EVALUATING CONSUMER SURVEY RESPONSES WITH IDENTITY THEORY AND IMPACTS OF ALTERNATIVE RESPONSES TO FOOT-AND-MOUTH DISEASE IN A LARGE FEEDLOT

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Submitted to the Faculty of the
Graduate College of
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
July 2020

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WITH IDENTITY THEORY AND IMPACTS OF

ALTERNATIVE RESPONSES TO FOOT-AND-MOUTH

DISEASE IN A LARGE FEEDLOT

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ACKNOWLEDGEMENTS

I owe an endless amount of gratitude to my dissertation chair, Bailey Norwood. My experience at Oklahoma State University has been enriched with your advice and friendship. Thank you for allowing me to teach and pursue leadership roles on campus as well as the profession during my doctoral program. Your collegial nature and mentorship have been appreciated and will not be forgotten.

To Amy Hagerman: thank you for letting me branch out of my wheelhouse of my behavioral economics background. It has been a joy getting a crash course in GAMS and learning about foreign animal disease. I am especially appreciative of your positivity and willingness to include me in your research program as you re-joined the department as a junior faculty member.

Thank you to the members of my committee, Wade Brorsen, Dayton Lambert, and Lan Zhu, for your helpful suggestions and comments to strengthen the quality of both projects.

I am eternally grateful to the faculty, staff, and graduate students in the Department of Agricultural Economics in the Ferguson College of Agriculture. While I was jokingly hesitant to wear orange and black, I will sincerely miss the friends and connections I have made throughout Agricultural Hall. Thank you – Wade Brorsen, Cheryl DeVuyst, Rodney Jones, Dayton Lambert, Derrell Peel, John Michael Riley, Joe Schatzer, Brian Whitacre, Anna Whitney, and Mike Woods – for your instruction, encouragement, mentorship and/or support during my time as a Cowboy. Earning a doctoral degree from a land-grant institution that heavily emphasizes teaching and applied research is something I will always value as I continue my career in the profession.

Last, but certainly not least, to my family – Mom, McKenna, Garett, Lane, Blake, Griffey, and Riggs – thank you for being supportive of my delaying of reality for the past decade. It means a great deal to me to reach my educational and career goals with your constant backing. While I know you are not fully sure what my profession entails, your encouragement has helped me continue through the highs and lows of pursuing a graduate degree.

Gloria in excelsis Deo

Name: LOGAN LEVI BRITTON

Date of Degree: JULY, 2020

Title of Study: EVALUATING CONSUMER SURVEY RESPONSES WITH IDENTITY THEORY AND IMPACTS OF ALTERNATIVE RESPONSES TO FOOT-AND-MOUTH DISEASE IN A LARGE FEEDLOT

Major Field: AGRICULTURAL ECONOMICS

Abstract: The first essay investigates consumer survey design. Survey design has evolved from asking respondents for replies they can easily provide a specific answer into considering the cognitive process of an individual. Due to this new survey design, respondents may not have specific answers researchers are looking for, which is often thought of as response bias. A recent study suggested this bias can be attributed to Identity Theory and the identities individuals express (who they are ideally versus who they are commonly each day). We examine this notion of identity expression influencing the responses to subsequent questions, which we term identity inertia, in the context of a sequence of questions. A conceptual model is developed to consider the importance of identities. We test this hypothesis with a sample of 2,354 respondents from the United States. Results indicate a moderate level of identity inertia being present in responses when more common activating questions are answered previously. We suggest researchers should ask questions that cue an individual's common identity first.

The second explores disease response in a large feedlot. The breakout of foot-and-mouth disease is a constant worry, and it is important to have a plan of how to respond in order to reduce supply disruptions, reduce the time for bans on exports, and maintain animal health and welfare. Previous studies have estimated the cost of management strategies in response to foreign animal disease can range from $150 million to $15 billion. This study examines response to foot-and-mouth disease using alternative management strategies in a large feedlot of more than 50,000 head. Data from a representative feedlot and epidemiological data are used in a discrete model with static prices. Recoverable profits are calculated from selling susceptible and recovered cattle and government indemnity payments from the depopulation of cattle less costs to manage disease and maintain cattle. The results indicate that strategies involving the movement of susceptible and recovered cattle to segmented slaughter has economic value over depopulating an entire feedlot.

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CAN IDENTITY THEORY HELP IMRPOVE SURVEY DESIGN AND INTERPRETATION?

Abstract

Survey design has evolved from asking respondents for replies they can easily provide a specific answer into considering the cognitive process of an individual. Due to this new survey design, respondents may not have specific answers researchers are looking for, which is often thought of as response bias. A recent study suggested this bias can be attributed to Identity Theory and the identities individuals express (who they are ideally versus who they are commonly each day). We examine this notion of identity expression influencing the responses to subsequent questions, which we term identity inertia, in the context of a sequence of questions. A conceptual model is developed to consider the importance of identities. We test this hypothesis with a sample of 2,354 respondents from the United States. Results indicate a moderate level of identity inertia being present in responses when more common activating questions are answered previously. We suggest researchers should ask questions that cue an individual's common identity first.

Keywords: survey design, Identity Theory, consumer behavior, survey research, social desirability bias

Introduction

Surveys are often used to gauge the opinions and thoughts of consumers on a myriad of topics, such as purchasing habits, perceptions of the food system, and policy issues. When survey design was a young science it was thought a simple process. The psychology of survey responses was depicted by the 'file drawer' model, where the respondent interprets the question and then retrieves the correct answer from their mind. So long as the subject interpreted the question correctly, a correct answer existed, and the subject could retrieve the answer, the survey design was a success (Tourangeau, Rips, and Rasinski 2003; Tourangeau 2003).

Now that the science of survey design is almost a century old, the file drawer model has been replaced by more complex models of how people answer survey questions. The file drawer model may be appropriate for some questions like a person's age. Yet for many other questions a 'true' answer may not exist, and respondents may not wish to be honest in their answer. Psychologists now consider many beliefs or attitudes to be constructed on the spot, when prompted, and the nature of that construction will differ depending on the setting. That is, an answer isn't waiting to be retrieved in a metaphorical file drawer of the mind. There is a large literature on the psychology of deception, and it is increasingly clear that dishonesty is a normal, regular occurrence in human interactions (DePaulo et. al. 1996; Feldman, Forrest, and Happ 2002). These two behaviors—on the spot construction of attitudes and deception—are on display not just in normal everyday interactions but in survey responses as well. From the researchers' point-of-view, this results in a 'bias' in survey responses.

One such bias is a demand effect, where respondents may have little to no exposure on a topic, but the question prompts them to provide an answer that does not represent their true opinions (King and Bruner 2000). For example, a person given a survey concerning the treatment of livestock raised for food may have never really thought about the topic, but the survey seems to suggest that many others believe livestock production is inhumane, so they report livestock should be treated better as well. Another form of bias is social desirability bias (SDB) in which respondents project themselves in the most favorable way relative to prevailing social norms (King and Bruner 2000). Here a person may be well versed in how livestock are raised and have no real personal worries with it. Yet, knowing they might be viewed unfavorably if they say otherwise, they report support for laws requiring better animal treatment.

The file drawer problem where individuals retrieve the true answer to the question asked has been replaced by a model where the individual searches for a good answer that addresses the question but also satisfies a variety of psychological motivations like impression management and reducing cognitive burden. This movement resulted in the Cognitive Aspects of Survey Methodology (CASM), an interdisciplinary field where researchers pay keen attention to the cognitive process of respondents forming answers for survey design and interpretation (Tourangeau 2003). CASM attempts to reduce measurement error through survey design rather than sampling error. Tourangeau, Rips, and Rasinski (2003) make note of how respondents construct attitudes over time and their experiences and how to recognize survey design effects, such as question ordering and question framing.

One achievement of these efforts is the four-stage cognitive model of how subjects must think about a question in order to provide an accurate answer (Tourangeau, Rips, and Rasinski 2003). The first step is comprehending the question in the manner intended by the researcher. Next, the subject must be able to retrieve from memory the pertinent information for answering the question. The third step is the most important for this study: the psychological motivations must be aligned such that the individual wants to and can report the most accurate answer (Willis 2008). This is the most difficult step to achieve. We have already discussed the demand bias and SDB, but consider another example. Suppose an individual is asked whether they voted in the 2016 presidential election. Suppose they did not, but they definitely plan to vote in 2020. Suppose further they assume that the researcher is attempting to determine the likelihood they will vote in 2020 based on their previous behavior. The individual may then lie and say they did vote in 2016 because it actually gives the researcher the information they seek (whether they will vote in 2020). CASM thus places greater demands on the researcher when forming survey questions and forces them to think harder about how the responses should be interpreted.

One particularly important bias CASM has addressed is question-ordering effects, where the answer a person gives depends on the order in which the responses are listed. On a self-administered questionnaire, like a pen-and-paper questionnaire or an internet survey, there is a primacy effect whereby the individual has a tendency to select responses appearing early in the list (Tourangeau, Rips, and Rasinki 2003). This effect is presumably an attempt to reduce cognitive burden. On the other hand, when an interviewer administers questions orally, there is a recency effect where they are more likely to choose a response later in the list, again, to reduce cognitive burden as those responses are easier to remember (Willis 2008).

In this paper, we consider an alternative potential source of question-ordering effects explained by Identity Theory in psychology. Identity Theory states that any one individual has multiple potential identities they can activate in any setting, and the identity (or portfolio of identities if they express multiple identities simultaneously) depends on the setting. The theory also states that when expressing different identities, they will do so in a way that makes the identities seem consistent with one another. That is, the nature in which any one identity is chosen differs depending on whether it is expressed in isolation or connected with other identities (Burke and Stets 2009).

Brenner and DeLamater (2016) were the first, to our knowledge, to use Identity Theory in explaining survey response patterns by showing how Identity Theory can be a cause of SDB, like when individuals say they exercise more than they really do. While they consider how Identity Theory may explain a person's behavior to any one question on a survey, we extend their work by investigating how it explains a person's answers to a sequence of questions.

A recent study by the Animal Sentience Institute found that nearly half of Americans want to ban slaughterhouses (Anthis 2017). Given that less than 7 percent of Americans are vegetarian or vegan (Lusk and Norwood 2016), those results seemed unrealistic. Yet, the study was replicated by one of the authors and reached the same results. That number of people truly wanting to eliminate meat is highly doubtful, so the source of this strange result might be the function of the survey design. The questions in both studies were not randomize as usually done to avoid social desirability bias. It is possible the identity cued in questions prior to the slaughterhouse question caused the results in both studies.

We suspect that the order of identity cueing questions will influence subsequent responses. Our objective is to test for this identity inertia. A conceptual model is constructed that blends economic principles with the cognitive process in the psychology literature. This model has the implication that, if different questions prompt the individual to activate different identities, the individual will attempt to answer any one question in a way that exhibits a similar identity to the identities expressed in previous questions.

Background

The concept of 'identity' in Identity Theory refers to, "the set of meanings that define who one is when one is an occupant of a particular role in society, a member of a particular group, or claims particular characteristics that identify him or her as a unique person," (Burke and Stets, 2009, p. 3). Identity Theory's main objective is to describe the relationship between a person and society, making it potentially useful in addressing SDB. The theory states that any one individual will possess multiple identities because they serve manifold roles in society, interact with different social groups, and describe themselves using diverse characteristics across various contexts. These identities are a mechanism by which the individual is linked to others in society, and the 'meanings' associated with an identity is determined not just by the person but society as well (Burke and Stets, 2009, p. 3).

While Identity Theory in psychology is not to be confused with the theory of the same name in philosophy, they have a similar historical origin in the writings of 18th

Century moral philosophers (Burke and Stets, 2009). Adam Smith, Adam Ferguson, David Hume, and other Scottish philosophers during the Enlightenment began an intellectual exploration of what it means to think of oneself and one's conscious decisions in a social setting. Rather than conceiving of morality as an objective entity, or a set of commands issued by Providence, these philosophers took the first step in depicting morality as a social construct. The eventual outcome was social sciences like psychology as well as a variety of philosophical disciplines like phenomenology.

Many economists may be familiar with Adam Smith's early work *The Theory of Moral Sentiments*, where he suggests that what is a moral or immoral act is determined by an impartial spectator, where that impartial spectator can be thought of as the consensus of one's community at a particular place and time regarding what is good and not (Raphael 2007). Philosophers built on Smith's work for two centuries, eventually culminating in Blumer's concept of symbolic interaction (1962) and Powers' perceptual control theory (1973). A complete description of these concepts is unnecessary here, but a succinct (and thus, likely unjust) explanation is as follows. Symbolic interaction theory says that 'objects' (*e.g.*, a person, a statement, a custom, or a word) do not have 'meanings' on their own, but instead those meanings result from the interactions between people (Aksan et al. 2008).

Perceptual control theory posits that what humans regulate is not so much their actions but their perceptions of their actions, and they adjust these perceptions based on feedback (Powers 1973; Stryker and Burke 2000). As the cruise control of a car makes adjustments based on the machine's perceived speed and not its objective speed, people can only respond to what they perceive—that is their window to objective reality.

Applied to Smith's impartial spectator, people are influenced by what they perceive the impartial spectator to approve of, as the spectator does not exist as an independent agent.

Between Adam Smith and the 12th Century developments in symbolic interaction and perceptual control theory emerged the notion that one person can contain multiple 'selves', like when William James ([1890] 1950) remarked in *Principles of Psychology*, "a man has as many social selves as there are individuals who recognize him …" (p. 126). This notion of multiple selves remained in the psychology literature to eventually become Identity Theory and has lately morphed into a different form in the economic modeling of individual decision-making (Alós-Ferrer and Strack 2014). While economics and psychology have sometimes viewed individuals as either rational versus impulsive, respectively, recent work has bridged the gap between the two disciplines. A Reflective-Impulsive Model has been developed to account for cognitive, motivational, emotional and behavioral elements in individual information processing and decision-making, reflecting a dual-system framework with an individual (Strack and Deutsch 2004).

Like most concepts, Identity Theory is easiest to understand through examples. Consider a hypothetical person: a 34-year-old, recently divorced man with full custody of his 4-year-old daughter, working a 9 to 5 job at an accounting firm. In society and his personal life, he serves multiple roles. One of those is being a single father of a young child. Part of being a single father means he feels the need to eat healthy, as he is the sole provider to his child, but it also means that he has little time to prepare breakfast. A single working father is one of his identities. A physically fit person active on the dating scene is another, so he also wishes to eat healthy to be attractive to others. Part of his personality is a willingness to cook and eat novel foods, and he sometimes describes himself as a ‘foodie.’ His eagerness to be adventurous by eating live octopi and rocky mountain oysters makes him unique and provides him fodder for conversation with others.

Much of the meaning of the words to describe these identities are determined by his society. While there is no scientific evidence that gluten is unhealthy, if his peers have deemed it unhealthy, then healthy eating for him may include abstaining from purchasing and consuming wheat products. What is adventurous eating is certainly determined by his culture. Eating worms is highly daring in the United States but a common practice in some cultures. Once he chooses an identity, he will then monitor feedback to ensure the correct identity (the one he wishes to activate) is on display. This is where perceptual control theory comes into play. For example, if he wants to seem an adventurous eater by consuming worms in the Fujian Province of China, he may learn by observing others’ reactions that it is a regular practice. Thus, he must find something novel to that area to eat to portray his targeted identity.

This idea of multiple selves is employed by numerous disciplines. The dual-processing nature of the mind, automatic and deliberative, has been used within economic studies (Alós-Ferrer and Strack 2014). Widely used in the psychology literature, multiple selves have been used to explain human behavior. A long-run versus short-term multiple selves model has been used to help people achieves happiness (Layous, Nelson, and Lyubomirsky 2012). Social psychologists have extended Identity Theory to understand not just one’s personal identity but their social identity describing their relation to other groups (Turner and Oakes 1988; Burke and Stets 2000; Hogg 2007; Gaertner et al. 2012). Other fields, such as sociology and marketing, have employed Identity Theory to recognize ineffective marketing strategies (Bhattacharjee, Berger, and Menon 2014), better understand the nature of gift giving (Ward and Broniarcyk 2011), and show how individuals view their possessions in relation to their self-identity (Belk 1988).

The following can be used to describe the hypothetical person's role in society in the example: a good father, an attractive person, and a 'foodie'. Rather than defining identities as social roles, we can describe them as a manifestation in eating behaviors, as shown in Fig. 1.1. There are times when he eats healthy, like when eating in front of his child or after eating unhealthy for a while. Other times he focuses on having food adventures by trying new foods, like when out with his friends or on a date. On weekday mornings, he has little time to spare to prepare and/or cook meals, so he focuses on convenience. Other times, like all us, he simply wants tasty food regardless of healthiness, novelty, or convenience.

Identity Theory has a unique set of vocabulary. The three most important terms are: prominence, salience, and verification. The hypothetical example above demonstrates how identity—as manifested through food choices—varies with context. Yet, the structure of Identity Theory begins with prominence, which is a preference for identity absence of context. There is a hierarchy of identities in terms of what the individual aspires to be and how that translates into expressed behavior (McCall and Simmons 1978). This hierarchy is driven by the core values and ideals possessed by the person. Those values and ideals are forces influencing decisions in all contexts, and so they exist independent of contexts (McCall and Simmons 1978).

Fig. 1.1 assigns a hypothetical prominence value to each of the four identities. This person aspires to be a healthy eater. That is how he wants others to think of him, and how he wants to perceive himself. Thus, ‘healthy eater’ is assigned the largest prominence value. Because he wants to be someone who values his long-term health over the immediate satisfaction of overeating something unhealthy, he wants to be someone in control over his emotions and in steady pursuit of long-term goals. The ‘focus solely on taste’ identity receives the lowest prominence score, and this may be the case even if that is his most common behavior. As he would rather other people think of him as an adventurous eater than one who cares mostly about convenience, ‘adventurous eater’ receives a higher prominence value than ‘convenience’, but is still lower than ‘healthy eater’.

Prominence alone cannot explain identity expression because it exists separate from context, whereas one purpose of Identity Theory is to explain how people express different personas in different times and places. Thus, McCall and Simon (1978) introduce the concept of salience factors, which describes the ‘situational self’ (Burke and Stets 2009) as opposed to the ‘ideal self’, which is described by prominence factors alone. One can think of salience factors as situation-dependent variables that make certain identities more likely to be expressed. Fig. 1.1 has a set of salience factors for two different contexts (1) dining out with friends and (2) weekday breakfast. When dining out with friends, the salience factor for ‘adventurous eating’ is particularly high. As opposed to weekday breakfast when the salience for ‘convenient’ is high. Even though neither of these identities represent the ideal self they are identities appropriate for the given situation the individual encounters.

It might be of further help to the economist to depict Identity Theory’s similarities to the standard consumer optimization problem for goods. The common problem taught to graduate students says that consumers optimize a utility function $U(X_1, X_2, \ldots, X_k)$ subject to an income constraint, $I = P_1X_1 + P_2X_2 + \cdots + P_kX_k$. Here, the utility function $U(X_1, X_2, \ldots, X_k)$ is akin to prominence values in that the importance of each good (separate from context) is determined by a fixed function. The context here is that the price of goods can differ, so the prices are like salience factors. The analogy is imperfect but useful. Just as consumers pick goods to maximize their utility given the set of prices, people choose the identity to activate based on the context. Both are guided by 'values' that are constant across all contexts, but there are other variables that guide choices which do account for the context in which the decision is made.

Identity expression is not static. It is a continuous flow of self-verification of the individual. The three components of verification include inputs, comparator, and output. Once an individual selects an identity or identities for a given situation, the same person monitors inputs provided by the environment in which they are placed (Burke 1991; Stets and Burke 2015). Whereas an economist may view identity as a set of preferences, psychologists think of identity as a control system seeking to ensure that perceptions of an individual's environment is consistent with the identity standards of the individual. We use our single father example further.

Let's say the father goes to eat with a group of friends to a fast food restaurant. In the morning, he completed a workout at the gym before heading to work. When it is time for lunch, he wants to eat at least one healthy item to treat himself for completing the workout. After seeing his friends order a burger, fries, and soda, he orders a burger, salad, and a water—after which his friends laugh at the odd trio of foods. This input is then used in the comparator component of Identity Theory. In this stage, the perceptions of the environment are compared to the identity the individual is wishing to express. While the single father wants to be somewhat unhealthy in his eating by purchasing a burger, his friends are suggesting that this is not the case by their remarks. He laughs, then changes his order to a burger, fries, and a soda instead to match his friends. The change in behavior is considered the output. This verification and monitoring process will occur continuously as he makes decisions, has conversations with others, and observes various social signals throughout his day. The verification process would be analogous to prices decreasing or increasing in the consumer optimization problem. Identities that are perceived to be more costly (low salience) would be expressed less often than those with low cost (high salience).

If Identity Theory accurately describes the interface between the individual and society, then it might provide useful guidance in mitigating various biases in research, like SDB or question-ordering bias in surveys. SDB occurs when the individual misrepresents their 'true' self to create a favorable impression to others—even on an anonymous survey. When not in agreement, prominence and salience of identities may cause a bias in measurement (Stryker and Serpe 1994). At this point, upon understanding Identity Theory, the reader may ask if a 'true' self even exists. We contend this might be the key in not only understanding the source of SDB, but also in dampening whatever bias it might cause in surveys. Brenner and DeLamater (2016) were the first to recognize this difference. They employ Identity Theory to provide an alternative understanding of SDB, an interpretation they consider and test. They note that a researcher may design a survey to gather information about one of the possible selves individuals possess, but a subject may have chosen to express a different self in their responses. That is, respondents may not be providing untruthful responses, as they are being truthful about one of their selves. The shortfall was in the design of the survey by the researcher to activate the targeted self of the respondent.

In the next section we develop a conceptual model of Identity Theory to explain question-ordering bias, whereby the answer to any one question is influenced by the questions asked previously. We suggest the verification component of Identity Theory might produce what we call *identity inertia* in surveys, whereby the identity expressed on any one question is influenced by the identities expressed on previous questions. If different survey questions cue different identities, and if a respondent desires consistency across questions in who they are as a person, our model shows that question-ordering effects will exist. The model thus provides a theoretical explanation for the question-ordering effect and has practical implications for how questionnaires should be designed. It will also be shown that Identity Theory is a possible theoretical explanation for SDB in some but not all cases.

Conceptual Model

Behaviors described by Identity Theory could be manifested in survey response behavior in a few ways. In this section, we explore its possible implications for how responses are influenced by the order of previous questions through the construction of a conceptual model. This is a mathematical model of Identity Theory in the spirit of familiar economic models. It should be noted that Identity Theory is rarely stated in mathematical terms as it is here, but we do so here for conformity with traditional economic models. Let $s_{i,c}$ be the *i*th potential self the individual can activate, where there are *N* potential identities in any context c. Let P_i be the prominence factor for identity i, and $\gamma_{i,c}$ be its salience factor in context c, where an increase in either factor increases the likelihood of the identity being activated. Recall that prominence ranks the identities in terms of desirability absence of context (thus the absence of a c subscript) as opposed to salience factors which describe how an identity is more or less likely to be activated in a specific context. It is the combination of prominence and salience factors which determine the identity or combination of identities a person chooses to express in each situation.

