Understanding Strategic Behavior and Its Contribution to Hypothetical Bias When Eliciting Values for a Private Good

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Understanding market demand and premiums paid for food products with social and environmental attributes is increasingly important to ensure adequate information for the agri-food system. Stated preference (SP) surveys are a flexible and affordable approach to elicit values, however the presence of hypothetical bias compromises their reliability. In this study, we seek to identify strategic behaviors and how they relate to hypothetical bias in SP survey for private goods. An online survey was conducted to measure willingness-to-pay (WTP) for regular and free-run eggs using two treatments, a nonhypothetical experimental auction and an open-ended elicitation question. We find that the bias associated with the presence of strategic behavior in the open-ended elicitation survey can be isolated by calculating premiums, which are defined as the difference between declared values for free-run eggs and regular eggs. The insight gained from this study can be used to improve experimental design of hypothetical SPs surveys and significantly reduce hypothetical bias.

Comprendre la demande et la volonté de payer pour des biens alimentaires avec des caractéristiques sociales et environnementales est important afin d'assurer une information adéquate pour le secteur agroalimentaire. Les sondages déclaratifs sont une approche flexible et peu coûteuse pour capturer les valeurs, par contre la présence d'un biais hypothétique réduit la fiabilité des valeurs ainsi estimées. Dans cette étude nous tentons d'identifier le comportement stratégique en lien avec le biais hypothétique intrinsèque aux sondages déclaratifs. À cet effet, nous réalisons un sondage en ligne qui mesure le consentement à payer pour des œufs réguliers et de poules en liberté en utilisant deux traitements, une enchère non hypothétique et une question ouverte. Nous trouvons que le comportement stratégique présent en situation déclarative peut être isoler en calculant la prime, laquelle est définie comme étant la différence entre la valeur déclarée pour les œufs de poules en liberté et des œufs réguliers. Les résultats de cette étude peuvent être utilisés pour améliorer le design expérimental des enquêtes de préférences révélées et limiter le biais hypothétique.

INTRODUCTION

Nonhypothetical experimental auctions (NHEAs) have been widely used in the literature to estimate the willingness-to-pay (WTP) for value-added attributes of a product (Lusk and Shogren 2007). NHEAs are considered superior to stated preference (SP)

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methods, which seek to understand consumer behavior by asking valuation questions in a hypothetical setting, since SP methods have been shown to produce estimates with hypothetical bias (List and Gallet 2001; Murphy et al 2005; Harrison 2006; Loomis 2011).[1]

NHEAs circumvent hypothetical bias by creating a real transaction setting for products; thus, the elicited values should be truthful. However, the experimental setting of NHEA imposes constraints since the product must be available for purchase,[2] and conducting such experiments is time consuming, logistically difficult, and costly to execute. Alternatively, hypothetical experiments are a low-cost solution that can theoretically provide a setting to estimate the value of any type of good, including those goods that may not be available in the marketplace. Further research is warranted on how to mitigate hypothetical biases in SP surveys, due to the affordability of these surveys and the flexibility of their applications.

Several approaches have been developed to try to mitigate hypothetical bias[3] but few have been established on solid theoretical grounds. It is following the noteworthy contribution of Carson and Groves (2007) that theoretical understanding of hypothetical bias has emerged by emphasizing that, under microeconomic rational, respondents answer survey questions to maximize utility. From this viewpoint, Carson and Groves (2007) suggest that a survey where the respondent perceives that his or her answer may have an economic consequence should produce truthful answers, free from hypothetical bias.

Following Carson and Groves' (2007) contribution, several field experiments have produced convincing results showing that hypothetical bias in WTP estimates is mitigated when respondents perceive a consequence. This has been shown in both binary choice (Herriges et al 2010; Vossler and Watson 2013) and discrete choice experiments (Vossler et al 2012). However, these promising results are restricted to public goods where a credible payment vehicle such as a tax or a utility surcharge can be evoked and potentially imposed, creating a perceived economic consequence for a respondent.

In contrast, the elicitation of values for a private good in a hypothetical setting cannot be fully consequential, since the declared values cannot be imposed (Carson and Groves 2007). Therefore, it seems inescapable that hypothetical bias will be present in the valuation of private goods.

However, the identification of the hypothetical bias opens the possibility of controlling for it. Lusk et al (2007) identify two beliefs that respondents could have regarding how answers to a survey can affect their utility. First, they could believe that a new product will be released and the survey will be used to determine prices at which the product will be available. Alternatively, they could believe that the offering of the new product has not yet been determined and that the answers to the survey will be used to determine if the demand and value of the new product is sufficient to justify offering it in the marketplace. In the first case, a rational respondent would strategically underbid with regard to his

[1] Hypothetical bias is the discrepancy between elicited values from a hypothetical treatment compared to the elicited value in a nonhypothetical situation.

[2] This creates a technical barrier for the estimation of nonmarket (public) goods. Nevertheless, some experimental designs such as those from Lusk and Norwood (2011) and Vossler et al (2012) have developed NHEA protocol to value nonmarket goods.

