use in other species.

Expected Utility Specification Results

Table 3 reports the results of the three model specifications fit to the choice experiment data, including (i) the conventional model for specification 1, where the influence of consumer perception of hormone use rate is implicit; (ii) specification 2's random expected utility model, incorporating beliefs and identification of preferences for hormone added, and (iii) specification 3, in which the modified random expected utility model allows different preferences for added hormones (UH) across meat products. Each of the three model specifications was estimated using the conditional logit approach and SAS 9.4.

Parameter magnitude and significance are similar across models using a traditional conditional logit method. Both -2 log-likelihood and AIC model selection criteria clearly favor the expected utility models of specifications 2 and 3, which separate beliefs, over the conventional utility model in specification 1. Consumers derive the highest utility from beef steak and the least utility from pork deli ham among meat products across all three conditional logit models. Marginal utility of hormone use rate ($UH - UNH$) is negative in the random expected utility model (specification 2), indicating that if a consumer believes a meat product is hormone added, he is less likely to choose the meat because it would result in disutility. Marginal utilities of perceived hormone use rates for individual meat products are also negative in the modified random expected utility model (specification 3). The marginal utility of hormone use rate is highest for beef steak (0.554) and lowest for pork deli ham (0.125). Generally, the magnitudes of marginal disutility of perceived hormone use rates within a species are higher for higher-value cuts than for lower-value cuts.

Effects on Willingness to Pay

When asked to state a WTP premium for NAH labels for each product, survey respondents indicated that they were willing to pay more for NAH-labeled meat products. Table 4 reports the mean stated

Table 3. Conditional Logit Parameter Estimates by Expected Utility Specification

	Specification 1: No NAH Label Consideration	**Specification 2: Overall Utility Change from NAH Label**	**Specification 3: Utility Change from NAH Label by Product**
	Conventional Expected Utility Model	**Random Expected Utility Model**	**Modified Random Expected Utility Model**
$-1\times$ price	0.483***	0.483***	0.483***
	(0.011)	(0.011)	(0.011)
Beef burger vs. none	2.302***	2.579***	2.595***
	(0.058)	(0.076)	(0.099)
Beef steak vs. none	3.429***	3.706***	3.774***
	(0.081)	(0.095)	(0.120)
Pork chop vs. none	1.979***	2.226***	2.296***
	(0.062)	(0.076)	(0.101)
Pork deli ham vs. none	1.089***	1.335***	1.160***
	(0.060)	(0.074)	(0.113)
Chicken breast vs. none	2.846***	3.102***	3.107***
	(0.054)	(0.071)	(0.080)
Chicken wing vs. none	1.173***	1.429***	1.397***
	(0.054)	(0.071)	(0.097)
Beans and rice vs. none	1.038***	1.039***	1.039***
	(0.055)	(0.055)	(0.055)
Pasta vs. none	1.567***	1.568***	1.568***
	(0.069)	(0.069)	(0.069)
$UH - UNH$		−0.443***	
		(0.078)	
UH (burger) $-$ UNH (burger)			−0.470*
			(0.130)
UH (steak) $-$ UNH (steak)			−0.554*
			(0.145)
UH (chop) $-$ UNH (chop)			−0.572*
			(0.147)
UH (ham) $-$ UNH (ham)			−0.125
			(0.170)
UH (breast) $-$ UNH (breast)			−0.452*
			(0.101)
UH (wing) $-$ UNH (wing)			−0.386*
			(0.141)
−2 log-likelihood	35,820.630	35,788.002	35,781.998
AIC	35,838.633	35,808.002	35,811.998

Notes: Single, double, and triple asterisks (*,**,***) denote statistical significance at the 10%, 5%, and 1% level, respectively. Numbers in parentheses are standard errors. $UH - UNH$ is relative preference for hormone added product over "no added hormone" (NAH) product.

Table 4. Stated Willingness-to-Pay Premium for Meat Products Labeled as "No Added Hormones"

Meat Product	Mean Premium ($/lb)	Std. Dev.	Max.	Min.
Beef steak	2.15	1.698	5	0
Beef hamburger	1.72	1.402	5	0
Pork chop	1.68	1.438	5	0
Pork deli ham	1.36	1.366	5	0
Chicken breast	1.76	1.402	5	0
Chicken wing	1.29	1.260	5	0

WTP NAH premium values across products. WTP premiums are highest for NAH-labeled beef steak ($2.15/lb) and lowest for NAH-labeled chicken wings ($1.29/lb). Heng, Peterson, and Li (2016) found a similar result for eggs. We choose a $5/lb upper limit in soliciting a stated WTP premium based on Syrengelas et al. (2018), who found that consumers were, on average, willing to pay $2–$3 per pound more for steak labeled as natural and without growth hormones. Less than 5% of our subjects chose to pay premiums of $5/lb or more for NAH-labeled beef hamburger, pork chops, pork deli ham, chicken breast, and chicken wings. Approximately 13% of subjects would pay a premium of $5/lb or more for NAH-labeled beef steak. The results suggest that the range of $0/lb to $5/lb for stated WTP premiums for NAH-labeled meat products is reasonable.