The desirability of any one identity, $s_{i,c}$, depends on the values of P_i and $\gamma_{i,c}$ in much the same way that the desirability of a good depends on the exogenous utility function parameters and prices. While the Identity Theory literature typically uses prominence and salience as descriptors and not exogenous factors, we do so here as a proxy for the exogenous factors that determine behavior, like genetics, the environment, and the specific context of a decision.

A person can choose to display a single identity or a medley of multiple identities, so we depict the decision variables of the model to be the weight ($w_{i,c}$) the person places on identity i in context c. The activated portfolio of identities is then represented as $S_c = \sum_{i=1}^{N} w_{i,c} s_{i,c}$. They cannot activate all identities fully at one time, so the weights are constrained such that $\sum_{i=1}^{N} w_{i,c} = 1, 0 \leq w_{i,c} \leq 1 \ \forall \ i$. For example, if $w_{1,c}$= 0.25 and $w_{3,c}$= 0.75, then the individual has activated identities 1 and 3, with identity 3 displayed with three times the intensity of identity 1, but with less intensity than if it was the only identity expressed (in which case $w_{3,c}$= 1).

The optimal selection of $w_{i,c}$ is a function of the prominence and salience characteristics specific to the person and the context. This function is written as

$f(w_{1,c},\dots,w_{N,c}|P_i,\gamma_{i,c})$. One attribute of Identity Theory not yet mentioned is how an individual manages identities when multiple identities are expressed. This will be particularly important for survey design because different questions will cue the respondent to activate different identities. As the respondent projects these multiple identities, they must reconcile some of those differences in the identity expression. A core tenet of Identity Theory is that, when expressed as a group, the activation of an identity has implications for how other identities are expressed.

We continue our example with the single father. If he is out dining with his friends and brings his child, he may not just choose to activate either the adventurous or healthy identity. He may choose a combination of the two—a novel food that is also healthy. The expression of one identity must be done in a way that is consistent with the other expressed identities (Burke and Stets 2009). In the context of a questionnaire, we hypothesize that as one individual proceeds from one question to the next, if different questions tend to cue different identities, they will answer each question differently than if the question was asked in isolation. That is, the 'context' of survey question is different when the individual has recently answered previous survey questions than if a single question is asked in isolation.

This suggests that the prominence and salience factors interact in such a way that the function mapping their values to the chosen identity portfolio is quite complex. For our purposes we represent $\max_{w_{i,c}} f(w_{1,c},\dots,w_{N,c}|P_i,\gamma_{i,c})$ as a simplified objective function plus a penalty term, where the person is penalized if they express multiple identities in ways that are inconsistent with previous behavior. The objective function is specified to take the linear form $\max_{w_{i,c}} \sum_{i=1}^{N}(P_i w_{i,c} + \gamma_{i,c} w_{i,c})$.

The penalty term accounts for the individual's attempt to reconcile their multiple selves as they go through the process of answering survey questions. Suppose our hypothetical father is taking a survey that first asks his level of agreement with the statement 'eating healthy is important to me'. If a higher score indicates greater agreement, he will likely indicate a high score because healthy eating is his identity with the highest prominence and the question itself seems to query the person's ideal self. Moreover, there is nothing in the context of the question that seems to invoke any of the three other identities we have described. Suppose the next statement on the survey is, 'I ate a healthy breakfast this morning'. Because his 'convenient' identity has a high salience factor on weekday mornings, his convenient breakfasts are not healthy. In terms of this one question, his answer should provide a low score, indicting disagreement, thereby revealing the truth about his 'convenient' identity. Yet, just a few seconds ago he activated his 'healthy eating' identity, and in those contexts, those two identities (healthy and convenient) contradict one another. To reconcile these two identities, he tells himself that although it was not healthy, he didn't eat a lot of it—something he would not have told himself had he not been given the previous statement. As such, he ultimately provides a higher level of agreement to this second statement than if the first had never been posed.

To account for respondents' hypothesized desire for expressing a consistent identity portfolio as they move from one statement to the next, we include the term penalty term $-\beta \sum_{i=1}^{N} \left(w_{i,c} - \overline{w}_i\right)^2$, where β is a positive parameter, $w_{i,c}$ is the expression of identity *i* in context *c* (where the context here is the specific survey question), and $\overline{w}_i$ is an indicator of how strongly identity *i* was expressed in the recent past. The larger the term, $\sum_{i=1}^{N}(w_{i,c}-\bar{w}_i)^2$, the less consistent the identity portfolios expressed in the survey. The larger (smaller) the value of β, the more (less) consistent identity expression matters to the person. The complete model showing how respondents choose which identities to express on a given survey question is then as follows

$$\max_{w_{i,c}} U = \sum_{i=1}^{N}(P_i w_{i,c} + \gamma_{i,c} w_{i,c}) - \lambda\left(1 - \sum_{i=1}^{N} w_{i,c}\right) - \beta \sum_{i=1}^{N}(w_{i,c} - \bar{w}_i)^2 \quad (1.1)$$

$$\text{subject to: } 1 \geq w_{i,c} \geq 0 \ \forall \ i$$

where utility, U, is maximized by selecting $w_{i,c}$, the extent to which identity *i* is expressed, *i = 1, 2, …, N,* in context *c*; P_i is the prominence of self *i*; $\gamma_{i,c}$ is the context-dependent salience factor of self *i* in context *c*; λ is a Lagrangian multiplier ensuring the total sum of identities expressed is 1; $\beta > 0$ is a penalty factor for expressing a self-portfolio inconsistent with past expressions; and $\bar{w}_i$ is the average expression of self *i* in past behaviors.

The major implication of this model is that, due to the penalty term and $\beta > 0$, the individual will display *identity inertia* as they complete a questionnaire. Each specific question in isolation may cue a unique identity portfolio $W_c = \{w_{1,c}, \dots, w_{i,c}, \dots, w_{N,c}\}$, but the individual will be hesitant to lurch from one distinct identity to the next and will instead attempt to activate an identity portfolio that is both suitable for the question being answered at the time and consistent with the portfolio activate in previous questions. The identity inertia results in answers that depend on the questions previously asked, providing one theoretical explanation for the ordering bias observed in surveys. Individuals make decisions based on the most recent information received, resulting in biased opinions toward the latest information (Tversky and Kahneman 1973).

Let us simplify the model to assume only two possible identities: the ideal self and the common self. The ideal self, w_1, describes the person's aspirations while the common self, w_2, describes their most frequent behaviors in daily life. These are separate identities because the person only rarely lives up to their ideal self. These selves regard the person's views on a matter of issues. For example, on the issue of livestock treatment, one may aspire toward humane treatment of farm animals yet rarely take animal welfare into account when making food purchases. Let us say the person is taking a survey regarding their views on the treatment of farm animals and has just provided their agreement to the first statement. If that first statement cues the individual to provide information on their ideal self (*e.g.*, What is your level of agreement?: I believe that farm animals should be treated humanely), then by the time they arrive at the second statement, the value of $\bar{w}_1$ (ideal self) is high and the value of $\bar{w}_2$ (common self) is low. Suppose the second statement cues their common behavior (*e.g.*, What is your level of agreement?: I take animal welfare into account when making food purchasing decisions), and must optimize equation 1.1 given the values of $\bar{w}_1 > \bar{w}_2$. The *c* subscript is dropped for simplification, though *c* = 1 could be used for statement 1 and *c* = 2 for statement 2. The slope of the isoquant for equation 1.1 at the second statement is given by

(1.2) $$\frac{\partial w_1}{\partial w_2} = \frac{-[P_2+\gamma_2-2\beta(w_2-\bar{w}_2)]}{[P_1+\gamma_1-2\beta(w_1-\bar{w}_1)]}.$$

While isoquants are typically convex, this isoquant is in fact a circle, so it is not a function. To see this, recall the formula for a circle is $(x-h)^2+(y-h)^2=r^2$ (where x and y are coordinates, h is a constant, and r is the radius) and note the isoquant can be written as

(1.3) $$-G = \left(w_1 - \frac{a_1}{2}\right)^2 + \left(w_1 - \frac{a_2}{2}\right)^2,$$

where

(1.4) $$a_i = \frac{[P_i + \gamma_i + 2\beta\bar{w}_i]}{\beta}$$

and

(1.5) $$G = (\bar{w}_1)^2 + (\bar{w}_2)^2 + \frac{U}{\beta} - \left(\frac{a_1}{2}\right)^2 - \left(\frac{a_2}{2}\right)^2.$$

If the person expressed only their ideal self in the first statement, then $\bar{w}_1$ = 1 and $\bar{w}_2$ = 0. When the second statement cues the common self, if there was no desire for consistency of identity expression ($\beta = 0$), and if they were answering honestly by their account, they would express only the common self ($\bar{w}_1 = 0; \bar{w}_2 = 1$). The person would indicate they never take animal welfare into account when shopping for food. Here, the individual is being honest (from the researchers' point-of-view) by saying they aspire to exhibit kindness toward animals, but in fact, rarely consider animal welfare in their daily life. When there is no penalty for inconsistency for these responses, the isoquant of equation 1.1 is linear with a slope of $\frac{-[P_2+\gamma_2]}{[P_1+\gamma_1]}$. This results in a corner solution, shown in Fig. 1.2, where the isoquant of the objective function is on the most upper right coordinate as possible while still touching the identity constraint $\bar{w}_1 + \bar{w}_2 = 1$, shown by point A.

Being this honest may make the person feel they are being hypocritical, and in the language of Identity Theory they are signaling two inconsistent identities, something they usually try to avoid. If they prefer to provide consistent signals about who they are, then the penalty parameter should be $\beta > 0$; they do not wish to switch from the ideal to the common self in a short amount of time. Thus, they indicate they do periodically take animal welfare into account when shopping in the second question and in the process activate half of each identity. The slope of the isoquant is no longer linear but results in the circular isoquant in Fig. 1.2 given by equation 1.2. The optimal identity portfolio is now where this circle is as upper right as possible while also touching the identity constraint. This optimal solution is point B, a mixture of the ideal and common self. As point B would not occur if this second question were not proceeded by the first it provides one explanation for the question-ordering effect in surveys.

Is the person being dishonest? One the one hand, they are being dishonest because they say they account for animal welfare when shopping when in fact they do not. On the other hand, if they were honest from the researchers' point-of-view, they would be providing two statements that cannot be simultaneously true. The idea of 'honesty' here is thus not a straight-forward concept. The researcher is wanting to understand 'the person' but there is more than one identity to the person. When the respondent says they account for animal welfare in food decisions and the researcher then learns they do not, the researcher may conclude the respondent is exhibiting SDB. Yet, what is really going on is that the ideal and the common self are contradictory by nature. Does this mean Identity Theory is a source, an explanation of SDB? So long as the ideal self of the respondent is like the ideal self of others, yes. Yet, SDB can still exist independently of Identity Theory if the person expresses a sentiment approved by others but inconsistent with their multiple identities. For example, if the person does not truly care about farm animals in their ideal or common self but says they do because that would be viewed favorably by others. This is an instance of SDB that isn't explained by Identity Theory—

unless one of the multiple selves is an identity of conformity. The extent to which Identity Theory and SDB is entangled is thus a matter of semantics.

We are not the first to hypothesize that Identity Theory can explain biases in survey behavior. Brenner and DeLamater (2016) argue that it helps explain social desirability bias whereby people misrepresent their true behaviors to seem more socially appealing, even on anonymous questionnaires. They argue that many survey questions asking about normative behaviors (*i.e.*, actions Smith's impartial spectator has a moral opinion about) induces the respondent to answer according to what their ideal self is rather than their actual behaviors, and the authors provide empirical evidence for their claim. For example, when our hypothetical father is asked if he eats a healthy breakfast every day, he will depict himself as a healthier breakfast eater than he really is. Even though he isn't one during the week because convenience is preferred due to time constraints, he will provide a response that depicts him as a healthy breakfast eater because 'healthy eater' is his ideal self.

Albeit, Identity Theory is not a silver bullet to the problems with bias addressed by previous work, but we believe it's a start in the right direction. Identity Theory provides us with an intellectual toolbox for designing survey questions by first asking researchers to explicitly state which of a person's potential identities they seek information about, a question rarely posed in survey design. It then suggests that we craft the series of questions so that individuals can provide information about that targeted identity and activate that identity in full, without contradicting recently activated identities in previous questions. First, though, we must confirm whether the predictions of Identity Theory as manifested in the above model are confirmed by empirical evidence.

Methodology

Previous sections described the assumptions and implications of Identity Theory as used in psychology to help explain interactions between an individual and society. A conceptual model was then developed to hypothesize how Identity Theory might explain question-ordering effects in surveys, whereby the answer to any one particular question depends upon the previously asked questions. This model concentrated on survey questions that will cue either an ideal self (the identity the respondent aspires to) or the common self (the identity describing common behaviors, which can but often do not live up to the ideal self). A tenet of Identity Theory is that people can express multiple identities simultaneously, and when they do, they attempt to make these identities seem consistent even though these identities in their pure form may conflict.

An implication is that in surveys where different questions cue the individual to activate different identities, they will not switch from one discrete identity to another, but they will instead provide responses that make those identities seem more coherent by blending those discrete identities. There will be inertia in identity expression, a tendency to not deviate far from identities displayed previously. If a question were cueing the ideal self, then it would likely induce the person to express the ideal self, at least in part, on that question and subsequent questions. This identity inertia should be dependent upon the time interval in which a sequence of survey questions is asked. The most recently asked questions would likely have the greatest inertial impact on the answer to the current question. If there is a break in the questions that do not cue a certain identity, creating a greater time interval between the expression of the two identities, the identity inertia should be damped.

The purpose of this section is to describe a statistical test used for detecting identity inertia in surveys. A survey was administered where respondents are asked the extent to which they agree or disagree with a series of statements. Some statements were written to cue the respondent's ideal self and some for the common self. These are referred to as ideal-activating (IA) and common-activating (CA) questions, respectively. The survey design randomizes whether IA or CA questions come first, as well as how many IA or CA are asked in a sequence, allowing us to test for identity inertia. The extent to which responses depend upon the number of most recent IA and CA questions is then tested within a statistical model. If individuals appear to activate their ideal-self (or common-self) the greater the number of previously asked IA questions (or CA questions), then the survey will be said to provide some evidence for the role of Identity Theory in surveys.

Two categories of IA and CA questions are used. To identify questions that should activate the ideal self, we rely on the literature on SDB that identifies general behaviors that are thought to be socially desirable but rarely lived up to in full. These concern non-food issues, like voting, gossiping, and honesty which we term non-food statements. A second category concerns a food-related issue, animal welfare which we term food statements. Due to the results of recent Animal Sentience Survey (Anthis 2017) being inconsistent with the percent of vegetarians, we suggest this curious outcome might be due to IA questions were asked before CA questions. This may have led people to convey more about their aspirations than their actual eating behaviors. The survey design and questions asked are shown in Fig. 1.3. Due to the randomization assignment of both non-food and food statements, respondents saw at least 10 and at most 24 total questions.

Non-Food Issues

The non-food IA questions deal with general behaviors that American societies approve of. The first IA non-food question asks respondents whether they agree that ‘citizens have a moral obligation to vote’. This statement is used under the assumption that most respondents will aspire to be a regular voting citizen. Not all will, of course, but there is no universal statement that is guaranteed to cue the ideal self in everyone. A statement like this was thought to generate the highest degree of support even among those who rarely vote.

This question is also used because it has a clear common-self counterpart. The first common-self question in the non-food category asks whether the respondent agrees that ‘I always vote’. This concerns an actual behavior in a real-life setting where there is a cost to identity expression. It is presumed that many Americans will agree that citizens have a moral obligation to vote but that, if they were being honest, would have to admit they do not always vote. It is hypothesized that the more IA (and fewer CA) questions a respondent answers before seeing the statement ‘I always vote’, the less likely they are to agree that they always vote because doing so would signal two conflicting identities.

The remainder of the IA and CA in the non-food categories has similar features. The IA question concerns something the respondent aspires to be (*e.g.*, honest) but rarely achieves in full (*e.g.*, complete honesty always is a rarity). Respondents are always asked non-food questions first. Within a group of IA or CA questions the order of the statements is randomized. These questions resemble the statements used in the Marlowe-Crowne self-reported social desirability scale (Crowne and Marlowe 1960) in that they describe behaviors most people wish to but fail to always emulate. Some respondents are shown 2 or 6 IA statements first, followed by 2 or 6 CA statements, and some are given the reverse order.

For some respondents a set of ‘buffer’ questions are asked between the IA and CA questions. These contain statements like ‘I prefer to watch reality shows on television over crime shows’ that are relatively neutral in the identity they activate relative to the other questions. That is, they do not attempt to cue an ideal-self or common-self as the other questions. While even the most mundane question requires some selection of identities, what makes the buffer questions unique is that they do not obviously appeal to the person’s ideal self. The greater the number of buffer questions between a set of IA and CA (or CA and IA) questions, the less impact identity inertia is hypothesized to have on the results. The number of non-food questions asked of respondents ranged from 4 to 18.

Let us begin building an empirical model of the survey responses. Denote Y_{it} as the expressed agreement by the *i*th individual to the *t*th question with a statement where 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree. The value of Y_{it} will depend on whether it is an IA or CA question, so let I_{it} be an indicator variable equaling one if an IA question was asked and zero otherwise, and C_{it} and B_{it} be indicator variables for CA and buffer questions, respectively. If the tenets of Identity Theory are manifested in the survey responses as described in the conceptual model, Y_{it} will also depend on the number of IA questions previously asked. By randomizing the number of IA and CA statements previously asked of respondents, we can measure and track which category of statements were posed more recently.

The most recently answered questions should have more influence on responses than questions in the more distant past, and it is not clear at what point a past question is no longer relevant, so we model the identity inertia effect using the exponential discounting variable $M_{it} = \sum_{k=1}^{t} \rho^k (I_{i,t-k} - C_{i,t-k})$. The variable M_{it} stands for 'memory' of past questions. The value of M_{it} is calculated using this formula even when the questions move from non-food to food issues. That is, M_{it} is not reset to zero on the first food issue question. Its value increases the more IA questions are asked in the past, decreases the more CA questions are asked, and is unchanged by the asking of a buffer question, for which $I_{it} = C_{it} = 0$. The value of ρ must be between zero and one, and was chosen *ex ante* to be 0.8. Alternative values of ρ are not considered until the first set of hypothesis tests to prevent pretesting and deterioration of statistical power due to multiple testing. We restrict $M_{i1} = 0$ for all *i* = 1 due to fact that respondents did not experience a question prior to the first. Thus, respondents were assumed to have a clean slate in term of their identity inertia. A statistical model explaining Y_{it} is expressed as

(1.6) $$Y_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 C_{it} + \beta_3 B_{it} + \beta_4 I_{it} M_{it} + \beta_5 C_{it} M_{it} + \epsilon_{it}$$

where the β_{it}s are parameters to be estimated and ϵ_{it} is a stochastic error term distributed according to the logistic distribution. This model formulation allows the answer to IA and CA questions to be impacted by the number and type of questions asked in the past, and allows the identity inertia (β_4 and β_5) impact to differ depending on whether the question cues the ideal or common self. If β_4 and/or β_5 are statistically significant, then an ordering-effect to the questions is present. Further, if $\beta_4 > 0$ and $\beta_5 > 0$, then the ordering effect is consistent with the predictions from the conceptual model in the previous section.

An additional variable is needed. It was suspected that an ordering effect would be present, as it usually is with surveys. To provide a benchmark as to whether the ordering effect is large, we deliberately include another effect: acquiescence bias. This occurs when people generally prefer to agree to statements than disagree (Tourangeau and Bradburn 2010). For some of the survey respondents, the CA questions for non-food items were reversed in valence, meaning instead of the statement 'I always vote' it says, 'Sometimes I fail to vote'. With this reversed valence, a higher value of Y_{it} indicates less desirable behavior that is not consistent with the ideal-self, as opposed to the other questions where a higher value of Y_{it} is more consistent with the ideal-self. As such, for observations with a reversed valence, the value of Y_{it} is reformatted to $7 - Y_{it}$. This is done so that a higher value of Y_{it} always indicates greater agreement with a desirable behavior. Nevertheless, because of the acquiescence bias, Y_{it} will likely be a lower value for reversed valence observations, on average. If V_{it} is an indicator variable for questions with reversed valence the statistical model now becomes

(1.7) $$Y_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 C_{it} + \beta_3 B_{it} + \beta_4 I_{it} M_{it} + \beta_5 C_{it} M_{it} + \beta_6 C_{it} V_{it} + \epsilon_{it}.$$

If the absolute value of β_4 or β_5 is greater than the absolute value of β_6, then it can be said (in this specific case) that the ordering effect is larger than the acquiescence effect.

Food Issues

After the individual had answered a set of non-food questions, they were presented with a set of IA and CA questions regarding a food-related issue: animal welfare. The topic of animal welfare is chosen because it was a recent animal welfare survey that helped inspire this research (Anthis 2017).

Why would so many meat-eaters say they wish to ban slaughterhouses and animal farming? One explanation is in the ordering of the questions, which was not randomized. Instead, respondents were first given a few questions that, for some, would seem to cue their ideal self. These include the following statements: (1) People should consume fewer animal-based foods (meat, dairy, and/or eggs) and more plant-based foods (fruits, grains, beans, and/or vegetables), (2) I have some discomfort with the way animals are used in the food industry, and (3) Farmed animals have roughly the same ability to feel pain and discomfort as humans. These questions do not ask about the respondents' actual eating behaviors but the behaviors they may aspire to. While not everyone aspires to be a vegetarian, health professionals have been urging Americans to eat more plants for some time, climate change groups are increasingly blaming animal agriculture for global warming, and the spirit of the last few decades is toward a greater concern for animal treatment. Perhaps the respondents agreed with these first set of questions because it asked about their aspirations and cued their ideal-self, but when confronted with a question about their actual eating habits, cueing the common self, the desire to not appear hypocritical induced them to activate a mixture of their ideal- and common-self. As such, many of them claim they are against the raising and slaughter of animals for food consumption when their eating habits say otherwise. Perhaps if they had been asked whether they would ban slaughterhouses and animal agriculture first, they would have indicated less support.

To test this hypothesis, respondents were administered three questions about livestock treatment that cue the ideal-self and three that cue the common-self, with the order of the selves activated randomized (unlike the Animal Sentience survey). Some respondents also answered a few buffer questions between the two identity types (as seen in Fig. 1.3). All six questions regarding animal welfare are pulled verbatim from the Animal Sentience survey (Anthis 2017).