[3] See Loomis (2011) for a more complete discussion.

or her true value to influence prices downward; this is referred to as price signaling. In the second case, a rational respondent would strategically encourage the provision of the good by overbidding relative to his or her true value; this is referred to this as provision signaling. Lusk et al (2007) and Mitani and Flores (2014) have empirically observed this type of behavior in a framed and hypothetical experimental setting.

As a generalization of Lusk et al's (2007) results, we suggest that hypothetical bias can be identified and interpreted if the following two conditions are met: (i) the respondent believes that the answers to the survey can change his or her utility and (ii) the researcher knows the respondent's beliefs.

We use an online survey to elicit values for regular and free-run eggs in both a hypothetical and a nonhypothetical treatment. As a first step, questions are used to identify strategic responses[4] based on how the participants believe the researchers will use the survey. We then code perceived consequences of the survey in dummy variables to measure the strategic response across treatments, as well as observing differences in behaviors in hypothetical settings. Finally, we take the difference between bids for free-run and regular eggs at the individual level and call this new variable Premium, which is then used as the dependent variable for an econometric model.

As expected from the literature, we identified strategic bidding in the hypothetical setting but not in the NHEA. Moreover, running an ordinary least squares (OLS) model on the premiums allowed to isolate the hypothetical bias.

The contribution of this paper is twofold. First, we identify strategic behaviors by asking open-ended questions on the respondent's belief of how the survey will be used. This differs from (Lusk et al 2007) who explicitly stated to what end the survey would be used (price or provision). Second, we identify econometrically the bias caused by the strategic behaviors and examine the ability of using this approach to mitigate hypothetical bias and correct WTP estimates.

The paper is organized as follows: the next two sections describe the experimental protocol and the empirical model, respectively. Results are then presented before concluding.

EXPERIMENTAL PROTOCOL

The data for this study are from an Internet survey on the WTP for a dozen regular and free-run eggs. The survey design was first tested on students, with follow-up questions, to ensure clarity of the task of the survey. Participants were recruited online from the Montreal area in the spring of 2012, using a payed for recruiting tool from Facebook. They had to be at least 18 years old and egg consumers. Potential participants were informed that they would receive $20 by mail for their participation and that the survey would take less than 30 minutes to complete. Participants were randomly allocated to either a hypothetical SP treatment or an NHEA treatment. In both cases, a neutral and short explanation presented the production methods used for each type of eggs.

[4] In this paper, strategic response is defined as a bid response that differs from the real value the consumer would pay for a good. This strategic response is a utility maximization behavior that can either be a conscious calculation of optimization or a natural (i.e., unconscious) behavior of maximization for selfish purposes.

The SP treatment included a standard “cheap talk” script to remind subjects to consider their budget constraints and to answer the survey as they would a real transaction in a grocery store. The average prices, as found in grocery stores in the Montreal area, for a dozen regular eggs ($3.10), a dozen organically produced eggs ($6.45), and dozen omega-3 eggs ($4.39) were included on the bidding page. The SP treatment asked an open-ended question as follows: “Please enter the maximum amount you would be willing to pay for a dozen regular (free-run) eggs.” Once the amount was entered and submitted, it could no longer be changed. The next page of the survey was identical to the previous, with prices for each type of egg included. However, it asked participants to declare the maximum price they would be willing to pay for a dozen free-run (regular) eggs. Note that the product order (regular and free-run eggs) faced by participants was randomly assigned.

The NHEA treatment used a Becker–DeGroot–Marschak auction (BDM) to elicit values. An explanation of the auction was followed by a practice round to illustrate the BDM mechanism. Once recruited, an additional $8 was added to the payout (for a total of $28) to compensate for the potential economic transaction of the binding auction. Participants were told that one treatment (regular or free-run) would be randomly selected as binding. If the participant’s bid was more than the randomly selected draw for that treatment, then the number drawn would be deducted from their payment. In exchange, the participant would receive a coupon to purchase a dozen eggs of the appropriate type at a local grocery store.

Following the bidding section, participants were asked to fill out standard socioeconomic questions. In order to identify possible strategies in the responses, an open-ended question asked them to describe in one sentence what they thought the study would be used for. Respondents that believed the survey would be used to guide decisions regarding future animal welfare policies as well as those who believe it would be used to help establish prices for eggs were identified as strategically bidding, for policy and for price, respectively. Since the product used in this study, free-run eggs, are already available, we do not assume that participants will strategically bid to increase their availability. However, participants concerned with hen welfare that believe that their answers to the survey could influence government policy or industry practices, could strategically overbid to signal an increase in demand. In this sense, we draw a parallel between the provision strategies to increase accessibility, as discussed by Lusk et al (2007) and Mitani and Flores (2014), with a policy strategy to increase production of free-run eggs. For the remainder of the paper, we will therefore use the term policy signaling.