Table 5 reports results from three model specifications implemented to further analyze WTP premiums for NAH-labeled meat products. The prevalence of survey respondents stating no premium (i.e., $0/lb) ranged from 13.8% for steak to 26.5% for deli ham. Stated WTP premiums of $0/lb were 16% or less for steak, hamburger, and chicken breast and 20% or more for pork chop, chicken wing, and deli ham. At the other end of the scale, 13% of respondents had a stated WTP premium of $5/lb for steak, while 3.5% or less had stated WTP premiums of $5/lb for the remaining meat products. Model 1 includes the consumer's perceived hormone use rate and indicates that WTP premiums for NAH-labeled meat products are indeed sensitive to consumer perceptions of hormone use rate in different livestock species. Model 2 incorporates the linear effects of demographics on WTP premiums, and Model 3 also includes interaction effects between consumer demographics and perception of hormone use rates. The result is that some linear-effect coefficients could have opposite signs in Models 2 and 3. Results from these models indicate that WTP premiums for NAH-labeled meat products are significantly influenced by consumer perceptions of hormone use rate. In general, higher hormone use rate perceptions result in higher WTP premiums for NAH-labeled meat products. Results from Model 3 indicate that the rate of perceived hormone use influences WTP across several demographic factors. Models 2 and 3 both indicate that demographic factors strongly impact WTP premiums for NAH-labeled meat products. AIC and log-likelihood values indicate that Model 3 is the preferred specification. Discussion here focuses on results from Model 3.

No significant differences in WTP for NAH labels are indicated between male and female respondents when hormone use rate perceptions are considered. However, higher perceptions of hormone use rates decrease WTP for NAH labels when children are present in the household (−$0.63).

In the survey, we asked, "Have you ever worked on a farm or ranch?" and "Do you currently farm or ranch for a living?" Subjects who answered yes to either question were counted as having farm experience. In a separate implementation of the FooDs survey, Lusk (2017a) found that about 40% of survey respondents who stated that they have farm experience worked on a farm that produces commercial livestock (e.g., cattle, swine, or poultry). The other 60% of respondents listing farm experience included those with backyard gardens, backyard chicken coops, and crop farms, for example. Less than half of survey respondents with "farm experience" worked in livestock production. When the interaction of farm experience and perceived hormone use rates is considered,

Table 5. Comparison of Impacts on Stated Willingness-to-Pay Premium ($/lb) for Meat Products Labeled as "No Added Hormones" using the Tobit Method