Empirical Model

The statistical model explaining answers to the food-related questions are the same as the model for the non-food questions, except there are no observations with reversed valence. Because the food and non-food questions concern such different topics, separate parameters are estimated for each set. If we let the g and f subscript denote the non-food and food-related questions, respectively, the complete statistical model can be written as

$$Y_{it} = \beta_0 + \sum_{k=g,f}\left(\beta_{1,k}I_{it} + \beta_{2,k}C_{it} + \beta_{3,k}B_{it} + \beta_{4,k}I_{it}M_{it} + \beta_{5,k}C_{it}M_{it}\right) + \beta_{6,g}C_{it}V_{it} + \epsilon_{it}. \quad (1.8)$$

One final variable is needed for the food questions. It might be that many people indicated support for banning slaughterhouses and eliminating animal farming in the Animal Sentience survey because they are not sure what it implies. Without animal farming and slaughter, there can be no meat consumption. Roughly half of the subjects were given the CA statements exactly as they appeared on the Animal Sentience survey, while the other half contained an addition shown in brackets in Fig. 1.3. For example, some saw the statement ‘I support a ban on slaughterhouses’ while others saw the statement ‘I support a ban on slaughterhouses and will stop eating meat’. The addition to each of the three CA questions is intended to clarify the consequences of the measure proposed. Let A_{it} be an indicator variable identifying questions with this addition. The statistical model now becomes

$$(1.9)\qquad Y_{it} = \beta_0 + \sum_{k=g,f}\left(\beta_{1,k}I_{it} + \beta_{2,k}C_{it} + \beta_{3,k}B_{it} + \beta_{4,k}I_{it}M_{it} + \beta_{5,k}C_{it}M_{it}\right) + \beta_{6,g}C_{it}V_{it} + \beta_{7,f}C_{it}A_{it} + \epsilon_{it}.$$

To avoid perfect multicollinearity, $\beta_{3,f}$ is left out of the estimated model. If $\beta_{7,f}$ is less than zero, then the addition to the CA statement reduces support for the statement and provides information on the extent to which people did not understand the Animal Sentience survey questions fully. The model is estimated as an ordered logit regression to account for the discrete nature of the dependent variable Y_{it}.

Hypotheses

The conceptual model of Identity Theory outlined earlier suggests identity inertia in the answering of survey questions. While it is well-known that answers to a single survey question are influenced by the questions asked previously (Tourangeau and Bradburn 2010), our model provides a theoretical explanation for ordering effects. While it is not intended to be an explanation for all ordering effects, if the model has empirical validity it can help researchers design survey questions.

The variable M_{it} measures the type of questions individual *i* faced previously to question *t*. The average value of M_{it} in the data is approximately zero because of the balanced nature of the randomization of IA and CA questions. Its standard deviation is

1.55, and its minimum and maximum values are -3.41 and 3.41, respectively (the minimum and maximum have similar absolute values due to the balanced randomization). Our model predicts that as the value of M_{it} rises, indicating more IA questions in the recent past, the higher the value of Y_{it} indicating greater agreement with the statement. This would mean a person is likely activating more of their ideal-self. Conversely, the lower the value of M_{it}, the lower the value of Y_{it} and activation of the common-self. As such, we hypothesize that $\beta_{4,g}$, $\beta_{5,g}$, $\beta_{4,f}$, and $\beta_{5,f}$ should each be positive.

There are a few other hypotheses not directly relevant to Identity Theory. The acquiescence effect should result in a negative value for $\beta_{6,g}$. The additional information that banning factory animal farming would lead to higher food prices and banning slaughterhouses and animal farming would eliminate meat as a food should reduce agreement, thus we hypothesize $\beta_{7,f}$ should also be less than zero. Finally, we hypothesize that $\beta_{1,k} > \beta_{2,k}$ for all *k*, as we believe individuals will be more eager to express their ideal self than their common self.

A few nuances regarding these tests are warranted. First, the test of whether $\beta_{4,g}$, $\beta_{5,g}$, $\beta_{4,f}$, and $\beta_{5,f}$ are greater than zero is not a test of Identity Theory itself, but our specific interpretation of how Identity Theory might be manifested in survey responses. Second, even if $\beta_{4,g}$, $\beta_{5,g}$, $\beta_{4,f}$, and $\beta_{5,f}$ are each greater than zero that alone does not prove Identity Theory is the explanation. Other interpretations are possible. Consider how, if people are more eager to agree with IA questions, and there is a simple ordering effect (without any theoretical explanation) whereby greater agreement in the past leads to greater agreement on the current question, then $\beta_{4,g}$, $\beta_{5,g}$, $\beta_{4,f}$, and $\beta_{5,f}$ will be greater than zero. No pristine test of Identity Theory in ordering effects is performed because no such test that we know of exists. Nevertheless, we proceed to test these imperfect hypothesis tests because we believe the role of Identity Theory in survey design is worth exploring.

Respondents

Data were collected via an online survey through Qualtrics from August to October 2019. A representative sample of nearly 2,600 was drawn from the U.S. population. After filtering out respondents under the age of 18 and incomplete responses to the main statements, the sample contained 2,354 respondents. Table 1.1 presents summary statistics of ten demographic variables collected from the survey.

While many are similar to the demographic profile of the nation, the sample is not representative of the general public as it is an opt-in survey where individuals must volunteer to participate in the survey in return for various forms of compensation. Yet, because the purpose of the study is to explore respondent behavior from the order of different identity cueing questions and is not intended to illustrate the attitudes of the whole nation, there is no need for a perfectly representative sample or sample balancing.

Results and Discussion

This section first describes the general pattern of survey responses separately for when ideal-self activating (IA) questions are asked first and when common-self activating (CA) questions are asked first. Descriptive statistics are then provided on the responses to the food issues. Then the empirical model in equation 1.9 is estimated as an ordered logit model and the primary hypothesis tests are conducted. A number of other variants of the ordered logit model are then evaluated.

The major hypothesis is that the survey responses will display a particular form of identity inertia, whereby the more IA questions answered in the recent past the higher their level of agreement will be and the more CA questions the lower their level of agreement. Fig. 1.4 and Fig. 1.5 display the frequency of responses by statement order, either IA or CA first, and statement type, either non-food or food. Fig. 1.4 displays the non-food statements. When ideal statements are asked first, respondents seem more likely to disagree those ideal statements, which is contrary to the predictions from the conceptual model. A somewhat similar distribution can be seen among the common and ideal responses when common statements are asked first. Noticeably, the responses for buffer statements shift toward the disagree side of the scale. Responses for the disagree choice shift from 31 to 41 percent. Fig. 1.5 shows the responses for the food-related questions when IA and CA statements are presented first, respectively. Again, the response distributions are nearly identical for each question type with slight differences between the two orderings.

We further examine responses by factors of the survey design. The mean responses for each identity type, statement order, and question type can be found in Table 1.2. We first group the mean responses to non-food issues according to whether there is a balanced number of IA and CA statements are presented, either two or six. If the results follow the predictions of the conceptual model, the average level of agreement should be higher when IA statements are presented first (column three should be greater than column five in every row). This is the case for three out of four comparisons when an equal number of IA and CA questions are asked, but for only one out of four comparisons when the number of IA and CA questions differ. We further examine the mean responses to food statements. Here the level of agreement is highest in both cases where the IA questions are asked first.

Notice something peculiar about the level of agreement with the IA versus CA questions. It was thought that agreement would generally be higher for IA questions, but this is not always the case. This suggests that the specific questions used may not be activating the ideal-self and the common-self as thought, but we defer this discussion for the ordered logit estimates.

Before discussing the ordered logit coefficients, we use contingency analysis to check where responses are dependent or correlated to each other. Using Pearson's chi-square tests, we check for independence among the responses to the IA and CA non-food (NF) statements when ideal and common questions are asked first, respectively.

$$H_0\text{: } ideal\ and\ common\ NF\ responses\ are\ statistically\ independent$$
$$H_A\text{: } ideal\ and\ common\ NF\ responses\ are\ not\ statistical\ independent$$

We reject the null hypotheses and conclude the responses to the IA and CA non-food statements are dependent when ideal statements are asked first ($\chi^2_{36} = 874.73$, $\mathrm{p} =< 0.01, \alpha = 0.05$) and when common statements are asked first ($\chi^2_{36} = 1{,}378.03$, $\mathrm{p} =< 0.01, \alpha = 0.05$). We also check for linear correlation among the responses to IA and CA non-food (NF) statements based on order using the Mantel-Haenszel test statistic.

$$H_0\text{: } ideal\ and\ common\ NF\ responses\ are\ not\ linearly\ correlated$$
$$H_A\text{: } ideal\ and\ common\ NF\ responses\ are\ linearly\ correlated$$

We again reject the null hypotheses and conclude there is a linear trend among responses to IA and CA non-food statements when ideal statements are asked first ($\chi_1^2 = 319.64, \mathrm{p} =< 0.01, \alpha = 0.05$) and when common statements are asked first ($\chi_1^2 = 572.64, \mathrm{p} =< 0.01, \alpha = 0.05$).

We then check for dependence and correlation among the IA and CA food statements based on order. Since some respondents received extended versions of the CA food statements, we split the data into four parts: responses when IA questions are asked first (non-extended CA), responses when CA questions are asked first (non-extended CA), responses when IA questions are asked first (extended CA), and responses when CA questions are asked first (extended CA).

$$H_0: ideal\ and\ common\ food\ responses\ are\ statistically\ independent$$
$$H_A: ideal\ and\ common\ food\ responses\ are\ not\ statistical\ independent$$

We reject the null hypotheses and conclude the responses to the IA and non-extended CA food statements are dependent when ideal statements are asked first ($\chi_{36}^2 = 608.91, \mathrm{p} =< 0.01, \alpha = 0.05$) and when common statements are asked first ($\chi_{36}^2 = 687.59, \mathrm{p} =< 0.01, \alpha = 0.05$). We reach similar conclusions for when extended CA statements are included and ideal statements are asked first ($\chi_{36}^2 = 633.62, \mathrm{p} =< 0.01, \alpha = 0.05$) and common statements are asked first ($\chi_{36}^2 = 666.11, \mathrm{p} =< 0.01, \alpha = 0.05$). We also check for linear correlation among the responses to food statements using the Mantel-Haenszel test statistic.

$$H_0: ideal\ and\ common\ food\ responses\ are\ not\ linearly\ correlated$$
$$H_A: ideal\ and\ common\ food\ responses\ are\ linearly\ correlated$$

We again reject the null hypotheses and conclude there is a linear trend among responses to IA and non-extended CA food statements when ideal statements are asked first ($\chi_1^2 = 242.12, \text{p} =< 0.01, \alpha = 0.05$) and when common statements are asked first ($\chi_1^2 = 295.12, \text{p} =< 0.01, \alpha = 0.05$). We reach similar conclusions with extended CA statements when ideal statements are asked first ($\chi_1^2 = 297.15, \text{p} =< 0.01, \alpha = 0.05$) and when common statements are asked first ($\chi_1^2 = 238.88, \text{p} =< 0.01, \alpha = 0.05$).

Through these tests, we see evidence that the responses to ideal and common statements are related to each other, no matter the context and what order statements are arranged. This makes intuitive sense, as we suspect that the identity type a previous question cues plays a factor in how respondents will answer future questions. A question-ordering effect exists. Whether it is the kind of effect predicted by our conceptual model is determined from the ordered logit estimates.

An ordered logit model specified in equation 1.9 was estimated using the PROC LOGISTIC procedure in SAS 9.4. Table 1.3 presents the results from the ordered logit model with the level of agreement (1 = strongly disagree to 7 = strongly agree) as the dependent variable and the Identity Theory indicators, memory, and interaction terms of the indicators and memory as explanatory variables.

Food vs. Non-Food Questions

While we cannot directly interpret the estimates, as they relate to latent utility that is unobservable and unclear in meaning (Greene 2012), we can make conclusions from the estimate signs and magnitudes. Particularly, we are interested in if the non-food IA and

CA parameters and food IA and CA parameters are jointly equal. Using Wald tests, we conclude the main effect parameters are not equal ($H_0\colon \beta_{1,g} = \beta_{2,g} = \beta_{1,f} = \beta_{2,f}, \chi_3^2 = 1281.49$, p $=< 0.01, \alpha = 0.05$).

We first evaluate the differences between the IA and CA questions. When designing the survey, it was assumed that there would be a greater agreement with the IA than the CA statements. This assumption was confirmed as both the IA parameter for non-food statements ($\beta_{1,g}$) and food statements ($\beta_{2,g}$) are greater than their CA counterparts ($\beta_{1,f}$ and $\beta_{2,f}$, respectively). This suggests that the two types of questions may indeed be cueing different identities. The IA non-food parameter is statistically different from the CA non-food parameter ($H_0\colon \beta_{1,g} = \beta_{2,g}, \chi_1^2 = 17.94$, p $=< 0.01, \alpha = 0.05$), and the IA food parameter is statistically different from the CA food parameter ($H_0\colon \beta_{1,f} = \beta_{2,f}, \chi_1^2 = 598.89$, p $=< 0.01, \alpha = 0.05$). This suggests that IA questions cue an individual's identity with a higher prominence. Yet, there is a larger difference in magnitude between the two IA and CA food statement parameters ($\beta_{1,f}$ and $\beta_{2,f}$, respectively), suggesting that while the group may aspire toward a more-plant based diet, they are less willing to give up eating meat. It is noted that the negative CA food statement parameter estimate ($\beta_{2,f}$) does not signal disagreement but rather the level of agreement is lower than the IA food statements.

We assumed that it would be difficult to test for an identity inertia with the food statements because the degree of what people aspire toward a plant-based diet was unknown. Yet, the results from Anthis (2017) and the results in Table A.1.1 suggest an inertia effect can be tested. Due to $\beta_{1,f}$ being positive and larger than $\beta_{2,f}$, the food questions can be used for a test of identity inertia in the same manner that was used for the non-food statements. Since the difference between the IA and CA estimates are larger for the food statements than the non-food statements, this might present a stronger test for identity inertia.

When comparing the same identities across non-food and food statements, we see a difference between the two IA parameter estimates (H_0: $\beta_{1,g} = \beta_{1,f}, \chi_1^2 = 165.55$, p $=< 0.01, \alpha = 0.05$). The same can be said for the CA parameter estimates (H_0: $\beta_{2,g} = \beta_{2,f}, \chi_1^2 = 700.00$, p $=< 0.01, \alpha = 0.05$). In both cases, the non-food questions are larger in magnitude than their food question counterparts. This may indicate the non-food statements produce higher levels of agreement in individuals regardless of which identity is cued. We can thus conclude the ideal self may be called upon more with the non-food statements more because of the general high level of agreement. Yet, there are larger differences between the IA and CA food statements. This may suggest that a food issues context cue less similar identities from individuals.

Analysis of Food Questions

Since we observe a large difference in the magnitude of the parameters of IA and CA food questions, the responses to the food questions are explored further. Fig. 1.6 displays the proportions of respondents with their respective level of agreement. Recall that two forms of CA questions were asked. In one form of the CA questions, the ban is simply described. These bans deal with factory farming, slaughterhouses, and animal farming. In the other form of CA questions, the statement is extended to inform the respondent of what supporting a ban would cause. For example, a ban in factory farming will result in paying higher prices for food. The second form is therefore referred to as ‘extended’ statements hereafter.

We first examine the responses to the first form of CA questions. We group the CA food questions because they have implications for daily food consumption, and are not general attitudes like the IA questions, thus giving a context environment for identity expression. More than 20 percent of respondents agree to support a ban on animal farming, much like the results of Anthis (2017). Yet, when the extended form is presented to respondents, the level of agreement drops between 4 to 13 percentage points for each statement. While this is not a national balanced sample, roughly one in five of the respondents have a negative view on animal farming that they think it should be eliminated.

It was suspected that the ordering of questions and/or a failure to understand the implications of a slaughterhouse ban was the reason for the larger percentage of people agreeing with a ban in Anthis (2017). Our results suggest the cause is not from question ordering. Even though we randomize question order, about 35 percent of respondents support a ban on slaughterhouses. Question ordering did not change these results. Fig. 1.7 and Fig. 1.8. display the portion of respondents with their level of agreement when ideal and common statements are asked first, respectively. When ideal statements are first, about 36 percent of respondents agree to a ban on slaughterhouses. Conversely, about 33 percent agree to a ban on slaughterhouses when common statements are provided first. In the extended form of the slaughterhouse ban question, fewer individuals agreed when the common statements came first. This is 5 percentage points lower than when ideal statements are asked first.

With the other CA food questions, there are slight to moderate differences to the responses depending on question order. In the animal farming questions, we get a blended effect. When common questions are first, fewer people disagreed with a ban on animal farming. For the extended animal farming ban question, more people disagreed when common statements were asked first. As for the non-extended question about factory farming, more individuals disagreed when ideal statements are asked first.

IA food questions concerned whether respondents believed people should move to a more plant-based diet, whether they experience discomfort in how animals are raised, and whether farm animals can feel pain similar to humans. Each question results in a larger portion of agreement from respondents than neither or disagreement. Due to about half of respondents saying diets should be composed of more plant-based foods and less animal-based food, the use of the food questions to cue ideal and common identities within respondents is only valid for a portion of the sample. Due to this result, we will need to modify the empirical model used to test for identity inertia. We see a negative and statistically significant for the extended questions ($\beta_{7,f}$). This indicates that respondents' level of agreement falls when the consequences of bans on animal agriculture practices, further supporting our findings from Fig. 1.6.

Identity Inertia

To explore the possibility of an identity inertia effect we examine the parameters ($\beta_{4,g}$,

$\beta_{5,g}$, $\beta_{4,f}$, and $\beta_{5,f}$). Wald tests are used to test the joint significance of the four memory parameters in question. We reject the null hypothesis and conclude the coefficients are different (H_0: $\beta_{4,g} = \beta_{5,g} = \beta_{4,f} = \beta_{5,f}, \chi^2_3 = 8.58, p = 0.04, \alpha = 0.05$).

We then look at the individual parameters. The interaction term of CA non-food questions and memory, $\beta_{5,g}$ is significant at the 5 percent level, while the interaction term for the CA food questions and memory, $\beta_{5,f}$, is only significant at the 0.10 level. The two interaction terms for IA questions and memory are insignificant at the 0.10 level. Recall that a higher value of the memory variable indicates more recent IA questions, which the conceptual model predicted should lead to greater agreement on the question being asked. Regarding the CA questions, both estimates are positive and similar in magnitude, which support our hypothesis from the conceptual model. Yet, the other memory interaction terms for the ideal statements are insignificant. If identity inertia in the way we predict is present in survey responses, it is only detected one-half to one-quarter of the time, depending on the confidence level, and for CA questions only.

Why would identity inertia be present when the common-self is cued by a question and not the ideal-self? One reason may have to do with the censored nature of the data. Agreement to ideal-self statements are higher than those to the common-self statements, so there is less room for the dependent variable to rise when IA questions are asked first. That is, agreement to ideal-self questions may appeal to identities with such a high prominence that the attributes of the previous questions may not matter. Compare this to questions prompting the common-self, which elicits less agreement in general, giving the dependent variable more room to increase due to identity inertia.

Another explanation has to do with salience. The IA questions concern general attitudes, while CA questions concern actual behaviors. These general attitudes are not grounded in real life unless the respondent regularly gives speeches regarding the virtues of voting, gossiping, and honesty. The CA questions are thus truer in daily life, more meaning, more salience, and thus might be answered with greater thought than the IA questions. This greater salience then allows CA questions to be influenced to a greater extent by the setting. In other words, perhaps people just always agree that 'voting is good' in every context but whether they are honest about their voting behaviors depends on the setting. This of course is *ad hoc* speculation, and it could be that the predictions of the conceptual model fail to pass all the hypothesis tests because the conceptual model is flawed or incomplete.

Now, consider the fact that identity inertia was not detected at the 0.05 significance level for either test in the food issues. While this could be because the identity inertia is a small effect, unable to be detected in the data. Indeed, although acquiescence bias is a known phenomenon (Tourangeau and Bradburn 2010) but it was not detected in the data either ($\beta_{6,g}$ is insignificant at the 0.05 level). Perhaps the empirical model in Table 1.3 is ill-suited for food issues, given the previous discussion that only about half of the respondents indicated agreement with the food IA questions. To accommodate this, we purposely split the data into two groups and estimated selected ordered logit models based on respondents who agreed with the food IA statements. If a respondent indicated an agreement greater than four for any of the IA food statements, they are included in the 'concerned' ordered logit model shown in Table A.1.1. These estimates provide the same basic results: identity inertia exists only for CA statements in non-food issues at the 0.05 significance level and exists for CA statements in food issues at the 0.10 level. Results for those respondents who indicated a neutral answer or disagreement in the food IA questions, or the 'not concerned' group, are shown in Table A.1.2.

Another way to incorporate preference heterogeneity is to estimate a latent class model, where instead of describing all respondents by one set of model parameters there are multiple classes of parameters. For example, if there are two classes, instead of estimating one value of

$\beta_{1,g}$, you estimate one value for class 1 and another value for class 2. Each respondent then has a certain probability of belonging to class 1 and a probability of belonging to class 2, and those probabilities sum to 100 percent. Table A.1.3 show the ordered logit results when two classes are used. Once again, we see the same results regarding identity inertia. For both classes, identity inertia is detected at the 0.05 significance level for CA non-food questions only.

Finally, let us consider the fact that the models thus far do not account for the panel nature of the data. Any one respondent answered multiple questions (ranging from 10 to 24) and if their errors are correlated this correlation can be accounted for in the estimation procedure. A random effects model was estimated whereby an addition stochastic error term v_i, which is a constant for each individual *i* but random across respondents, and $v_i \sim N(0, \sigma_v^2)$. The results shown in Table A.1.4 suggests that identity inertia exists at the 5% level in CA statements for both food and non-food issues. This is the only model thus far for which identity inertia is detected at the 5% level for CA food statements.

The models estimated provide one clear result: in the case of non-food statements, the questions prompting individuals to activate their common-self differ when they are proceeded by statements prompting the ideal self. They not only differ, but indicate greater agreement, as predicted by the conceptual model. There were a few other instances predictions from the conceptual model that did not come to fruition, including identity inertia for IA statements and identity inertia for CA statements for food issues.

Conclusions

Psychological biases, such as demand, social desirability, and acquiescence, have been found to exist in consumer surveys. While their effects have been found empirically throughout the literature, they are not detected every time even though we know these biases exist when respondents answer questions.

We postulate extensions of Identity Theory from the social psychology literature in the context of survey design and the potential biases from their results. Given its framework of people possessing multiple identities that are expressed in certain situations, we develop a theoretical model were individuals maximize their utility be choosing which identity or identities to exhibit given the context they face. We believe questions may activate different identities in respondents and thus cause a bias based on the need for consistency expression. That is, depending on the context of a question, a respondent may indicate how they aspire to be or how they actually behave in real life and try to do so without contradicting the identity expressed in previous questions. When respondents are asked a sequence of questions, their responses to future items may remain unchanged or deviate marginally from the questions they had in the past depending on which of their identities were cued.

Based on previous literature and logic of survey design, we develop a questionnaire and attempt to test empirically identity inertia. We test these theories through a survey questionnaire to elicit ideal-activating and common-activating behavior from individuals. A sample of 2,354 respondents were asked to provide their agreement with varying statements related to moral behavior and animal welfare. Through empirical evidence, we show that social desirability bias may exist by the ordering of questions. To alleviate this bias, we suggest researchers design surveys in a manner the call upon an individual's ideal identity first.

Results indicate that a moderate identity inertia effect is present when questions cue their common (or behavioral) self. Respondents have higher levels of agreement when more questions relating to their common self are asked in the past. We suggest that when building a survey to include a series of questions, researchers should not ask respondents questions relating to actual behavior or context-specific situations preceding questions that relate to their ideal self.

It has been noted that while previous research has tried to explain the biases in responses in survey questionnaires through its characteristics, such as wording and context effects, this study focuses on attributing the bias to the multi-faceted nature of individuals. Whereas previous work has been attentive on mitigating respondent bias, we suggest developing questions on surveys not solely based on the wording or phrasing used within the individual items but to consider the identity dimensions possessed by individual respondents. SDB may be viewed as a source of measurement error in self-reported survey. On the other hand, it may be an opportunity for researchers to learn about respondent self-view and prominence of identity expression (Brenner and DeLamater 2016).

This study failed to capture the prominence of each identity as done in previous studies. We assumed that the responses to the IA statements indicated an individual's level of prominence for those identities. Rather than assume, we could have provided various societal roles to the respondents, such as model citizen or supporter of animals, and asked them to rate their level of importance for those respective roles. Connections have been made between prominence and salience of identities when respondents have provided a value of a societal or behavioral role (Brenner and DeLamater 2016; Stryker and Serpe 1994). Future studies can examine a denser array of identities as well as attention to different applied issues. Brenner and DeLamater (2016) note the ought self "is the person one believes he or she ought to be given [societal, community, and group] norms" (p. 336). The survey in this study uses two identities and situational contexts, respectively, to explain the behavior of individuals. As we allude to within the theoretical framework of Identity Theory, individuals can express a portfolio of identities. By expanding the identity spectrum allowed by individuals and environments where those behaviors can be expressed, we might have more opportunities to test for identity inertia.

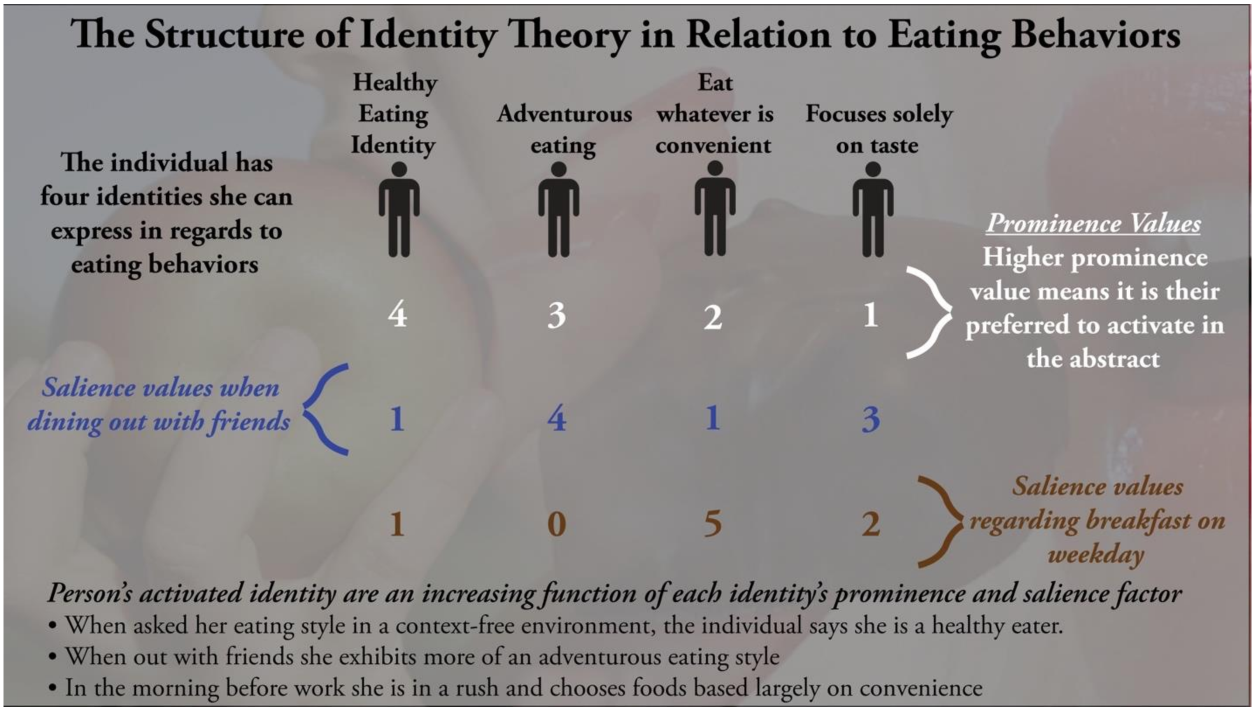


Figure 1.1. Example of Identity Theory

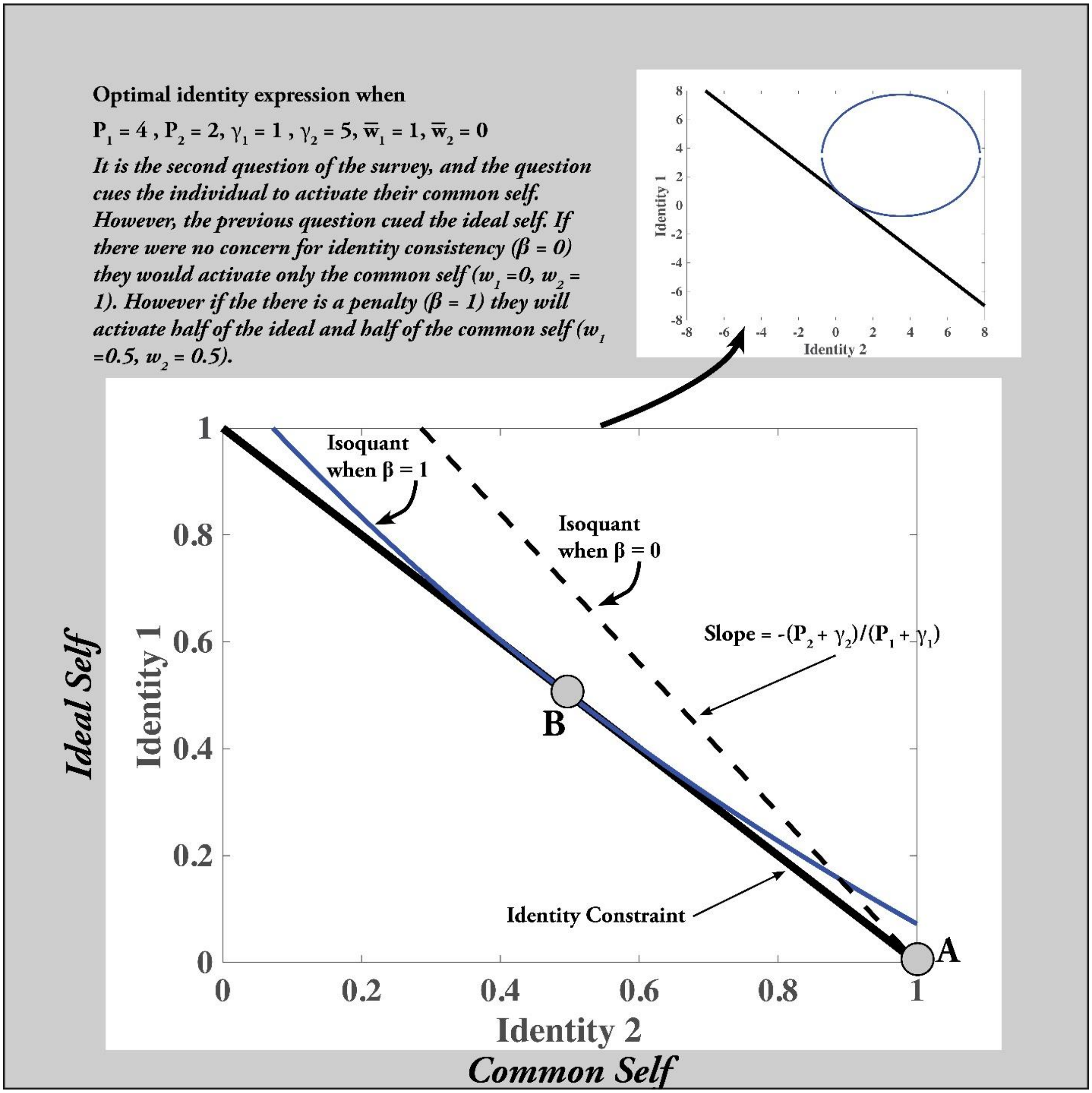


Figure 1.2. How identity inertia effects survey response

Non-Food Questions

Respondents randomly selected to see either
A) ideal-activating (IA) or
B) common-activating (CA)
questions first

A	**B**
Shown 2 or 6 IA questions	Shown 2 or 6 CA questions
↓	↓
Shown 0, 2, or 6 buffer questions	Shown 0, 2, or 6 buffer questions
↓	↓
Shown 2 or 6 CA questions	Shown 2 or 6 IA questions

2-6 non-food IA questions[a]:

1. Citizen have a moral obligation to vote.
2. Not voting is an insult to those who died protecting democracy.
3. A good person should never gossip.
4. A good person should avoid listening to gossip.
5. I always try to be honest.
6. A person who lies cannot be trusted.

3 food IA questions:

1. People should consume fewer animal-based foods (meat, dairy, and/or eggs) and more plant-based foods (fruits, grains, beans, and/or vegetables.).
2. I have some discomfort with the way animals are used in the food industry.
3. Farmed animals have roughly the same ability to feel pain and discomfort as humans.

Food Questions

Respondents randomly selected to see either
C) ideal-activating (IA) or
D) common-activating (CA)
questions first

C	**D**
Shown 3 IA questions	Shown 3 CA questions
↓	↓
Shown 0 or 3 buffer questions	Shown 0 or 3 buffer questions
↓	↓
Shown 3 CA questions	Shown 3 IA questions

2-6 non-food CA questions[a]:

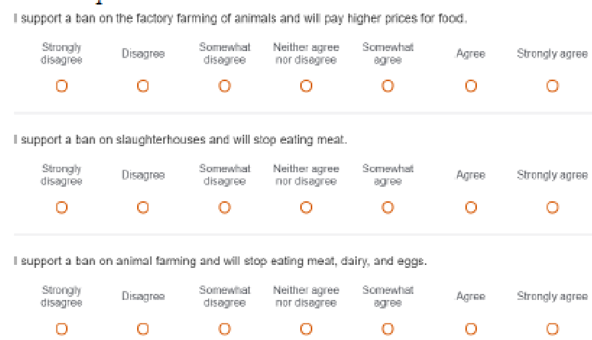
1. I always vote.[b]
2. I always research the political candidates before I vote.[b]
3. I never gossip.[b]
4. I never listen to gossip.[b]
5. My friends would say I always tell the truth.[b]
6. In the last month I have not told a lie.[b]

3 food CA questions:

1. I support a ban on the factory farming of animals (and will pay higher prices for food).[c]
2. I support a ban on slaughterhouses (and will stop eating meat).[c]
3. I support a ban on animal farming (and will stop eating meat, dairy, and/or eggs).[c]

Format of Questions

All questions are posed as statements where the individual then indicates the extent to which they disagree or agree with the statement, where 1 = strongly disagree, …, 4 = neither disagree nor agree, …, and 7 = strongly agree. See example of three food CA questions below.



2-6 non-food buffer questions[a]:

1. Some of the comedies I watch on television refer to political issues.
2. Some of the dramas I watch on television refer to political issues.
3. I prefer to watch reality shows on televisions over crime shows.
4. My television is larger than most of my friends' television.
5. I usually record television shows and fast-forward through the commercials.

I usually record television shows but I still like to watch the commercials.

3 food buffer questions:

1. I usually watch television shows every night.
2. I listen to the news on the radio.
3. I still live in the town I grew up in.

Notes: [a] - Respondents seeing only 2 of IA, CA or buffer questions are always given the first two in the list.
[b] - For some respondents, the valence of these questions was reversed so that individuals would rather disagree than agree it.
[c] - Half of the respondents saw this question with, and half without, the extended text in brackets.

Figure 1.3. Survey design and questions

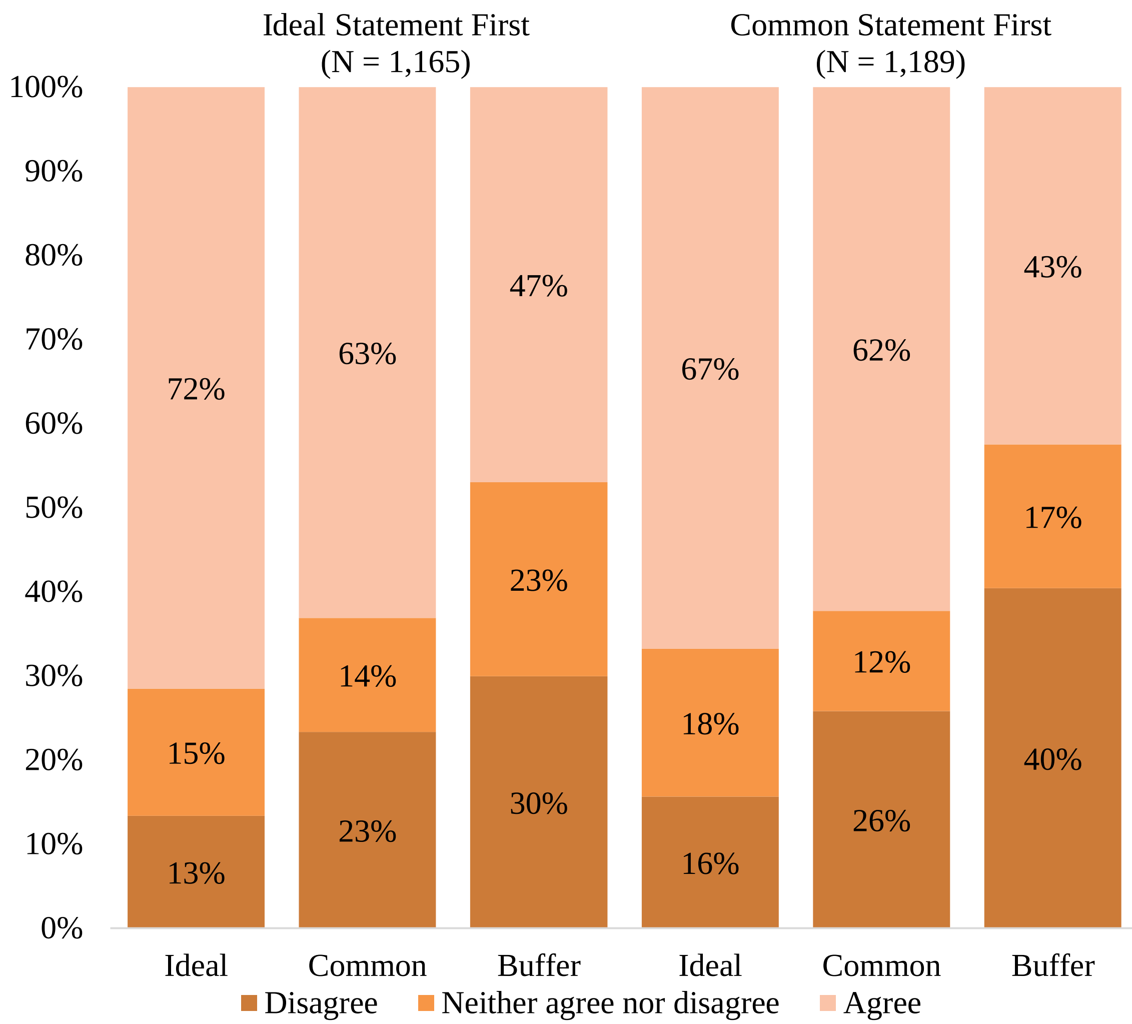


Figure 1.4. Frequency of responses of non-food statements by question order
Notes: Responses to statements were given on a scale where 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree. Respondents answering 1-3 are said to disagree, 4 are said to neither agree nor disagree, and 5-7 are said to agree.

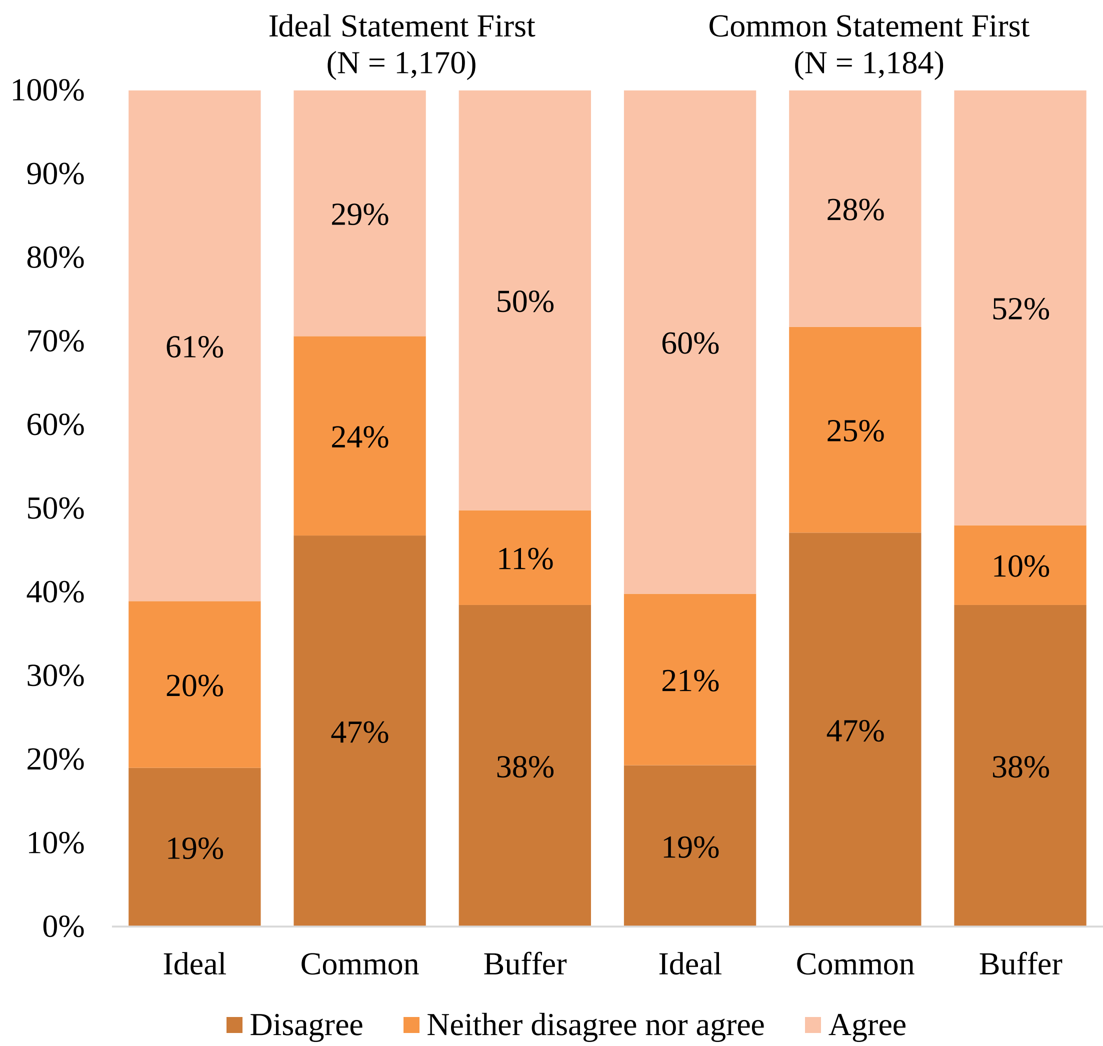


Figure 1.5. Frequency of responses of food statements by question order
Notes: Responses to statements were given on a scale where 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree. Respondents answering 1-3 are said to disagree, 4 are said to neither agree nor disagree, and 5-7 are said to agree.

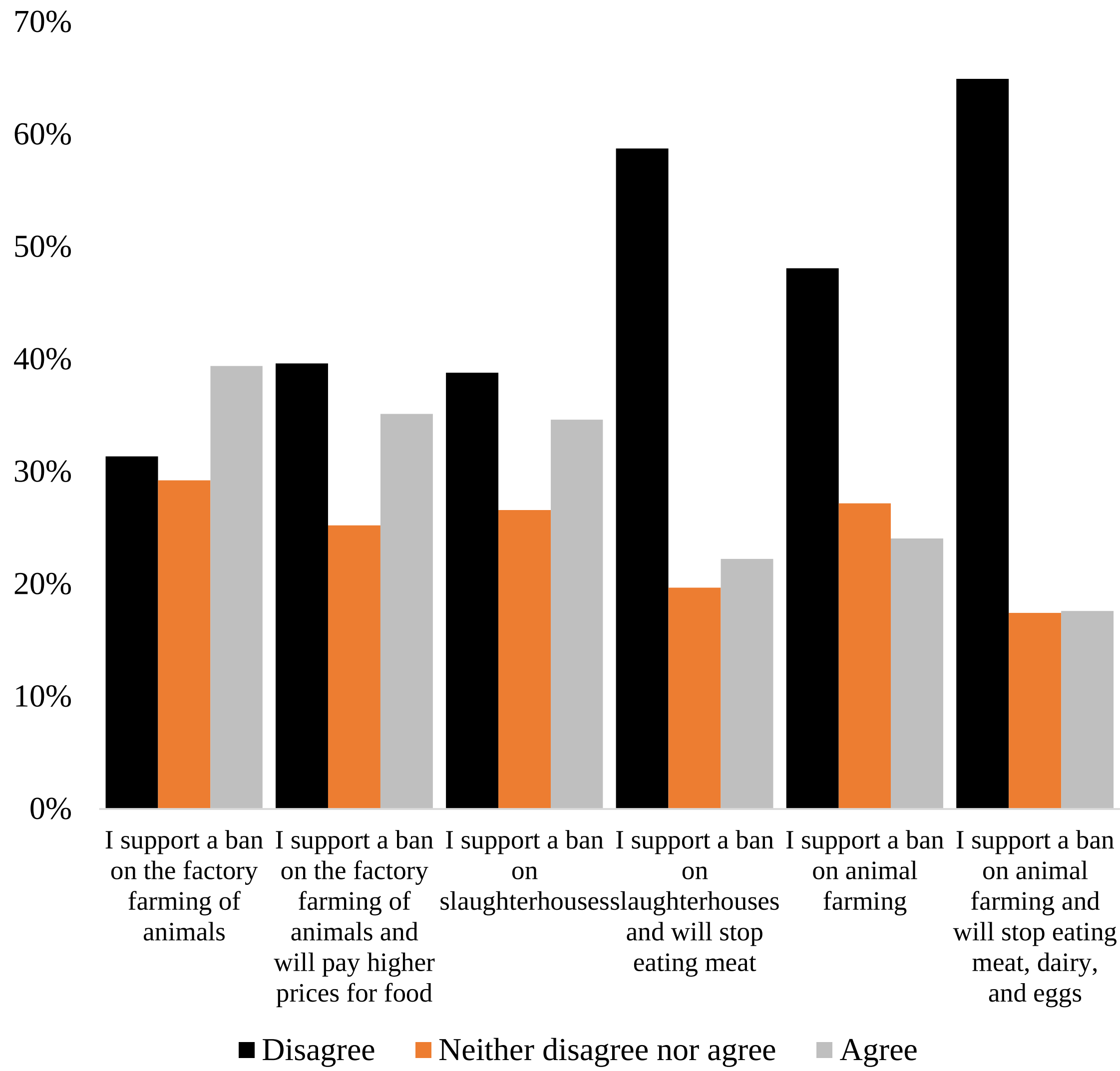


Figure 1.6. Responses to common-activating food statements regarding bans on livestock and meat production

Notes: Responses to statements were given on a scale where 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree. Respondents answering 1-3 are said to disagree, 4 are said to neither agree nor disagree, and 5-7 are said to agree.