Variable	Model 1		Model 2		Model 3	
Intercept	1.113***	(0.063)	0.975***	(0.155)	1.182***	(0.357)
Hormone use rate	0.333***	(0.074)	0.319***	(0.072)	−0.051	(0.537)
Meat types (vs. chicken wing)						
Beef steak	0.908***	(0.066)	0.904***	(0.063)	0.912***	(0.063)
Beef hamburger	0.418***	(0.066)	0.418***	(0.063)	0.426***	(0.062)
Pork chop	0.402***	(0.066)	0.401***	(0.063)	0.407***	(0.062)
Pork deli ham	0.081	(0.066)	0.080	(0.063)	0.085	(0.062)
Chicken breast	0.475***	(0.066)	0.475***	(0.063)	0.474***	(0.062)
Demographics						
Female vs. male			0.176***	(0.039)	0.042	(0.095)
Farm experience			0.218***	(0.057)	−0.354**	(0.146)
Children presence			0.337***	(0.047)	0.713***	(0.122)
Age (vs. $\geq$ 75 years)						
18–24 years			0.215*	(0.115)	0.564**	(0.268)
25–34 years			0.408***	(0.111)	0.693***	(0.257)
35–44 years			0.061	(0.114)	0.39	(0.264)
45–54 years			−0.204*	(0.109)	0.361	(0.249)
55–64 years			−0.368***	(0.110)	0.234	(0.257)
65–74 years			−0.409***	(0.111)	0.171	(0.256)
Education (vs. masters or professional degree)						
Up to high school			0.109*	(0.062)	0.003	(0.149)
Some college			−0.116*	(0.060)	−0.137	(0.148)
4-year college degree			0.107**	(0.054)	0.239*	(0.143)
Income (vs. $\geq$ \$160,000)						
< \$20,000			−0.296***	(0.082)	−0.350*	(0.209)
\$20,000–\$39,000			−0.173**	(0.083)	−0.564***	(0.212)
\$40,000–\$59,000			−0.212**	(0.086)	−0.818***	(0.227)
\$60,000–\$79,000			−0.197**	(0.079)	−0.799***	(0.208)
\$80,000–\$99,000			−0.189**	(0.079)	−0.355	(0.220)
\$100,000–\$119,000			−0.171**	(0.085)	−0.358	(0.234)
\$120,000–\$139,000			−0.332***	(0.094)	−0.392	(0.267)
\$140,000–\$159,000			0.192**	(0.093)	−0.921***	(0.228)
Regions (vs. Plains)						
Far West			0.055	(0.091)	−0.480**	(0.231)
Great Lakes			0.136	(0.093)	−0.250	(0.234)
Mideast			0.058	(0.088)	−0.032	(0.222)
New England			−0.190*	(0.111)	−0.056	(0.288)
Rocky Mountain			−0.004	(0.134)	0.216	(0.342)
Southeast			0.232***	(0.086)	−0.200	(0.219)
Southwest			0.063	(0.101)	−0.018	(0.256)
Interaction of hormone use rate with						
Female					0.218	(0.152)
Farm experience					0.973***	(0.227)
Children present					−0.628***	(0.191)
18–24 years					−0.587	(0.411)
25–34 years					−0.470	(0.396)
35–44 years					−0.609	(0.402)
45–54 years					−0.969**	(0.382)
55–64 years					−1.060***	(0.391)
65–74 years					−0.976**	(0.391)

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Table 5. – continued from previous page

Variable	Model 1	Model 2	Model 3	
Up to high school			0.18	(0.236)
Some college			0.05	(0.234)
4-year college degree			−0.238	(0.220)
< $20,000			0.035	(0.325)
$20,000–$39,000			0.630*	(0.327)
$40,000–$59,000			1.017***	(0.349)
$60,000–$79,000			0.985***	(0.316)
$80,000–$99,000			0.257	(0.332)
$100,000–$119,000			0.256	(0.370)
$120,000–$139,000			0.116	(0.401)
$140,000–$159,000			1.969***	(0.352)
Far West			0.947**	(0.376)
Great Lakes			0.749*	(0.384)
Mideast			0.163	(0.363)
New England			−1.114	(0.447)
Rocky Mountain			−0.381	(0.557)
Southeast			0.825**	(0.357)
Southwest			0.210	(0.410)
Log-likelihood	-11,061	-10,780	-10,708	
AIC	22,137	21,630	21,541	

Notes: Single, double, and triple asterisks (*,**,***) denote statistical significance at the 10%, 5%, and 1% level, respectively. Numbers in parentheses are standard errors. Model 1 includes no sociodemographic variables. Model 2 incorporates linear sociodemographic variables. Model 3 includes linear sociodemographic variables and the interaction of perceived hormone use rate with individual sociodemographic variables.

the linear coefficient estimate for farm experience is negative (−$0.35), while the interaction coefficient is positive ($0.97). However, consumers with farm experience who believe no hormones are added in meat (−$0.35) have lower WTP premiums than consumers without farm experience who believe there to be a 100% hormone use rate in meat production.

Model 3 also suggests that perceived hormone use rates can affect WTP premiums for NAH-labeled meat products differently across categories within a demographic variable. For example, WTP premiums for NAH-labeled meat products are generally higher among younger age groups than among older age groups. Hormone use perception has a significant negative effect on WTP premiums for NAH-labeled meat products in the older age groups (ages 45–74), but it is does not significantly impact WTP premiums for younger age groups (ages 18–44). This suggests that younger consumers are actually more "set in their ways" than older consumers regarding preferences for NAH labels on meat products. However, in considering education levels, those with a 4-year college degree have an increased WTP relative to others ($0.24), but there is no difference in impact of hormone use rate perceptions across education levels.