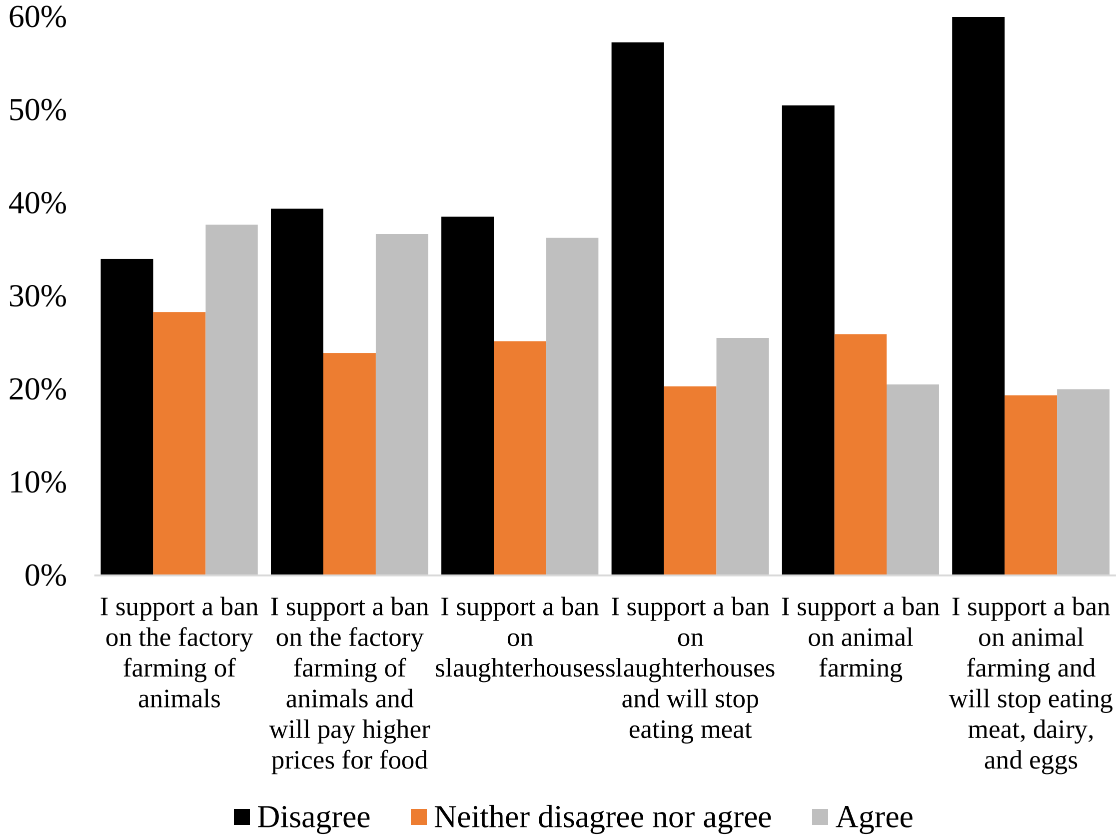


Figure 1.7. Responses to common-activating food statements regarding bans on livestock and meat production when ideal statements are asked first
Notes: Responses to statements were given on a scale where 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree. Respondents answering 1-3 are said to disagree, 4 are said to neither agree nor disagree, and 5-7 are said to agree.

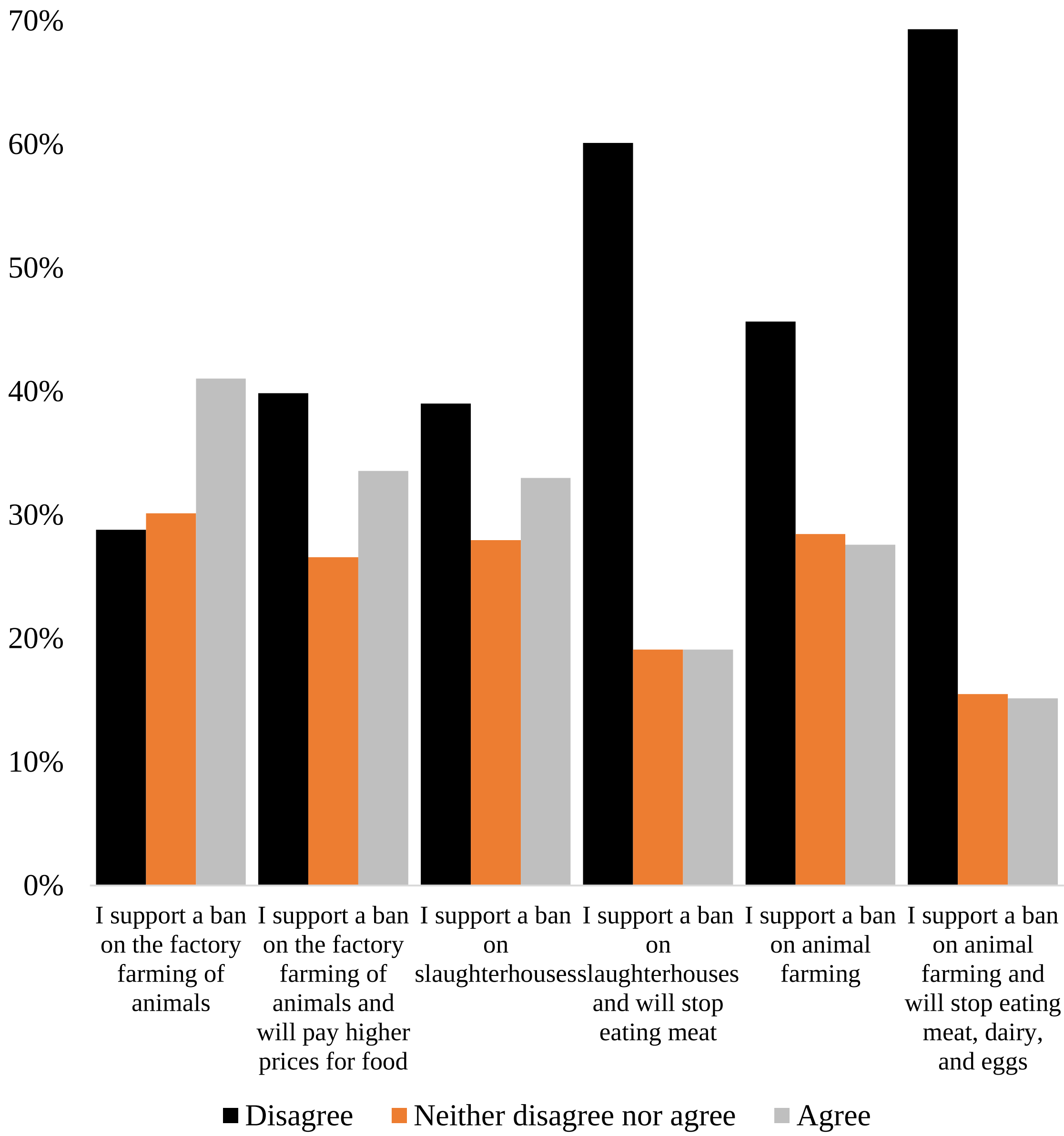


Figure 1.8. Responses to common-activating food statements regarding bans on livestock and meat production when common statements are asked first

Notes: Responses to statements were given on a scale where 1 = strongly disagree, 4 = neither agree nor disagree, and 7 = strongly agree. Respondents answering 1-3 are said to disagree, 4 are said to neither agree nor disagree, and 5-7 are said to agree.

Table 1.1. Summary Statistics of Demographic Variables (N = 2,600)

Variable	Description	Frequency	Percent
Age	35-44	550	21.15
	25-34	538	20.69
	55-64	425	16.35
	65 or older	418	16.08
	45-54	407	15.63
	18-24	262	10.08
Gender	Male	1,334	51.41
	Female	1,256	48.40
	Other	5	0.19
Marital Status	Married	1,333	51.31
	Never married	625	24.02
	I have a life partner but am not married	260	10.01
	Divorced	203	7.81
	Widowed	108	4.16
	Separated but still married	53	2.04
	Other	17	0.65
Income (Annual Pre-tax Household Income in U.S. Dollars)	$100,000 to $149,999	448	17.23
	$75,000 to $99,999	338	13.00
	$50,000 to $59,999	241	9.27
	$150,000 or more	238	9.15
	$60,000 to $74,999	216	8.29
	$40,000 to $49,999	171	6.58
	Less than $5,000	166	6.38
	$25,000 to $29,999	130	5.00
	$20,000 to $24,999	129	4.96
	$30,000 to $34,999	107	4.12
	$35,000 to $39,999	95	3.65
	$7,500 to $14,999	321	12.35
Region	East	284	10.92
	Midwest	432	16.61
	South	1,001	38.49
	West	856	32.91
Total Residents	Number of residents in household	2.74	1.41
Children	Number of children in household	2.52	2.58
Unemployed	Number of unemployed in household	1.77	0.42
Fully Employed	Number of full employed in household	1.30	0.46
Education	High school diploma	988	38.00
	Bachelor’s degree	659	25.35
	Associate’s degree	464	17.85
	Graduate degree	414	15.92
	No high school diploma	75	2.88

Notes: Summation of percentages may not equal 100 due to rounding. Summation of frequencies may not equal 2,600 due to missing responses.

Table 1.2. Mean Responses by Survey Design Factors (N = 2,354)

	Statement Order			
Identity Type	Ideal Asked First		Common Asked First	
	Non-Food Statements[a]			
Balanced	*N*	*Mean Response*	*N*	*Mean Response*
Two IA statements	480	4.97	433	5.12
Two CA statements		5.27		5.23
Six IA statements	388	5.45	497	5.18
Six CA statements		4.97		4.82
Unbalanced				
Six IA statements	161	5.22	115	4.98
Two CA statements		4.59		4.73
Two IA statements	136	4.98	144	5.05
Six CA statements		4.84		5.06
	Food Statements[b]			
	N	*Mean Response*	*N*	*Mean Response*
Three IA statements	1,170	4.85	1,184	4.81
Three CA statements	1,170	3.56	1,184	3.54

Notes: IA and CA refer to ideal-self activating and common-self activating questions.
[a] – Respondents were asked either 2 to 6 non-food ideal-activating (IA) and common-activating (CA) statements, respectively.
[b] – Respondents were asked 3 food IA and CA statements, respectively.

Table 1.3. Estimated Ordered Logit Regression with Response as Dependent Variable[a] (N = 2,354)

Variable	Parameter	Estimate (Std. Error)	χ^2-value
Ideal (Non-Food)	$\beta_{1,g}$	0.889*** (0.051)	305.31
Common (Non-Food)	$\beta_{2,g}$	0.736*** (0.056)	172.50
Buffer (Non-Food)	$\beta_{3,g}$	-0.174*** (0.061)	8.13
Ideal (Non-Food) × Memory	$\beta_{4,g}$	0.015 (0.013)	1.35
Common (Non-Food) × Memory	$\beta_{5,g}$	0.050*** (0.013)	15.42
Ideal (Food)	$\beta_{1,f}$	0.521*** (0.051)	102.78
Common (Food)	$\beta_{2,f}$	-0.372*** (0.055)	45.05
Buffer (Food)	$\beta_{3,f}$	0.000[b]	
Ideal (Food) × Memory	$\beta_{4,f}$	-0.004 (0.014)	0.06
Common (Food) × Memory	$\beta_{5,f}$	0.026* (0.014)	3.40
Common (Non-Food) × Valence	$\beta_{6,g}$	0.027 (0.037)	0.51
Common (Food) × Extended	$\beta_{7,f}$	-0.561*** (0.042)	179.21

Notes: * and *** denote statistical significance at the 0.10 and 0.01 level, respectively.
[a] – The threshold and intercept parameters are not shown for succinctness.
[b] – Coefficient is normalized to zero for model identification.
[c] – Memory denotes the M_{it} variable.
[d] – Valence denotes the V_{it} variable for when statement agreement is switched.
[e] – Extended denotes the A_{it} variable for extended forms of common (food) questions are asked.

REFERENCES

Aksan, N., K. Buket, M. Aydin, and S. Demirbuken. 2008. “Symbolic Interaction Theory.” *Procedia - Social and Behavioral Sciences*. 1(1):902-904.

Alós-Ferrer, C. and F. Strack. 2014. “From Dual Processes to Multiple Selves: Implications for Economic Behavior.” *Journal of Economic Psychology*. 41:1-11.

Anthis, J. 2017. Survey of US Attitudes Towards Animal Farming and Animal-Free Food. Animal Sentience Institute. Retrieved at https://www.sentienceinstitute.org/animal-farming-attitudes-survey-2017.

Belk, R. 1988. “Possessions and the Extended Self.” *Journal of Consumer Research*. 15(2):139-168.

Bhattacharjee, A., J. Berger, and G. Menon. 2014. “When Identity Marketing Backfires: Consumer Agency in Identity Expression.” *Journal of Consumer Research*. 41(2): 294-309.

Blumer, Herbert. 1962. “Society as symbolic interaction.” Pp. 179–92 in Human behavior and social processes, edited by A. M. Rose. Boston: Houghton Mifflin.

Brenner, P.S. and J. DeLamater. 2016. “Lies, Damned Lies, and Survey Self-Reports? Identity as a Cause of Measurement Bias.” *Social Psychology Quarterly*. 79(4):333-354.

Burke, P.J. 1991. “Identity Processes and Stress.” *Social Psychology Quarterly* 43:18-29.

Burke, P.J. and J.E. Stets. 2009. *Identity Theory*, New York: Oxford University Press.

Cerri, J., J. Thøgersen, and F. Testa. 2019. “Social Desirability and Sustainable Food Research: A Systematic Literature Review.” *Food Quality and Preference* 71:136-140.

Chandon, P., V.G. Morwitz, and W.J. Reinartz. 2005. “Do Intentions Really Predict Behavior? Self-Generated Validity Effects in Survey Research.” *Journal of Marketing*. 69:1-14.

Crowne, D. P. and D. Marlowe. 1960. “A New Scale of Social Desirability Independent of Psychopathology.” *Journal of Consulting Psychology*. 24(4):349-350.

Crowne, D. P. and D. Marlowe. 1974. The Approval Motive: Studies in Evaluative Dependence. New York: Wiley.

DePaulo, B.M., D.A. Kashy, S.E. Kirkendol, M.M. Wyer, and J. Epstein. 1996. “Lying in Everyday Life.” Journal of Personality and Social Psychology, 70, 979–995.

Feldman, Robert S., James A. Forrest, and Benjamin R. Happ. 2002. “Self-Presentation and Verbal Deception: Do Self-Presenters Lie More?” *Basic and Applied Social Psychology*. 24(2):163-170.

Fisher, R.J. 1993. “Social Desirability Bias and the Validity of Indirect Questioning.” *Journal of Consumer Research*. 20: 303-315.

Fitzsimons, G.J. and V.G. Morwitz. 1996. “The Effect of Measuring Intent on Brand-Level Purchase Behavior.” *Journal of Consumer Behavior*. 23:1-11.

Gaertner, L., C. Sedikides, M. Luke, E.M. O’Mara, J. Iuzzini, L. Eckstein Jackson, J. Cai, and Q. Wu. 2012. “A Motivational Hierarchy Within: Primacy of the Individual Self, Relational Self, or Collective Self?” *Journal of Experimental Social Psychology*. 48(5):997-1013.

Greene, W.H. 2012. Econometric Analysis, 7th ed. Pearson/Prentice Hall.

Grice, H.P. 1975. Chapter 19: Logic and Conversation. *Studies in the Way of Words.* Harvard: University Press.

Haddad, E.H. and J.S. Tanzman. 2003. “What Do Vegetarians in the United States Eat?” *American Journal of Clinical Nutrition*. 78(3):626-632.

Hafner-Fink, M. and S. Uhan. 2011. “Bipolarity and/or duality of social survey measurement scales and the question-order effect.” *Quality & Quantity* 47:839-852.

Hogg, M.A. 2007. “Uncertainty-Identity Theory.” *Advances in Experimental Social Psychology*. 39:69-126.

James, W. 1890. *The Principles of Psychology*, New York: H. Holt and Company.

King, M.F. and G.C. Bruner. 2000. “Social Desirability Bias: A Neglected Aspect of Validity Testing.” *Psychology and Marketing*, 17(2):79-103.

Kahneman, D. 2011. *Thinking, Fast and Slow*. Farrar, Straus and Giroux: NY, NY.

Kasmirli, M. 2018. “What We Say vs What We Mean: What is Conversational Implicature?” *Aeon.com*. Accessed June 13, 2018 at https://aeon.co/ideas/what-we-say-vs-what-we-mean-what-is-conversational-implicature.

Kross, E., M.G. Berman, W. Mischel, E.E. Smith, and T.D. Wager. 2011. "Social Rejection Shares Somatosensory Representations with Physical Pain." *Proceedings of the National Academy of Sciences of the United States of America*. 108(15):6270-6275.

Lusk, J.L. 2015. Food Demand Survey. 2(9).

Lusk. J.L. 2003. "Effects of Cheap Talk on Consumer Willingness-to-Pay for Golden Rice." *American Journal of Agricultural Economics,* 85(4):840-856.

Lusk, J.L. and F.B. Norwood. 2010. "Direct versus Indirect Questioning: An Application to the Well-Being of Farm Animals." *Social Indicators Research,* 96(3):551-565.

Lusk, J.L. and F.B. Norwood. 2016. "Some Vegetarians Spend Less Money on Food, Others Don't." *Ecological Economics*. 130: 232-242.

Malhotra, N.K. 1988. "Some Observation on the State of the Art in Marketing Research." *Journal of the Academy of Marketing Science* 616:4-24.

McCall, G.J. and J.L. Simmons. 1978. Identities and Interactions: An Examination of Human Associations in Everyday Life. New York: Free Press.

McLean, K.C., M. Pasupathi, and J.L. Pals. 2007. "Selves Creating Selves Creating Selves: A Process Model of Self-Development." *Personality and Social Psychology Review*. 11:262-278.

Morwitz, V.G. and G. J. Fitzsimons. 2004. The Mere-Measurement Effect: Why Does Measuring Intentions Change Actual Behavior? *Journal of Consumer Psychology*. 14:64-74.

Murray, S. and F.B. Norwood. 2018. *FooDS: Food Demand Survey*. 5(9): January 18, 2018. Department of Agricultural Economics. Oklahoma State University. Accessed October 17, 2018 at http://agecon.okstate.edu/files/January%202018.pdf.

Norwood, F.B. and J.L. Lusk. 2011. "Social Desirability Bias in Real, Hypothetical, and Inferred Valuation Experiments." *American Journal of Agricultural Economics*. 93(2):528-534.

Norwood, F.B., G.T. Tonsor, and J.L. Lusk. 2019. "I Will Give You My Vote but not My Money: Preferences for Public versus Private Action in Addressing Social Issues." *Applied Economic Perspectives & Policy*. 41:96-132.

Paul, A.S., J.L. Lusk, F.B. Norwood, and G.T. Tonsor. 2019. "An Experiment on the Vote-Buy Gap with Application to Cage-Free Eggs." *Journal of Behavioral and Experimental Economics*. 79:102-109.

Plant, E. A., P. G. Devine, and P. C. Brazy. 2003. "The Bogus Pipeline and Motivations to Respond Without Prejudice: Revisiting the Fading and Faking of Racial Prejudice." *Group Processes and Intergroup Relations*. 6(2):187-200.

Powers, W.T. 1973. *Behavior: The control of perception*. Chicago: Aldine.

Raphael, D.D. 2007. *The Impartial Spectator*. Oxford University Press: Oxford, UK.

Reese, J. 2017. "Survey of US Attitudes Towards Animal Farming and Animal-Free Food October 2017." Accessed July 5, 2018 at https://www.sentienceinstitute.org/animal-farming-attitudes-survey-2017.

Smith, A. 1817. The Theory of Moral Sentiments. Boston, MA: Wells and Lilly. (Original work published 1759).

Smith, T.W. 1992. Thoughts on the Nature of Context Effects. In; Schwartz, N. and S. Sudman, (eds.) Context Effects in Social and Psychological Research. Springer: New York.

Somin, I. 2015. "Over 80 Percent of Americans Support 'Mandatory Labels on Foods Containing DNA'." *The Washington Post*. Accessed July 5, 2018 at https://www.washingtonpost.com/news/volokh-conspiracy/wp/2015/01/17/over-80-percent-of-americans-support-mandatory-labels-on-foods-containing-dna/?utm_term=.11ef7dfafdb6.

Stets, J.E. and R.T. Burke. 2005. "New Directions in Identity Control Theory." *Advances in Group Processes* 22:43-64.

Strack, F. and R. Deutsch. 2004. "Reflective and Impulsive Determinants of Social Behavior." *Personality and Social Psychology Review* 8:220-247.

Stryker, S. and P.J. Burke. 2000. "The Past, Present, and Future of an Identity Theory." *Social Psychology Quarterly* 63:284-297.

Stryker, S. and R.T. Serpe. 1994. "Identity Salience and Psychological Centrality: Equivalent, Overlapping, or Complimentary Concepts?" *Social Psychology Quarterly* 57:16-35.

Sudman, S. and N.M. Bradburn. 1974. *Response Effects in Surveys*. Chicago: Aldine.

Tonsor, G.T. and R.S. Shupp. 2011. "Cheap Talk Scripts and Online Choice Experiments: 'Looking Beyond the Mean'." *American Journal of Agricultural Economics*. 93(4):1,015-1,031.

Tourangeau, R. 2003. "Cognitive Aspects of Survey Measurement and Mismeasurement." *International Journal of Public Opinion Research* 15(1):3-7.

Tourangeau, R. and N. M. Bradburn. 2010. The Psychology of Survey Response. *The Handbook of Survey Research*. Revised edition. Editors J.D. Wright and P. V. Marsden. New York: Academic Press.

Tourangeau, R., M.P. Couper, and F. Conrad. 2004. “Spacing, Position, and Order: Interpretive Heuristics for Visual Features of Survey Questions.” *The Public Opinion Quarterly* 68(3):368-393.

Tourangeau, R., E. Singer, and S. Presser. 2003. “Context Effects in Attitude Surveys. Effects on Remote Items and Impact on Predictive Validity.” *Sociological Methods & Research* 31(4):486-513.