Not surprisingly, WTP for NAH labels in meat products is negatively related to income level. One exception is the $140,000–$159,000 income group. For example, WTP premiums for consumers with incomes of $140,000–$159,000 (−$0.92) are lower than for those with incomes of more than $160,000, but WTP premiums increase with perceived hormone use rate among consumers with incomes of $140,000–$159,000 ($1.97). That is, changes in hormone use perception have less effect on WTP premiums for NAH-labeled meat products for the highest income (more than $160,000) than for those in the income range of $140,000–$159,000. In general, WTP premiums for NAH-labeled meat products for lower-income consumers (<$79,000) are lower than for higher-income consumers. Hormone use rate perception has a stronger positive effect on WTP premiums for NAH-labeled meat products for lower-income consumers (<$79,000) than for higher-income consumers, with the exception of the $140,000-159,000 group. WTP premiums for NAH-labeled meat products are higher for consumers with incomes of more than $140,000 than for lower-income consumers.

Regional differences are evident as well. WTP premiums for NAH-labeled meat products for people in the Far West are lower than for people in other regions, and their WTP is also the most sensitive to hormone use rate perception. Hormone use rate perception has a stronger positive effect on WTP premiums for NAH-labeled meat products for people living in the Far West ($0.95), Great Lakes ($0.75), and Southeast ($0.83) regions than for those in the Mideast, New England, Rocky Mountain, Southwest, and Plains regions.

Conclusions

Though consumers are concerned about hormone use in meat animals, our results indicate that most overestimate hormone use in poultry and pork production and underestimate hormone use in beef production. Ironically, consumer perceptions of hormone use prevalence in different meat animal species are shown here to be an important factor in meat demand. Results reveal that relative preferences for conventionally labeled over NAH-labeled meat products from cattle, hogs, and chickens are negatively related to consumers' utility. Meat demand is also affected by consumers' misbeliefs about hormone use in different livestock species.

Consumers are willing to pay more for NAH-labeled meat products on average, relative to unlabeled products. WTP premiums for NAH-labeled beef steak are higher relative to lower-value meat cuts, both beef and nonbeef. The implication is that for high value meat products, consumers may care more about whether hormones are added in production. This is also supported by higher WTP premiums for high-value, NAH-labeled cuts within a species. Additionally, results indicate that consumer perceptions of the rate of hormone use in production positively correlates with the premium that they are willing to pay for NAH-labeled product. Interestingly, survey respondents who correctly perceive no hormone use in pork or poultry may still be willing to pay a premium for the NAH label. Heng, Peterson, and Li (2016) found consumers are still willing to pay a premium for eggs with the NAH label, even after being informed that no hormones are used in the industry. This raises the question of whether consumers provided with factual information about hormone use in meat animal production make different choices than those represented here.

NAH labels increased consumer WTP for the six meat products in the choice set, including pork and poultry products, for which hormone use is universally prohibited in U.S. production. This labeling claim may lead consumers to believe that the product is different or healthier than similar unlabeled products, while—in reality—no poultry and pork products are produced with added hormones. In fact, the "no added hormones" claim cannot be used on the labels of pork or poultry unless it is followed by a statement that says, "Federal regulations prohibit the use of hormones" (U.S. Department of Agriculture, 2015). However, manufacturers may shrink, minimize, or obscure this statement of clarification. Policy makers may need to reconsider how label information is defined, presented to the consumer, and regulated. Further, potential consumer welfare losses may be minimized by educating consumers with factual hormone use information in meat production. This work further illustrates delivering correct information to consumers using labeling claims is a challenge.

Positive premiums for NAH labels—despite the industry-wide ban on hormone use—do explain why some pork and poultry products are marketed with NAH labels. Data on the percentage of NAH-labeled pork and poultry have proven difficult to find. The Nielsen Company (2017) reports that 8% of deli meat items were labeled NAH, and that the category saw a 14% growth rate from May 2016 to April 2017. The Food Marketing Institute (2017) reports that four in ten shoppers want a greater assortment of meat with no added hormones. Although producers may gain premiums from NAH labels on pork or poultry products, general demand for pork and poultry may be dampened by consumers' misperception of hormone use. NAH labels can actually perpetuate consumers' misperceptions of hormone use in pork and poultry production. Policy makers may wish to revisit the impact of NAH labels on pork or poultry products. Our results imply that the premiums from NAH labels on pork and poultry products could drop substantially—or even evaporate—if consumers

correctly perceive that hormones are not used in pork and poultry production. Conversely, if all pork and poultry products were labeled NAH in the interest of transparency, consumers could make more informed decisions at the meat counter and producers would potentially benefit.

Consumer misbeliefs about hormone use in the meat industry affect food choices. Given that most consumers have little direct involvement in food production, many food choices are likely made with inaccurate beliefs regarding production claims. Our results find that consumer perceptions—or misperceptions—are correlated with their WTP for NAH labels, highlighting the impacts that misperceptions can have on food choice and on willingness to pay for those food choices.

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