Turner, J.C. and P.J. Oakes. 1988. *Self-Categorization Theory and Social Influence.* In: Paulus, P.B. (Ed.), *The Psychology of Group Influence*. 2nd edition. Erlbaum, Hillsdale, NJ.

Tversky, A. and D. Hahneman. 1973. “Availability: A Heurist for Judging Frequency and Probability.” *Cognitive Psychology* 5(2):207-232.

Wang, Z., T. Solloway, R. M. Shiffrin, J. R. Busemeyer. 2014. “Context Effects Produced by Question Orders Reveal Quantum Nature of Human Judgments.” *Proceedings of the National Academy of Sciences.* doi: 10.1073/pnas.1407756111.

Ward, M. and S. Broniarczyk. 2011. “It’s Not Me, It’s You: How Gift Giving Creates Giver Identity Threat as a Function of Social Closeness.” *Journal of Consumer Research* 1(1):164-181.

Willis, Gordon B. 2008. *Encyclopedia of Survey Research Methods*. Editor: Paul J. Lavrakas. Sage Publications: NY, NY.

Zaller, J. and S. Feldman. 1992. “A Simple Theory of the Survey Response: Answering Questions versus Revealing Preferences.” *American Journal of Political Science* 36:579-616.

APPENDICES

Appendix A. Additional Analysis Tables.

Table A.1.1. Estimated 'Concerned' Selected Ordered Logit Regression with Response as Dependent Variable[a] (N = 1,672)

Variable	Parameter	Estimate (Std. Error)	χ^2-value
Ideal (Non-Food)	$\beta_{1,g}$	0.684*** (0.059)	134.11
Common (Non-Food)	$\beta_{2,g}$	0.393*** (0.065)	36.42
Buffer (Non-Food)	$\beta_{3,g}$	-0.427*** (0.071)	35.90
Ideal (Non-Food) × Memory[c]	$\beta_{4,g}$	0.005 (0.015)	0.13
Common (Non-Food) × Memory[c]	$\beta_{5,g}$	0.050*** (0.015)	9.30
Ideal (Food)	$\beta_{1,f}$	0.746*** (0.060)	154.86
Common (Food)	$\beta_{2,f}$	-0.328*** (0.065)	25.67
Buffer (Food)	$\beta_{3,f}$	0.000[b]	
Ideal (Food) × Memory[c]	$\beta_{4,f}$	-0.004 (0.017)	0.04
Common (Food) × Memory[c]	$\beta_{5,f}$	0.020* (0.017)	1.46
Common (Non-Food) × Valence[d]	$\beta_{6,g}$	0.164*** (0.044)	13.69
Common (Food) × Extended[e]	$\beta_{7,f}$	-0.531*** (0.050)	114.72

Notes: * and *** denote statistical significance at the 0.10 and 0.01 level, respectively.
[a] – The threshold and intercept parameters are not shown for succinctness.
[b] – Coefficient is normalized to zero for model identification.
[c] – Memory denotes the M_{it} variable.
[d] – Valence denotes the V_{it} variable for when statement agreement is switched.
[e] – Extended denotes the A_{it} variable for extended forms of common (food) questions are asked.

Table A.1.2. Estimated 'Non-Concerned' Selective Ordered Logit Regression with Response as Dependent Variable[a] (N = 682)

Variable	Parameter	Estimate (Std. Error)	χ^2-value
Ideal (Non-Food)	$\beta_{1,g}$	1.678*** (0.102)	270.97
Common (Non-Food)	$\beta_{2,g}$	1.859*** (0.112)	275.78
Buffer (Non-Food)	$\beta_{3,g}$	0.592*** (0.121)	23.97
Ideal (Non-Food) × Memory[c]	$\beta_{4,g}$	0.035 (0.023)	2.23
Common (Non-Food) × Memory[c]	$\beta_{5,g}$	0.059** (0.024)	5.84
Ideal (Food)	$\beta_{1,f}$	0.040 (0.102)	0.15
Common (Food)	$\beta_{2,f}$	-0.430*** (0.109)	15.56
Buffer (Food)	$\beta_{3,f}$	0.000[b]	
Ideal (Food) × Memory[c]	$\beta_{4,f}$	0.004 (0.026)	0.03
Common (Food) × Memory[c]	$\beta_{5,f}$	0.038 (0.027)	2.01
Common (Non-Food) × Valence[d]	$\beta_{6,g}$	-0.318*** (0.071)	20.17
Common (Food) × Extended[e]	$\beta_{7,f}$	-0.818*** (0.080)	104.07

Notes: ** and *** denote statistical significance at the 0.05 and 0.01 level, respectively.

[a] – The threshold and intercept parameters are not shown for succinctness.

[b] – Coefficient is normalized to zero for model identification.

[c] – Memory denotes the M_{it} variable.

[d] – Valence denotes the V_{it} variable for when statement agreement is switched.

[e] – Extended denotes the A_{it} variable for extended forms of common (food) questions are asked.

Table A.1.3. Estimated Latent Class Regression with Response as Dependent Variable[a] (N = 2,354)

		Latent Class 1		Latent Class 2	
Variable	Parameter	Estimate (Std. Error)	Z-value	Estimate (Std. Error)	Z-value
Constant				-0.652*** (0.103)	-6.33
Ideal (Non-Food)	$\beta_{1,g}$	-0.393*** (0.105)	-3.74	3.956*** (0.283)	13.99
Common (Non-Food)	$\beta_{2,g}$	0.555*** (0.087)	6.40	1.927*** (0.138)	13.99
Buffer (Non-Food)	$\beta_{3,g}$	-0.755*** (0.092)	-8.21	0.564*** (0.158)	3.58
Ideal (Non-Food) × Memory[c]	$\beta_{4,g}$	0.065** (0.032)	2.03	-0.069 (0.055)	-1.26
Common (Non-Food) × Memory[c]	$\beta_{5,g}$	0.053*** (0.020)	2.62	0.087*** (0.031)	2.79
Ideal (Food)	$\beta_{1,f}$	-0.873*** (0.103)	-8.46	3.695*** (0.269)	13.75
Common (Food)	$\beta_{2,f}$	-2.077*** (0.128)	-16.18	3.084*** (0.283)	10.92
Buffer (Food)	$\beta_{3,f}$	0.000[b]		0.000[b]	
Ideal (Food) × Memory[c]	$\beta_{4,f}$	-0.032 (0.035)	-0.91	0.043 (0.058)	0.74
Common (Food) × Memory[c]	$\beta_{5,f}$	0.021 (0.026)	0.81	0.042 (0.044)	0.94
Common (Non-Food) × Valence[d]	$\beta_{6,g}$	-0.307*** (0.066)	-4.66	0.446*** (0.095)	4.68
Common (Food) × Extended[e]	$\beta_{7,f}$	0.378*** (0.104)	3.63	-2.679*** (0.276)	-9.70

Note: **, and *** denote statistical significance at the 0.05, and 0.01 level, respectively.

[a] – The threshold parameters are not shown for succinctness.

[b] – Coefficient is normalized to zero for model identification.

[c] – Memory denotes the M_{it} variable.

[d] – Valence denotes the V_{it} variable for when statement agreement is switched.

[e] – Extended denotes the A_{it} variable for extended forms of common (food) questions are asked.

Table A.1.4. Estimated Random-Effects Ordered Logit Regression with Response as Dependent Variable[a] (N = 2,354)

Variable	Parameter	Estimate (Std. Error)	Z-value
Ideal (Non-Food)	$\beta_{1,g}$	0.899*** (0.060)	15.10
Common (Non-Food)	$\beta_{2,g}$	0.776*** (0.064)	12.11
Buffer (Non-Food)	$\beta_{3,g}$	-0.195*** (0.069)	-2.81
Ideal (Non-Food) × Memory[c]	$\beta_{4,g}$	0.016 (0.013)	1.21
Common (Non-Food) × Memory[c]	$\beta_{5,g}$	0.034** (0.014)	2.40
Ideal (Food)	$\beta_{1,f}$	0.466*** (0.060)	7.82
Common (Food)	$\beta_{2,f}$	-0.503*** (0.064)	-7.87
Buffer (Food)	$\beta_{3,f}$	0.000[b]	
Ideal (Food) × Memory[c]	$\beta_{4,f}$	0.018 (0.015)	1.21
Common (Food) × Memory[c]	$\beta_{5,f}$	0.051*** (0.015)	3.38
Common (Non-Food) × Valence[d]	$\beta_{6,g}$	-0.085* (0.045)	-1.86
Common (Food) × Extended[e]	$\beta_{7,f}$	-0.638*** (0.046)	-13.76
Variance of random effects	σ_v^2	0.848 (0.035)	24.22

Note: *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 level, respectively.

[a] – The threshold and intercept parameters are not shown for succinctness.

[b] – Coefficient is normalized to zero for model identification.

[c] – Memory denotes the M_{it} variable.

[d] – Valence denotes the V_{it} variable for when statement agreement is switched.

[e] – Extended denotes the A_{it} variable for extended forms of common (food) questions are asked.

Appendix B. Institutional Review Board Approval.

Dear Bailey Norwood,

The Oklahoma State University Institutional Review Board (IRB) has approved the following protocol modification:

Protocol Number: AG-19-36
PI: Bailey Norwood
Title: Using Identity Theory to improve survey design
Review Type: Exempt
Modifications Made: eliminating some previous questions on the survey and adding new questions

You will find a copy of your Approval Letter in the generated documents section on IRBManager. Click IRB - Modification to go directly to the event page. Please click attachments in the upper left of the screen to access the approval letter. Stamped recruitment and consent documents can also be found in this location. Only the approved versions of these documents may be used during the conduct of your research.

As Principal Investigator, it is your responsibility to do the following:

Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.

Submit a request for continuation if the study extends beyond the approval period.

Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and

Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB office at 405-744-3377 or irb@okstate.edu.

Best of luck with your research,

Sincerely,

Dawnett Watkins, CIP
Whitney McAllister, MS

Oklahoma State University
Institutional Review Board
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CHAPTER II

ALTERNATIVE MANAGEMENT STRATEGIES IN RESPONSE TO FOOT-AND-MOUTH DISEASE IN A LARGE FEEDLOT

Abstract

The breakout of foot-and-mouth disease is a constant worry, and it is important to have a plan of how to respond in order to reduce supply disruptions, reduce the time for bans on exports, and maintain animal health and welfare. Previous studies have estimated the cost of management strategies in response to foreign animal disease can range from $150 million to $15 billion. This study examines response to foot-and-mouth disease using alternative management strategies in a large feedlot of more than 50,000 head. Data from a representative feedlot and epidemiological data are used in a discrete model with static prices. Recoverable profits are calculated from selling susceptible and recovered cattle and government indemnity payments from the depopulation of cattle less costs to manage disease and maintain cattle. The results indicate that strategies involving the movement of susceptible and recovered cattle to segmented slaughter has economic value over depopulating an entire feedlot.

Keywords: animal health, foot-and-mouth disease, disease response, agricultural policy, simulation model

Introduction

U.S. feedlots contain more than 14 million cattle (USDA NASS 2020a). Feedlots concentrate cattle populations in a relatively small geographic area for ease of management. In addition, limited number of states contain the majority of feedlots. Foot-and-mouth disease (FMD) is a highly contagious viral disease that affects cloven-hoofed animals. The disease often causes high morbidity in susceptible livestock species, which results in respiratory problems and other physiological issues. Clinical signs of FMD include vesicles developing around the mouth and hoofs of livestock (Muroga 2012). When first detected in a previously FMD-free country, the economic impacts are often significant, including market closures with trading partners, losses associated with disease containment, and loss of consumer confidence in a livestock sector. FMD is not a zoonotic disease, so meat from recovered animals is safe for human consumption.

Emergency response to contain FMD in large feedlots may be challenging due to labor and equipment resource constraints, disposal capacity for approved methods, environmental management, and timely detection of the disease. In previous studies, the costs associated with FMD management has been estimated to range from $150 million up to $188 billion for various sizes of feedlots at regional levels as well as the economic impacts for implementing disease-containing strategies (Elbakidze et al. 2009; Ward et al. 2009; McReynolds and Sanderson 2014; Schroeder et al. 2015). The U.S. Department of Agriculture (USDA) has focused on policies related to full herd depopulation as a response to FMD (McReynolds and Sanderson 2014). Depopulation refers to euthanizing all infected livestock with or without clinical signs based on positive test results from the Foreign Animal Disease Diagnostic Laboratory. Depopulating an infected herd prevents the continued spread of the disease. Few studies have examined FMD management strategies in large feedlots. For those studies that examined FMD in feedlots with a large capacity, the control strategies were limited to stamping out alone as a disease control measure for feedlots (DeOtte and DeOtte 2010). “Stamping out” refers to eradication through movement restrictions, quarantines, surveillance and tracing, and depopulation of infected livestock. Due to the economic losses to producers and taxpayer dollars from a complete depopulation, strategies that reduce the need for costly carcass disposal and find a use for high-value animal protein should be considered. After the devastating impact of FMD associated with depopulation on livelihoods and genetics in countries like Japan in 2010 (Muroga et al. 2012), countries with large and valuable livestock industries have started to consider whether alternatives exist for depopulation of FMD recovered livestock. Yet, there is very little information on the feasibility and potential impacts of such alternative management strategies on spread and financial losses to producers.

In this study, we examine a feedlot’s recoverable profit and government expenditure from implementing three alternative strategies to manage an outbreak of FMD in a feedlot with a capacity of 50,000 or more head. The three management strategies are 1) complete depopulation; 2) segmented harvest (also known as controlled slaughter); and 3) welfare depopulation followed by controlled slaughter. Under these alternative strategies, we assume cattle that recover from the disease can be moved into the food supply for further processing (Arzt et al. 2011). Government expenditure in the scope of this study is defined as the direct cost related to disease management and eradication. We use the term ‘recoverable profit’ because it is unlikely that a feedlot will experience even a breakeven profit during an FMD outbreak. Yet, a combination of indemnification payments for depopulated livestock and controlled marketing may allow producers to retain enough revenue to keep them in business. This is one of the first studies to examine the economics of FMD eradication strategies in which FMD recovered animals are harvested in a controlled environment and enter the food supply in the United States.

The study explores the economic impacts of implementing alternative FMD management strategies in a large feedlot of 50,000 head in the United States. The study's objectives include estimating feedlot operator recoverable profits and government payments from indemnities on depopulated livestock. Producers may be compensated for some disease management expenses, such has occurred in highly contagious poultry disease outbreaks, and thus we included these reimbursements in this study. We find that controlled slaughter and welfare depopulation as an alternative method carries value for cattle with an average weight greater than 1,035 lbs. For cattle with an average weight of less than 1,000 lbs., depopulation is the favored management strategy for a large feedlot.

Background

U.S. cattle production accounts for about 18 percent of the total cash receipts of agricultural commodities, which amounts to about $67 billion (USDA ERS 2019). Feedlots are heavily concentrated in the Midwest and the Southern Great Plains. In 2019, there were about 4.7 million cattle in 74 feedlots having a capacity of 50,000 and over (USDA NASS 2020a). This represents about 32 percent of all cattle in feedlots in the United States.

While FMD has a low mortality rate among mature livestock, the disease causes high morbidity in adult livestock (USDA APHIS 2012). In 2001, the United Kingdom (UK) faced an FMD outbreak that resulted in the depopulation of over 750,000 cattle (Thompson et al. 2002). This resulted in £3.1 billion ($4.7 billion) in economic losses to the UK agriculture and food sector. The United States has not experienced an FMD outbreak since 1929 (McCauley et al. 1979); however, preparing and taking proper precautions can reduce spreads of animal disease and other economic consequences when an outbreak does occur (DERFE 2007; Paarlberg et al. 2008; Elbakidze et al. 2009; Tozer, Marsh, and Perevodchikov 2015). Detection of FMD in a country can reduce consumer confidence, close trade markets with partner countries, decrease domestic supply, and other economic implications (Schroeder et al. 2015; Johnson, Seeger, and Marsh 2016). These effects depend on the size of the outbreak, duration of the disease, and number of animals infected and depopulated. A potential FMD outbreak poses risks to the business continuity of local farms and service providers (Doel 2003).

FMD Response

Within the United States, studies have focused on the origination and introduction of the disease. Some studies have estimated economic losses for regional FMD outbreaks, including several studies that have examined simulations of FMD in California, Texas, Kansas, and the Midwest. One of the earliest such regional studies estimated the potential cost of FMD in California to be $13.5 billion (Ekboir 1999). As time went on, and the capacity to simulate disease spread nationally was developed, larger scale economic analyses were performed, beginning with Schoenbaum and Disney (2003) that estimated

FMD economic impacts that totaled $789.9 million. Other studies have focused on at-risk industries, including the high-value cattle feeding sector. Pendell et al. (2007) simulated an FMD outbreak in southwest Kansas and the surrounding region. Economic losses of an FMD outbreak were estimated to be larger when starting in large feedlots rather than smaller scale feedlots or cow-calf operations (Pendell et al. 2007).

U.S. Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS) is the animal health authority for the United States, responsible for supporting and overseeing FMD response. Yet, all emergency response begin with a state's animal health authority unless a national state of emergency is declared. This had led to federal, state, and industry collaborations to develop animal health responses policy that aims to eradicate FMD without causing excessive damage to the industry.

Depopulation has been the preferred method of eradication by other countries that have had FMD outbreaks. It has also been the planned method of eradication for localized or regional outbreaks by the USDA APHIS. Stamping out as a management strategy has enormous costs to producers, government entities, and taxpayers. Depending on the spread and severity of the disease in a geographical region, a stamping out strategy may not be feasible given resource constraints. This creates an incentive for alternative responses to be considered and examined.

Regions that have dense, large animal populations in particular pose a challenge to stamping out. Ward et al. (2009) simulated an FMD outbreak in the Texas Panhandle, an area with a high livestock population density. They determined that an average outbreak lasted around 50 days and about 100 herds would need to be depopulated to contain the disease. In the worst-case scenarios of the study, these measures increase to 8-

9 months and the eradication of 230 herds when the disease initiated in large company feedlots. When those include large feedlots, the number of animals depopulated become very large due to the high density of livestock in a confined space. In a large capacity setting, eradication and disposal of more than 70,000 head of cattle in a feedlot would take 16 days (DeOtte and DeOtte 2010). U.S. animal health officials think vaccination can be used as a disease management strategy if stamping out cannot contain the disease in a timely manner (Parent, Miller, and Hullinger 2011).

Alternative management strategies have incorporated vaccination programs in response to FMD outbreaks in a feedlot setting. Schroeder et al. (2015) investigated using vaccination strategies to manage FMD outbreak in the Midwest. Without an emergency vaccination program, government costs would total $11 billion and consumer and producer welfare losses would be nearly $188 billion. Elbakidze et al. (2009) examined mitigation strategies, such as time of detection, slaughter of infected herds, and vaccination availability, of FMD in highly concentrated animal feed regions in the Texas Panhandle region. This simulation estimated losses to the local cattle industry to total around $1 billion. Hagerman et al. (2012) focused on two varying hypothetical scenarios of an FMD outbreak in the central valley of California and Texas Panhandle. Mean welfare losses ranged from $2.7 billion to $21.9 billion. These two studies concluded that vaccination programs were not cost effective as disease control method (Elbakidze et al. 2009; Hagerman et al. 2012). Yet, Hagerman et al. (2012) did find that, as a disease detection delays expanded, vaccination was a preferred strategy under high levels of risk aversion. While these focused on smaller scale feedlot capacities, they showed the value of a timely response to a disease outbreak.

Price Shock and Recovery

The global market will likely react to the news of an FMD outbreak, but the magnitude of that impact depends on a few variables. Total cattle inventory, consumer confidence and demand for beef products, and changes in imports and exports all play major factors in how cattle prices will be affected.

Countries with active infections of FMD are prone to decreases in domestic meat supply and reductions in exports (Schroeder et al. 2015). In these situations, international demand for meat from FMD-free countries will increase because of strict export guidelines set by the World Organisation for Animal Health (OIE). The price premiums for meat products deemed FMD free without vaccination by the OIE range from 10 to 50 percent in the world marketplace (Rich, Winter-Nelson, and Brozović 2005). This could cause losses for major meat exporting countries like the United States, such as when bovine spongiform encephalopathy (BSE) was discovered in 2003.

Prices after the discovery of a BSE-infected cow within the United States in late 2003 were depressed for a month and rebounded to near pre-level two months after (Marsh, Brester, and Smith 2008). Beef prices rebounded in a few months due to strong consumer beef demand, a low number of cattle in inventory, and decreased imports of Canadian beef. Prices returned to equilibrium shortly after this event, but this dampened the beef export market. Some of the top U.S. beef importers, such as Japan, Korea, Taiwan, and China, imported beef from other countries for several years until those markets opened back up. The banning of U.S. beef resulted in significant welfare losses to U.S. beef producers (Mutondo, Brorsen, and Henneberry 2009) and decreased total exports of beef after BSE (Taha and Hahn 2014).

Tozer, Marsh, and Perevodchikov (2015) examined the economic welfare impacts of a hypothetical FMD outbreak in Canada over a 50-year span. In the short term, prices fell due to decreased beef demand and international trade restrictions. Tozer, Marsh, and Perevodchikov (2015) found that beef prices were largely impacted by the number of cattle depopulated, reducing immediate supply. Price increased in the intermediate term when trading markets reopened and international demand increased. This increase was due to decreased domestic supply due to depopulation and the retention of breeding females for long-term production plans. In the long run, prices shifted back to equilibrium after two cattle cycles and producer decisions to retain cows.

Disposal of Animals

In the wake of response to foreign animal disease (FAD), producers are faced with decisions of mortality disposal. Disposal methods must meet local, state, and national guidelines due to carcass volume, all while minimizing environmental contamination and disease spread. Common disposal methods include burials, incineration, composting, and biodigestion. Depending on the location and severity of an outbreak in highly concentrated livestock regions, disposal may present a challenge to producers and government officials. A 2010 study estimated that if the Texas Panhandle were to experience a FAD outbreak, more than 300,000 animals would be in the infection zone and may have to be euthanized, resulting in an indemnification of $300 million (DeOtte and DeOtte 2010). Due to the large volume and the movement restrictions on carcasses in these FAD events, feedlots have an incentive to invest in on-site disposal capacity. The willingness to pay for disposal capacity by producers depends on the size of feedlot and rate of death loss (Thompson et al. 2018).

Conceptual Model

Based on the literature and procedures outlined in the USDA APHIS FMD Response Plan, we examine three strategies that could be used to mitigate and manage the spread of disease and their effects on a representative feedlot's profits. The first is traditional stamping out for virus elimination. While this situation is practical when the number of cattle is relatively small, its feasibility and economic advisability dwindles as the feedlot capacity increases. Stamping out a large feedlot could take several months in addition to yielding the highest government response costs at that site.

The second strategy is to send cattle to a processor under controlled slaughter. We define controlled slaughter as segmented processing of cattle that have recovered from FMD or are at high risk due to sharing a location with FMD-infected cattle at a separate packing facility in which approved by an arbitrator. Under this strategy, only cattle that are susceptible (non-infected cattle as confirmed by diagnostic testing prior to movement) or recovered (known to have been infected but fully improved from clinical disease at the time of slaughter) are moved to the processing facility. These terminal cattle would be transported directly to slaughter without passing through sale barns or other feeding facilities.

Welfare depopulation is the third strategy. In the event recovered cattle have limited mobility or face severe physical detriments as a result of clinical disease, they would be euthanized rather than going to a processor.

The last two management strategies could be used in combination with vaccination programs. Vaccination should reduce the likelihood of infection in any given animal, and lessen the clinical effects of disease if an animal should become infected, thereby reducing the spread potential. One consequence of vaccination may be improved carcass quality in recovered livestock. Once the feedlot vaccinates cattle, it can choose one of two routes. It can allow both recovered and non-infected vaccinates to go to controlled slaughter. Alternatively, vaccination can be used to stop disease spread followed by depopulation. Exploring the potential impacts of vaccination requires more detailed epidemiological modeling than what was available at the time of this study but would provide a useful extension of this research.

Model Framework

We assume a feedlot receives profit from selling cattle less expenses from inputs used to produce cattle. The profit function can be expressed as

(2.1) $$\max_{y} E(\pi) = [E(P) - E(r)]y$$

subject to: $y \geq 0$

where $E(\pi)$ is expected profit; P is the price of cattle; r is management cost; and y is level of output. Price and costs are assumed to follow a random distribution.

Assuming a feedlot faces an FMD outbreak, the operator will maximize profits by mitigating risks and savings animals. Within this study, 100 scenarios of potential disease outcomes derived from USDA APHIS FMD spread modeling results are used. Each disease outcome determines the number of susceptible, infected, recovered, depopulated, and death loss cattle by week for the duration of the potential outbreak, where duration is measured as the first day an animal becomes infected until the last day an infected animal is detected. The profit function is modified to consider these scenarios, and animal disease statuses. The function can be expressed as

(2.2)

$$\pi_{bik} = \sum_{t=1}^{T}\left(P_t W_{it} N_{biktR} + \beta(P_t W_{it} N_{biktR}) - \left(\sum_{s=1}^{S} N_{bikts}(r_t F_t + M_t + J_t) + \boldsymbol{C_{bikts}N_{bikts}}\right) + GN_{biktX}\right)$$

where the *k*th strategy is selected by the feedlot operator to maximize recoverable profit in the *i*th weight group in the *b*th scenario, π_{bik}; P_{bit} is the price in dollars per hundredweight of the *i*th weight group in time *t*; W_{bit} is the hundredweight of weight group *i* in time *t*; N_{bikts} is the number of head in the *i*th weight group in the *s* status under strategy *k* in time *t*; U as a subscript represents cattle in the susceptible status; R as a subscript represents cattle in the recovered status; X as a subscript represents cattle in the depopulated status; β is a discounting factor associated with recovered cattle; $\boldsymbol{C_{bikts}}$ is a vector of costs associated with implementing the *k*th strategy in time *t* for cattle in the *s* status; r_{bit} is the cost of feed in time *t*; F_t is the amount of feed given to each head of cattle in time *t*; M_t is other management costs to cattle in time *t*; J_t is the cost associated with animal health in time *t*; and G is a government indemnity payment for depopulated cattle.

The model used weekly timesteps in response so limitations on resources are expressed in weekly terms. While the model is not an optimization with constraints, resource limitations will impact the speed with which stamping-out or controlled slaughter can be completed. The number of cattle sent to processing would be restricted based on slaughter plant capacity, the number of cattle that can be moved based on truck availability and capacity, the number of personnel allowed to implement disease management strategies, and hours personnel are allowed to work on response activities. The representative feedlot normally loads about 1,700 head of cattle for processing in an average week and can load a maximum of 8,000 head (personal communication 2020a). For a feedlot with over 51,000 head capacity, this means controlled slaughter could take anywhere between 7 weeks and 30 weeks, depending on resources available.

Under this model, government expenditure is defined as the direct costs related to disease management and eradication on that feedlot. It will not include any sunk costs in personnel or training for the responders, laboratory personnel, or incident management team members. We assume the feedlot will have access to six USDA APHIS response teams—made up of USDA APHIS employees or contractors—each with five trained personnel who can perform specialized activities in the FMD response at this representative feedlot. These teams are working 11-hour shifts in a week during the outbreak and switch out with new teams every 21 days or when response activities are complete. For example, one set of teams may be trained in depopulation procedures or surveillance procedures. Another may specialize in disposal activities. Each strategy will have its own set of costs that are based on the unique set of activities required for response.

In each scenario, depopulation is assumed to be achieved through captive bolt followed by a euthanasia solution. Disposal is assumed to be achieved through on-site burial in nearby fields. Cleaning and disinfection are assumed to be limited to cleaning organic materials out of pens, following by composting that material. Virus elimination in indoor areas included fogging on chemical disinfectant, and outdoor areas are simply assumed to be exposed to UV light to kill the virus. All equipment would then be decontaminated with other activities are completed through washing and chemical disinfectant.

Data and Methods

We develop an empirical model based on a feedlot operator's profit-maximizing problem. Following the classic susceptible-infected-recovered/removed (SIR) framework (Rich and Winter-Nelson 2007), each animal in the feedlot will have one of three statuses at any given time in the hypothetical outbreak. Susceptible cattle are not infected but could become infected in future periods. Infected cattle are either subclinically (nearly or completely asymptomatic) or clinically infected and can shed the virus thereby infecting other cattle. Recovered/removed cattle are further split into cattle that are recovered from FMD, cattle that are depopulated due to FMD infection, and cattle that die from FMD or secondary infections or conditions not uncommon in a feedlot setting. Fig. 2.1 displays the movement of cattle to these three statuses.

We recognize that infected cattle are a subset of the entire population, but we assume these cattle will eventually be sent to processing as recovered at a discounted price or they will die from FMD complications or being euthanized. Cattle die either from complications associated with FMD, natural death loss including secondary infections from other common feedlot diseases (co-morbidity), or having to be depopulated for welfare reasons, such as mobility issues. Thus, we account for those possibilities in the model. At the end of the hypothetical outbreak, all cattle in the feedlot will be in one of three mutually exclusive statuses: susceptible, recovered, or death loss.

Given the costs associated with implementing a management strategy, an operator can generate revenue from selling both susceptible and recovered cattle as well as getting paid an indemnity by the government for any losses incurred from depopulation. At this time, USDA APHIS does not pay indemnity on cattle that have died from disease. Expenses incurred by the feedlot include implementing disease management strategies, feeding, regular management costs, and routine vaccinations.

Performance data from a representative feedlot of more than 50,000 head is coupled with hypothetical disease spread data provided by USDA APHIS to be incorporated into the analysis. The feedlot-level data is from a representative feedlot within the region with the exact location and feedlot owner remaining undisclosed due to confidentiality. There are 100 different scenarios of hypothetical disease spread which vary the start, spread, and severity of FMD in the feedlot.

Table 2.1 presents summary statistics of the representative feedlot. The feedlot data includes placement week, placement weight, average daily gain (ADG), market weight, and sex type for each group of cattle brought into the feedlot. Placement weight of steers and heifers are 756 and 681 lbs., respectively, while sale weights are 1,360 and 1,227 lbs., respectively. The percentage change in the sale and placement weight, often referred to as shrink, is 3.37 percent for all cattle. This is consistent with the shrink observed in transporting cattle (Gill et al. 1992). ADG for steers are marginally higher than for heifers, 3.51 and 3.08 lbs. per day, respectively. There are more than 690,000 cattle (62,768 average head per year) in the dataset with steers and heifers representing 70.7 29.3 percent of the total head, respectively.

Cattle were placed in the feedlot by placement weight group in 50-lb. increments, referred to as ‘placement lots’ hereby after. The lightest placement lot (L1) in the feedlot is 500 lbs. while the heaviest (L12) is 1,050 lbs. From the representative firm data, about 85 percent of the cattle are in the medium placement lots (L3 to L8 or 600 to 850 lbs.). The number of cattle in each placement lot is displayed graphically in Fig. 2.2.

Cattle weights at the time of the outbreak are estimated based on data from the representative feedlot. Since the feedlot data contains multiple years, cattle placement weights are averaged across years for each week to get 52 data points. January is the highest risk period for FMD outbreaks in the northern hemisphere, so we assume that the FMD outbreak begins in week 1. To group cattle based on the distribution of cattle weights at the FMD infection in January, we pulled the placement weights from weeks 32 to 52. To simplify the calculation, cattle are assumed to gain weight linearly from their placement week until January. For the largest weight grouping at the time of infection, the average placement weight from the 32nd week is added to the product of ADG and 154 days on feed. This process is repeated for the 10 other weight groups at increments of two weeks for the average placement weight and 14-day increments for the days. For example, the second lightest group’s weight takes the average placement weight at the 52nd week and adds it to the product of ADG times 14 days on feed. For the lightest group’s weight, the average placement weight at the first week is used.

We assume that while the feedlot is managing the disease, susceptible and recovered cattle might be moved to processing before a desired sale weight is reached. Recovered cattle likely experience suppressed growth, thus finish at a weight lighter than expected (Paarlberg et al. 2008). Processors have indicated discounts would be required for livestock that have recovered from foreign animal disease (Tonsor and Schulz 2019). Considering this suppressed growth and a reduction in the price received, we select a discount factor *ex-ante* of 20 percent for recovered cattle. Price for steers and heifers (in U.S. dollars per hundredweight) are taken from monthly averages from 2009-2019 (USDA NASS 2020b). The price per hundredweight for steers, heifers, and mixed lots are \$121, \$118, and \$119.5, respectively. The final sale weights are divided by 100 to get in hundredweight terms.

Animal health, feeding, and general management costs are used from Extension publications (Lawrence and Ellis 2008; Lardy 2018). Animal health and management costs are assumed to be in per head terms. Feeding costs are in cents per lb. per head, which is taken by the average weekly pounds of feed per animal in the representative feedlot (personal communication 2020a). Disease management costs are from a preliminary study from Oklahoma State University (personal communication 2020b). These costs relate to the detection, surveillance, cleaning and disinfecting, euthanasia and disposal of animals per head. A summary of all price and cost assumptions can be found in Table 2.2.

The time element to this study is duration of disease. While clinical signs of FMD may take several days to manifest, we assume that the feedlot is constantly surveilling for disease. This is particularly true if a feedlot is nearby another premises that has a confirmed case of FMD, in which case routine surveillance would be done at the feedlot, and it is possible that virus could be detected even before the first clinical signs. In order to examine a wider range of spread in the feedlot, this routine surveillance for a feedlot in a surveillance zone was assumed for this study.

Once a sample has been collected, the goal is to have a result back within 24 hours from the state animal disease diagnostic laboratory. If the state laboratory test result is non-negative, the sample is sent to the Foreign Animal Disease Diagnostic Laboratory for confirmation of FMD detection.

Table 2.3 displays the average cattle weight at infection and number of head per weight grouping and sex. Duration ranges from 6 to 414 days, with the average outbreak occurring about 53 days. There are 10 scenarios were disease duration lasts longer than 180 days.

The average number of infected cattle is 1,702 head per scenario. The largest hypothetical outbreak affects 9,288 head of cattle (17.9 percent of the feedlot) while the smallest outbreak infects 9 head. The average number of cattle infected by sex and weight grouping is displayed graphically in Fig. 2.3. The highest frequency of FMD occurs in the two lightest two weight groupings, where the average number of infected by scenario is between 50 to 70 head.

The number of cattle that are infected in each of the 100 scenarios are used to calculate the number of susceptible, recovered, depopulated, and FMD death loss cattle in each week of the hypothetical outbreak. Bovine respiratory disease (BRD) commonly occurs in feedlots and has a similar morbidity rate to FMD (Snowder et al. 2006). Previous studies have shown that the death loss from BRD can increase by 37 percent in some cattle pens (Peel 2020). The feedlot's average death loss of 2.38 percent is increased by 35 percent to approximate FMD death loss and morbidities. This calculated death loss is taken times the number of infected cattle to generate the number of cattle that die from FMD and other complications. Under a welfare depopulation strategy, cattle that have limited mobility and significant detriments will be euthanized. We assume 10 percent of infected cattle will be depopulated, and the remaining 90 percent will recover from FMD.

When an outbreak of FAD occurs in a herd, USDA APHIS provides indemnity payments to recompense the value of depopulated cattle. Indemnities are only paid for cattle that are depopulated (USDA APHIS 2015). The Livestock Indemnity Program (LIP) payment rate is $1,268.80 per head. Indemnity payments are calculated by multiplying by the number of cattle depopulated by the LIP payment rate. As well, USDA APHIS may provide another indemnity to cover a proportion of operational expenses as done with recent outbreaks of highly pathogenic avian influenza (USDA APHIS 2017). We assume that USDA APHIS will cover at least half of expenses related to disease management in the second indemnity, so the feedlot will pay half and the indemnity will cover the remaining portion.

We develop model in which susceptible and recovered cattle are sold for revenue while any cattle depopulated from the feedlot result in an indemnity payment from the government less operational and disease management costs. The model is solved in General Algebraic Modeling System (GAMS 2019). We calculate a feedlot's recoverable profit and government expenditure for the duration of an FMD outbreak.

Results and Discussion

Results are reported in Tables 2.4 to 2.7 using a color formatting from dark green to red denoting most favorable to least favorable outcomes for the feedlot and government. These recoverable profits do not take into account the full losses by the feedlot. While the model produced recoverable profits and government expenditure for each scenario, weight grouping, and management strategy combination, we report averages across scenario. Calculated recoverable profits and government expenditure were analyzed used linear mixed model methods where strategy is a fixed effect and scenario is a random effect. Post-hoc tests include pairwise comparisons. All tests were conducted at the nominal 0.10 level of significance.

Table 2.4 shows the average recoverable profits from the model by weight grouping and management strategy. At the feedlot level, implementing a depopulation strategy would be favored over all others by the representative feedlot. The mean recoverable profit of nearly $15 million at the feedlot level for depopulation is significantly different from the other two strategies. The number of cattle that are depopulated under a welfare depopulation strategy is 10 percent of infected cattle. The difference of about $80,000 between these two strategies is the result of depopulating more cattle to produce indemnity payments less the costs associated with depopulation.

While depopulation may be preferred at the feedlot level, there is a difference among recoverable profits across strategies at the weight grouping level. We further test the difference among mean recoverable profits across strategies for these weight groupings. For all groupings, depopulation is significantly different from controlled slaughter and welfare depopulation. For cattle weight less than 1,000 lbs. at the point of infection, depopulation would result in higher recoverable profits. In groupings at least an average weight of 1,035 lbs. at infection, either controlled slaughter or welfare depopulation would be preferred. These recoverable profits are indicative of the number of head in each lot. About 58 percent of all heifers are in weight groups 1 to 4. The revenue of these groupings is less than the indemnity payment. About 70 percent of all steers are in groupings heavier than weight group 5. Due to their heavier weight, these steers are more valuable when sent to processing rather than depopulation.

Depopulation may be favorable from a feedlot perspective; however, this strategy is not optimal from a government standpoint. The government may not favor this strategy due to the high costs associated with depopulation and disposal of a large number of cattle and the consequent need for large numbers of trained personnel and equipment.

The feedlot may generate recoverable profits under these hypothetical disease outbreaks, but costs will be incurred for disease management and indemnities paid by the government. We assumed the government would pay at least half of the disease management expenditures. Table 2.5 displays the results of the calculated government expenditure from the model results. At the feedlot level, controlled slaughter would be the preferred method by the government due to its lower total costs when compared to the other two strategies. Controlled slaughter would cost about $1.8 million on average to implement as opposed to $72.6 million on average for depopulation of the entire herd.

We make pairwise comparisons of mean expenditure between strategies. Depopulation is statistically different from the other two strategies. Controlled slaughter and welfare depopulation are different by about $227,000. Controlled slaughter assumes we do not depopulate any cattle, so the feedlot or government does not incur any of those respective costs. For nearly all weight groupings, government expenditure from controlled slaughter differs from welfare depopulation.

Due to the recoverable profits being averaged across scenario in the presentation of results, the severity and impact of the worst FMD outbreaks are not apparent. Ten of the 100 scenarios of hypothetical FMD outbreak had durations of longer than 180 days and a larger number of cattle infected than the average scenario. Under these 10 scenarios with longer disease outbreaks, the feedlot is incurring more operational costs in addition to managing and eradicating the disease. Thus, several recoverable profits in these selective scenarios are negative. Table 2.6 displays the result of the 10 selective scenarios. In these instances, depopulation would be the feedlot's favored strategy because it produces the smallest negative recoverable profit of -$999 million.

Again, we make pairwise comparisons between the strategies across the feedlot. The mean recoverable profit for depopulation is statistically different from the other two strategies. As previous studies found, the economic benefits to controlled slaughter to feedlot owners decreases as the head of infected in the feedlot and disease duration increase. This may point to a need for monitoring for early detection and exploring means for disease spread suppression with feedlots. We see further the favorability in selling cattle with a weight heavier than 1,000 lbs. in either a controlled slaughter or welfare depopulation strategy. Despite the negative recoverable profits, depopulation is preferred in lighter weight cattle. In these lighter weight cattle, the indemnity payment helps offsets costs associated with operational and disease management.

Table 2.7 displays the government expenditure in the model with disease durations longer than 180 days. Again, we observe controlled slaughter as the preferred strategy to a feedlot from a government standpoint with mean costs of $17.6 million. The mean government expenditure for the feedlot differs across strategy. In these longer disease durations, controlled slaughter differs significantly from welfare depopulation for nearly all weight groupings. While 10 percent of infected cattle are depopulated under a welfare depopulation strategy, these longer durations and infection rates result in higher expenditure to manage the number of cattle that are depopulated.

Conclusions

This study examined the economic impacts of alternative management strategies for FMD response in a large feedlot of more than 50,000 head. Data from a representative feedlot are coupled with data from an epidemiological disease spread model to create a discrete programming model. Recoverable profits of the feedlot and government expenditure are calculated for 100 alternative disease outcomes.

The model results indicate that controlled slaughter and welfare depopulation may be the preferred alternative over depopulation from a government on-farm response expenditure perspective. While the feedlot may incur additional costs from depopulating a few cattle with limited mobility or physical detriments under a welfare depopulation strategy, there is still a gain in recoverable profit produced from an indemnity payment. From a government and a taxpayer perspective, controlled slaughter is favored due to the low costs.

While this study investigated response to FMD in a single feedlot, we recognize such an outbreak would likely cause ripple effects along the supply chain depending on its scope and severity. Once FMD is detected in a feedlot, USDA APHIS procedure is to put a halt movement order on any livestock within at least a 5-mile radius of the perimeter of an infection zone and monitor the movement of any livestock within a 6-mile radius (USDA APHIS 2015) since the disease can spread to other livestock species via indirect and direct contact points. Future studies might consider spatial components and the effects of alternative FMD responses in operations of other livestock species within the region. Estimating sector or larger economy impacts due to an FMD outbreak in a large feedlot would be valuable knowledge to the agriculture and food industry.

This study did not consider inward movement of cattle into the feedlot. In the event USDA APHIS approves the movement of cattle, feedlots may continue purchasing and receiving cattle yet isolate these animals from others to avoid disease spread. We recognize the profit measures calculated in this study do not account for forgone revenues of shutting down a feedlot's operation as well as the opportunity costs of having empty pens. Future studies could extend these considerations and how they would influence a feedlot operation's ability to remain solvent.

Research in the future could examine alternative management strategies that include vaccinations programs. When used as a method for disease reduction for the intention of increasing the number of recovered cattle, vaccination would only be beneficial to a feedlot owner to the degree it would have on the discount of recovered cattle. That is, if vaccination does not reduce the number of cattle infected and/or the discount required for recovered cattle, then it would not be in a feedlot's best interests to vaccinate for FMD. It is possible for a feedlot to use a combination of the three management strategies used in this study. For example, due to delays in movement, some cattle may be too big for the processing line. It may be necessary to depopulate some larger weight groups while still moving cattle in the optimal slaughter weight to processing.

Animal disease response has social components that feedlot operators should consider. While disposing of many carcasses presents logistical issues for producers, these events will likely be picked up by news and media outlets due to the economic impact and societal concerns about animal welfare. Disposal methods such as burials and incineration may be viewed negatively by the public and end consumers of meat products. From a scientific perspective, meat from recovered animals is safe to eat (Artz et al. 2011). Although alternative management strategies attempt to conserve resources and move healthy and/or recovered livestock into further processing, these responses

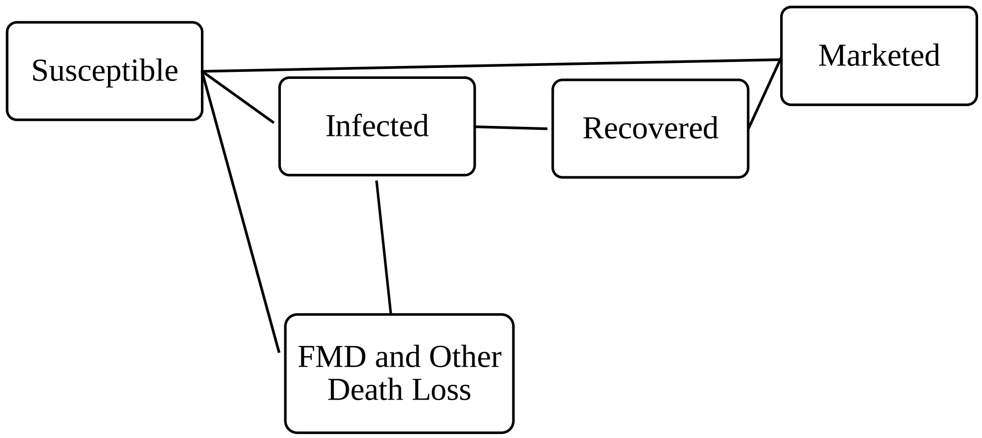

Figure 2.1. Statuses of cattle in feedlot under foot-and-mouth disease outbreak

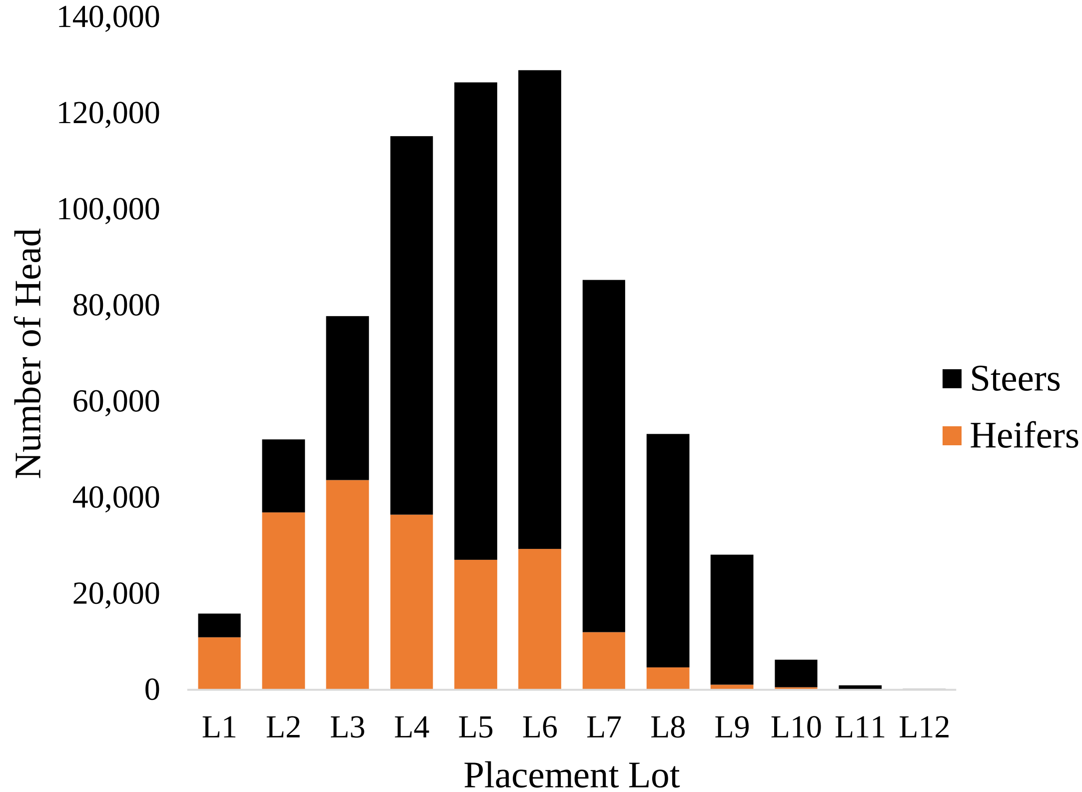

Figure 2.2. Number of cattle by placement lot and sex in representative feedlot

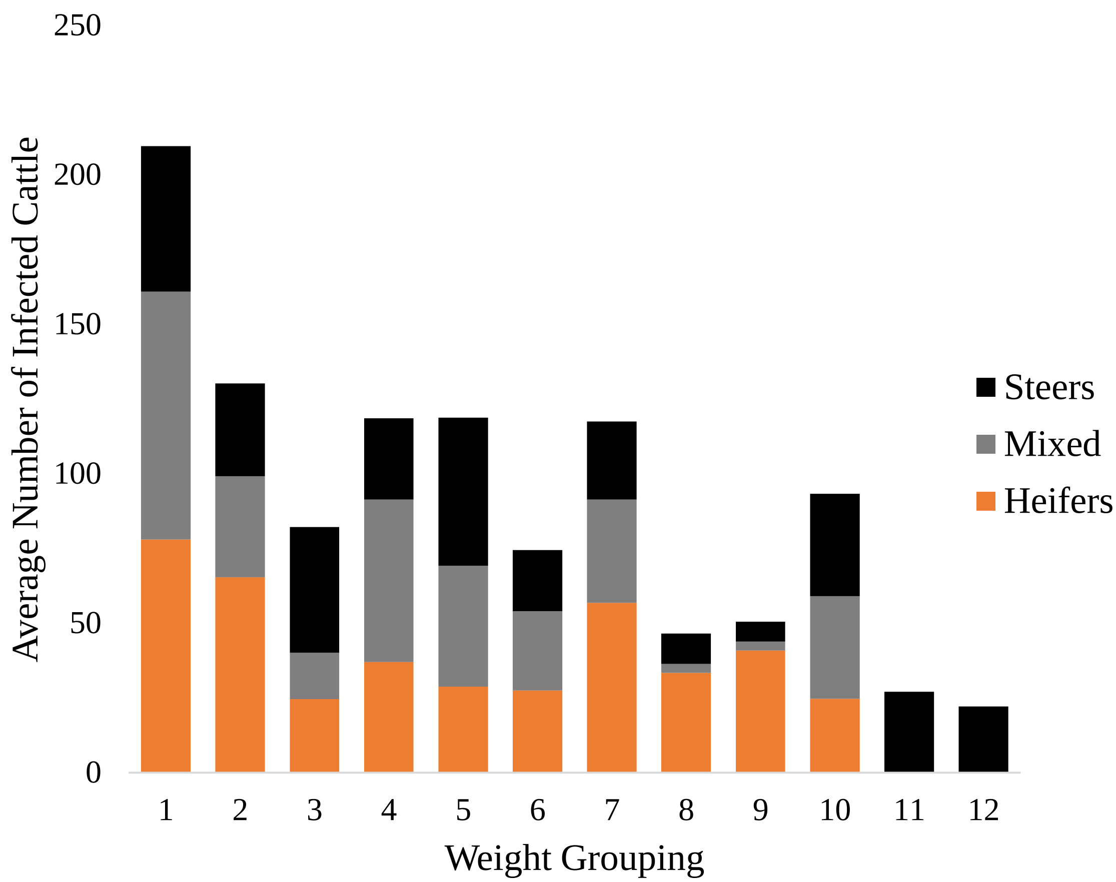

Figure 2.3. Average number of cattle infected by weight grouping and sex from epidemiology data

Table 2.1. Summary Statistics for Representative Feedlot (11 Years)

Variable	Unit	All[a]	Steers	Heifers
Average purchase weight	lbs.	732	756	681
Average market weight	lbs.	1,317	1,360	1,227
Average shrink	%	3.31	3.19	3.56
Average days on feed	Days	169	168	171
Average daily gain	lbs./day	3.36	3.51	3.07
Average feed to gain	Dry matter lbs.	6.21	6.10	6.43
Average sick head days	%	0.91	0.83	1.09
Average death loss	%	2.38	2.29	2.57
Total head	Count	690,285	487,772	202,513
Total pens	Count	6,434	4,357	2,077
Average pen size	Head per pen	107	112	98

Note:
[a] – All is the combination of steers and heifers.

Table 2.2. Summary of Prices and Costs Used

Variable	Notation	Value	Source
Price			USDA NASS (2020)
Steers		\$121 per hundredweight	
Heifers	P_{bit}	\$118 per hundredweight	
Mixed		\$119.5 per hundredweight	
Feeding Costs	r_{bit}	\$0.08 per lb.	Lardy (2018)
Total Feed	F_t	192 lbs. per head per week	Personal Communication (2020a)
Management Costs	M_t	\$57.43 per head	Lawrence and Ellis (2008)
Animal Health Costs	J_t	\$12 per head	Lawrence and Ellis (2008)
Trucking Costs	$\boldsymbol{C_{bikts}}$	\$4 per mile	Personal Communication (2020a)
Virus Detection Costs	$\boldsymbol{C_{bikts}}$	\$68.87 per head	Personal Communication (2020b)
Appraisal Costs	$\boldsymbol{C_{bikts}}$	\$89 per head	Personal Communication (2020b)
Virus Elimination Costs	$\boldsymbol{C_{bikts}}$	\$63.90 per head	Personal Communication (2020b)
Disposal Costs	$\boldsymbol{C_{bikts}}$	\$70.12 per head	Personal Communication (2020b)
Government Indemnity	G	\$1,268.80 per head	USDA FSA (2020)

Table 2.3. Summary of Cattle Numbers and Average Weight at Foot-and-Mouth Disease Infection by Weight Grouping and Sex

	Steers		*Heifers*		*Mixed*	
Weight Grouping (Average Weight)	Number of Head	Average Weight at Infection (lbs.)	Number of Head	Average Weight at Infection (lbs.)	Number of Head	Average Weight at Infection (lbs.)
1 (700)	800	769	1,200	674	700	658
2 (740)	1,600	778	2,800	728	1,000	714
3 (775)	2,700	832	2,930	757	1,100	735
4 (804)	3,830	846	2,900	792	1,000	773
5 (847)	4,600	909	2,400	814	700	817
6 (902)	4,800	957	2,400	887	400	862
7 (944)	4,000	1,024	1,400	902	300	905
8 (999)	3,080	1,067	600	984	300	947
9 (1,035)	2,000	1,131	200	1,020	100	954
10 (1,088)	700	1,169	200	1,064	100	1,030
11 (1,226)	200	1,226	n/a	n/a	n/a	n/a
12 (1,279)	100	1,279	n/a	n/a	n/a	n/a

Notes: n/a – not applicable. There are no heifer and mixed cattle in the L11 and L12 weight groups.

Table 2.4. Average Recoverable Profits from Model by Weight Grouping and Strategy (U.S. Dollars)

Weight Grouping (Average Weight)	*Strategy* Controlled Slaughter	Depopulation	Welfare Depopulation
1 (700)	-471,430[a]	818,285[b]	-465,923[c]
2 (740)	-686,326[a]	1,634,404[b]	-674,577[c]
3 (775)	-485,810[a]	2,039,844[b]	-474,742[c]
4 (804)	-250,849[a]	2,343,393[b]	-235,948[c]
5 (847)	217,817[a]	2,327,328[b]	239,716[a]
6 (902)	819,824[a]	2,310,710[b]	828,087[a]
7 (944)	1,022,263[a]	1,733,364[b]	1,027,532[a]
8 (999)	1,023,111[a]	1,213,543[b]	1,023,699[a]
9 (1,035)	785,348[a]	701,374[b]	785,595[a]
10 (1,088)	356,537[a]	304,223[b]	356,970[a]
11 (1,226)	94,690[a]	60,653[b]	94,742[a]
12 (1,279)	53,822[a]	30,148[b]	53,830[a]
Feedlot Total	2,478,997[a]	15,517,271[b]	2,558,981[c]

Notes: Estimates with different letters significantly differ across strategy at the 0.10 level. Recoverable profits are analyzed using linear mixed models. Post-hoc analysis includes pairwise comparisons.

Table 2.5. Average Government Expenditure from Model by Weight Grouping and Strategy (U.S. Dollars)

	Strategy		
Weight Grouping (Average Weight)	Controlled Slaughter	Depopulation	Welfare Depopulation
1 (700)	93,122[a]	3,833,015[b]	104,936[c]
2 (740)	186,301[a]	7,663,842[b]	213,103[c]
3 (775)	232,109[a]	9,554,338[b]	260,282[c]
4 (804)	266,586[a]	10,974,457[b]	305,666[c]
5 (847)	265,737[a]	10,924,830[b]	331,677[c]
6 (902)	261,923[a]	10,796,685[b]	289,446[c]
7 (944)	196,434[a]	8,097,848[b]	216,919[c]
8 (999)	137,073[a]	5,657,547[b]	139,639[c]
9 (1,035)	79,211[a]	3,269,518[b]	80,477[c]
10 (1,088)	34,459[a]	1,420,801[b]	37,235[c]
11 (1,226)	6,897[a]	283,966[b]	7,497[c]
12 (1,279)	3,453[a]	141,803[b]	3,631[a]
Feedlot Total	1,763,305[a]	72,618,649[b]	1,990,508[c]

Notes: Estimates with different letters significantly differ across strategy at the 0.10 level. Expenditure profits are analyzed using linear mixed models. Post-hoc analysis includes pairwise comparisons.

Table 2.6. Average Recoverable Profits from Model by Weight Grouping and Strategy (U.S. Dollars) with Disease Duration >180 Days

		Strategy	
Weight Grouping (Average Weight)	Controlled Slaughter	Depopulation	Welfare Depopulation
1 (700)	-66,190,112[a]	-52,951,364[b]	-65,981,357[a]
2 (740)	-128,990,185[a]	-105,638,205[b]	-128,820,784[c]
3 (775)	-156,902,089[a]	-131,578,785[b]	-156,777,862[c]
4 (804)	-176,623,237[a]	-151,002,495[b]	-176,569,613[c]
5 (847)	-170,736,965[a]	-150,403,470[b]	-170,689,423[c]
6 (902)	-163,104,088[a]	-148,438,804[b]	-163,068,876[c]
7 (944)	-118,168,484[a]	-111,315,384[b]	-118,156,435[c]
8 (999)	-79,740,080[a]	-77,745,684[b]	-79,720,018[a]
9 (1,035)	-44,081,651[a]	-44,914,777[b]	-44,079,105[a]
10 (1,088)	-18,981,405[a]	-19,532,027[b]	-18,979,004[a]
11 (1,226)	-3,557,563[a]	-3,906,621[b]	-3,557,382[a]
12 (1,279)	-1,715,575[a]	-1,954,543[b]	-1,715,530[a]
Feedlot Total	-1,128,791,434[a]	-999,382,157[b]	-1,128,115,390[c]

Notes: Estimates with different letters significantly differ across strategy at the 0.10 level. Recoverable profits are analyzed using linear mixed models. Post-hoc analysis includes pairwise comparisons.

Table 2.7. Average Government Expenditure from Model by Weight Grouping and Strategy (U.S. Dollars) with Disease Duration >180 Days

		Strategy	
Weight Grouping (Average Weight)	Controlled Slaughter	Depopulation	Welfare Depopulation
1 (700)	935,858[a]	38,154,381[b]	1,388,065[c]
2 (740)	1,864,665[a]	76,575,785[b]	2,256,564[c]
3 (775)	2,321,854[a]	95,514,571[b]	2,648,319[c]
4 (804)	2,663,460[a]	109,835,505[b]	2,806,931[c]
5 (847)	2,652,777[a]	109,422,346[b]	2,793,456[c]
6 (902)	2,618,022[a]	108,012,757[b]	2,736,638[c]
7 (944)	1,963,151[a]	81,023,417[b]	2,013,373[c]
8 (999)	1,371,300[a]	56,553,849[b]	1,451,199[c]
9 (1,035)	792,096[a]	32,695,635[b]	807,556[c]
10 (1,088)	344,493[a]	14,211,594[b]	358,643[c]
11 (1,226)	68,904[a]	2,842,101[b]	70,991[a]
12 (1,279)	34,485[a]	1,419,806[b]	35,400[a]
Feedlot Total	17,631,066[a]	726,261,747[b]	19,367,135[c]

Notes: Estimates with different letters significantly differ across strategy at the 0.10 level. Expenditures are analyzed using linear mixed models. Post-hoc analysis includes pairwise comparisons.

REFERENCES

Arzt, J., N. Juleff, Z. Zhang, L.L. Rodriguez. 2011. "The Pathogenesis of Foot-and-Mouth Disease I: Viral Pathways in Cattle." *Transboundary and Emerging Diseases* 58(4): 291-304.

DeOtte, R.E., Jr. and R.E. DeOtte, III. 2010. "Considerations for Management of Livestock During an Infectious Animal Disease Incident as an Alternative to Massive Carcass Disposal using Foot-and-Mouth Disease in Beef Cattle Feedlots as an Example." Paper presented at the International Symposium on Air Quality and Manure Management for Agriculture Conference Proceedings, Dallas TX, 13–16 September.

Doel, T.R. 2003. "FMD Vaccines." *Virus Research* 81:81-99.

Ekboir, J. L.S. Jarvis, D.A. Sumner, J.E. Bervejillo, and W.R. Sutton. 2002. "Changes in Foot and Mouth Disease Status and Evolving World Beef Markets." *Agribusiness* 18(2): 213-229.

Elbakidze, L., L. Highfield, M. Ward, B.A. McCarl, and B. Norby. 2009. "Economics Analysis of Mitigation Strategies for FMD Introduction in Highly Concentrated Animal Feeding Regions." *Review of Agricultural Economics* 31(4): 931-950.

General Algebraic Modeling System (GAMS). 2019. Release 27.1.0, Fairfax, VA, USA.

Gill, D., K. Barnes, K. Lusby, and D.S. Peel. 1992. *Ranchers' Guide to Custom Cattle Feeding*. Beef Cattle Handbook. Extension Beef Cattle Resources Committee. BCH-8040. Accessed 05 June 2020 at http://www.iowabeefcenter.org/bch/RanchCustomFeeding.pdf

Hagerman, A.D., B.A. McCarl, T.E. Carpenter, M.P. Ward., and J. O'Brien. 2012. "Emergency Vaccination to Control Foot-and-mouth Disease: Implications of its Inclusion as a U.S. Policy Option." *Applied Economic Perspectives and Policy* 34(1):119-146.

Lardy, G. 2018. *A Cow-calf Producer's Guide to Custom Feeding.* North Dakota State University Extension. Fargo, North Dakota. Accessed 05 June 2020 at https://www.ag.ndsu.edu/publications/livestock/a-cow-calf-producers-guide-to-custom-feeding/as1162.pdf.

Lawrence, J.D. and S. Ellis. 2008. *Monthly Returns from Cattle Feeding.* Iowa State University Extension, Ames, Iowa. Accessed 05 June 2020 at https://www.extension.iastate.edu/agdm/livestock/pdf/b1-35.pdf.

Marsh, J.M., G.W. Brester, and V.H. Smith. 2008. "Effects of North American BSE Events on U.S. Cattle Prices." *Review of Agricultural Economics* 30(1):136-150.

McCauley, E.H., A.A. Nasser, J.C. New, W.B. Sundquist, and W.M. Miller. 1979. *A Study of Potential Economic Impact of Foot and Mouth Disease in the United States*. St. Paul: University of Minnesota.

McReynolds, S.W. and M.W. Sanderson 2014. "Feasibility of Depopulation of a Large Feedlot During a Foot-and-Mouth Disease Outbreak." *Journal of the American Veterinary Medical Association* 244(3):291-298.

Muroga, N., Y. Hayama, T. Yamamoto, A. Kurogi, T. Tsuda, and T. Tsutsui. 2012. "The 2010 Foot-and-Mouth Disease Epidemic in Japan." *Journal of Veterinary Medical Science* 74(4):399-404.

Mutondo, J.E., B.W. Brorsen, and S.R. Henneberry. 2009. "Welfare Impacts of BSE-Driven Trade Bans." *Agricultural and Resources Economics Review* 38(3):324-329.

Paarlberg, P.L. A.H. Seitzinger, J.G. Lee, and K.H. Matthews, Jr. 2008. *Economic Impacts of Foreign Animal Disease.* ERR-57. U.S. Department of Agriculture, Economic Research Service.

Parent, K.B., G.Y. Miller, and P.J. Hullinger. 2011. "Triggers for Foot and Mouth Disease Vaccination in the United States." *Scientific and Technical Review* 30(3):789-796.

Peel, D.S. 2020. "The Effect of Market Forces on Bovine Respiratory Disease." *Veterinary Clinics of North America: Animal Practice* 36(2):497-508.

Pendell, D.L., J. Leatherman, T.C. Schroeder, and G.S. Alward. 2007. "The Economic Impacts of a Foot-and-Mouth Disease Outbreak: A Regional Analysis." *Journal of Agricultural and Applied Economics* 39(S1):19-33.

Rich, K.M. and A. Winter-Nelson. 2007. "An Integrated Epidemiological-Economic Analysis of Foot and Mouth Disease: Application to the Southern Cone of South America." *American Journal of Agricultural Economics* 89(3):682-697.

Rich, K.M., A. Winter-Nelson., and N. Brozović. 2005. "Modeling Regional Externalities with Heterogeneous Incentives and Fixed Boundaries: Applications to Foot and Mouth Disease Control in South America." *Review of Agricultural Economics* 27(3):456-464.

Schoenbaum, M.A. and W.T. Disney. 2003. “Modeling Alternative Mitigation Strategies for a Hypothetical Outbreak of Foot-and-Mouth Disease in the United States.” *Preventive Veterinary Medicine* 58:25-52.

Schroeder, T.C., D.L. Pendell, M.W. Sanderson, and S. McReynolds. 2015. “Economic Impact of Alternative FMD Emergency Vaccination Strategies in the Midwestern United States.” *Journal of Agricultural and Applied Economics* 47(1):47-76.

Snowder, G.D., L.D. Van Vleck, L.V. Cundiff, and G.L. Bennett. 2006. “Bovine Respiratory Disease in Feedlot Cattle: Environmental, Genetic and Economic Factors.” *Journal of Animal Science* 84(8):1,999-2,008.

Taha, F.A. and W.F. Hahn. 2014. “The Impact of BSE on U.S. Exports of Beef and Pork.” *Agribusiness* 30(1):5-16.

Thompson, D., P. Muriel, D. Russell, P. Osborne, A. Bromley, M. Rowland, S. Creigh-Tyte. And C. Brown. 2002. “Economic Costs of the Foot and Mouth Disease Outbreak in the United Kingdom in 2001.” *Scientific and Technical Review* 21(3):675-685.

Tonsor, G.T. and L.L. Schulz. 2019. Role of Packers and Processors in Livestock Biosecurity Effort. Organized symposium at Western Agricultural Economics Association. Coeur d’Alene ID, 30 June – 2 July.

Tozer, P.R., T.L. Marsh, and E.V. Perevodchikov. 2015. “Economic Welfare Impacts of Foot-and-Mouth Disease in the Canadian Beef Sector.” *Canadian Journal of Agricultural Economics* 63(2):163-184.

U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2011. *Feedlot 2011 – Part I: Management Practices on U.S. Feedlots with a Capacity of 1,000 or More Head*. Washington, D.C. Accessed 05 June 2020 at https://www.aphis.usda.gov/animal_health/nahms/feedlot/downloads/feedlot2011/Feed11_dr_PartI_1.pdf

U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2014. *Foot-and-Mouth Disease Response Plan: The Red Book*. Washington, D.C. Accessed 05 June 2020 at https://www.aphis.usda.gov/animal_health/emergency_management/downloads/fmd_responseplan.pdf.

U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2015. “FMD Response: Ready Reference Guide – Quarantine, Movement Control, and Continuity of Business.” Washington, D.C. Accessed 05 June 2020 at https://www.aphis.usda.gov/animal_health/emergency_management/downloads/fmd_rrg_cob_qmc_plan.pdf.

U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2015. “Emergency Response Procedures – Appraisal and Indemnity.” Washington, D.C. Accessed 05 June 2020 at https://www.aphis.usda.gov/animal_health/downloads/animal_diseases/ai/ER-Appraisal-Indemnity.pdf.

U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2017. “Highly Pathogenic Avian Influence (HPAI) – Appraisal and Compensation: What You Need To Know If You Have an HPAI-Infected Bird Flock.” Washington, D.C. Accessed 05 June 2020 at https://www.aphis.usda.gov/publications/animal_health/2016/hpai_appraisal_compensation.pdf.

U.S. Department of Agriculture Economic Research Service. 2019. Cattle & Beef – Sector at a Glance. Washington, D.C. Accessed 05 June 2020 at https://www.ers.usda.gov/topics/animal-products/cattle-beef/sector-at-a-glance/.

U.S. Department of Agriculture Farm Service Agency. 2020. “Livestock Indemnity Program Fact Sheet.” Washington, D.C. Accessed 05 June 2020 at https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/livestock_indemnity_program_lip-fact_sheet.pdf.

U.S. Department of Agriculture National Agricultural Statistics Service. 2020. Cattle on Feed (February 2020). Washington, D.C. Accessed 05 June 2020 at https://www.nass.usda.gov/Publications/Todays_Reports/reports/cofd0220.pdf.

U.S. Department of Agriculture National Agriculture Statistics Service. 2020. NASS – Quick Stats. Washington, D.C. Accessed 05 June 2020 at https://data.nal.usda.gov/dataset/nass-quick-stats.

Ward, M.P., L.D. Highfield, P. Vongseng, and M. Graeme Garner. 2009. “Simulation of Foot-and-Mouth Disease Spread within an Integrated Livestock System in Texas, USA.” *Preventive Veterinary Medicine* 88(4):286-297.

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