Strategic bidding associated with policy and price signals were, respectively, attributed the value 1 for the dummy variables FOR_POLICY and FOR_PRICE. Participants were also asked to rank the top four attributes that most influenced their food purchase decisions among the following: animal welfare production methods, price, genetically modified products, nutritional attributes, and food safety. The attributes animal welfare and price were selected to be included in the model since the first variable is directly related to the study and the second is the most important attribute in forming purchase preferences as identified by participants. A dummy variable P_WELFARE was included to identify subjects who rated animal welfare production in their top two priorities when making food choices. The dummy variable P_PRICE was created to identify subjects who similarly rated price in their top two priorities when making food choices.

Empirical Model Specifications

The empirical model used in the analysis was

$$\mathbf{WTP}_{it} = \max(0, \alpha + \beta' x_i + \delta_{1t}\text{P\_WELFARE} + \delta_{2t}\text{P\_PRICE} + \delta_{3t}\text{FOR\_POLICY} + \delta_{4t}\text{FOR\_PRICE} + \varepsilon_t) \quad (1)$$

where $\mathbf{WTP}_{it}$ is the willingness-to-pay for the ith consumer for a dozen regular eggs when $t = 1$ and for a dozen free-run eggs when $t = 2$, x_i is the vector of sociodemographic variables. The parameters δ_{1t} and δ_{2t} measure the effect of a consumer's priorities for welfare and price, respectively, when making food purchases. The parameters δ_{3t} and δ_{4t} are measures of strategic bidding and ε_t is the nuisance parameter.

We also calculated a third model based on the premiums paid for a dozen free-run eggs defined as:

$$\mathbf{WTP}_{\mathbf{ipremium}} = \mathbf{WTP}_{i2} - \mathbf{WTP}_{i1} \quad (2)$$

$$\mathbf{WTP}_{\mathbf{ipremium}} = \alpha + \beta^{*\prime}\text{x} + \delta_1^*\text{P\_WELFARE} + \delta_2^*\text{P\_PRICE} + \delta_3^*\text{FOR\_POLICY} + \delta_4^*\text{FOR\_PRICE} + \varepsilon \quad (3)$$

The first two models are for regular eggs and free-run eggs ($\mathbf{WTP}_{it}$ with $t = 1{,}2$) and are estimated using an OLS model since we only have a few observation with zero bids.[5] The third model is on premiums ($\mathbf{WTP}_{\mathbf{ipremium}}$) and represents the value added that each respondent gave for free-run eggs relative to their regular egg value. The premium model is estimated using OLS since we allow negative values, indicating disutility of free-run eggs. The three models (regular eggs, free-run eggs, and premiums) estimate the parameter for the declared values of SP and NHEA treatments independently.

RESULTS

Table 1 reports descriptive statistics for the hypothetical (SP) and nonhypothetical (NHEA) treatments. Both treatments share comparable samples with less than 40% of respondents being male, the average age being between 34 and 40, and the majority of respondents holding a university degree.[6]

The answers to the open-ended question regarding the intended use of the study were classified in six subgroups, with the distribution of the perceived use of the survey not statistically different across treatments. The groupings are as follows: 15% did not answer

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[5] A tobit was conducted to account for the eight zero bids. The results are similar to the OLS and statistical significance for all parameters is the same under both specifications.

[6] Comparisons with the Montreal population are not done given that the goal of the study is to compare behavior across hypothetical and nonhypothetical treatment.

Table 1. Descriptive statistics for the hypothetical and nonhypothetical treatments

Variable Name	Stated preference % or mean (SD)*	NHEA % or mean (SD)[a]
Sociodemographic		
Gender (male = 1)	37.5	37.7
Age (in years)	34.5 (14)	39.8 (15.4)
University degree (bachelors, masters, or PhD)	52.3	63.1
Household > 2	27.4	27.9
Buys organic always or often	14.3	11.5
Priorities when buying food		
P_WELFARE	32.3	25.6
P_PRICE	64.0	56.6
Beliefs on how survey will be used		
FOR_POLICY	25.0	25.4
FOR_PRICE	32.0	34.4
Number of participants	128	122

Note: [a]For dummy variables the percentage of 1's is given, otherwise it is the sample mean.

the question or made it clear that they did not know for what the survey would be used for; 3% thought the research was about them or their behavior not about eggs; 9% thought the survey was linked to promotion or would be used to inform consumers; 17% thought that results would be used to create client profiles to help understand current markets; 25% believed the study would be used to inform producers or government about the demand for free-run eggs; while 32% believed that results would be used to determine price for regular eggs and/or free-run eggs. The last two groups are identified as strategically bidding for policy and for price, respectively.[7]

Respondents that fall into a subgroup that is not coded may perceive a consequence that gives rise to a strategic behavior. For example, a respondent that perceives that the survey will be used for promotional purposes may give a strategic response. However, in such case a dominant perceived consequence is difficult to identify as opposed to strategies directed toward price and policy of the good.

The price of the product was a main concern when making purchase decisions for over half of respondents in both samples, while animal welfare was important for approximately one-third of respondents in the SP sample and a quarter of respondents in the NHEA sample.

Table 2 reports the average declared values per treatment for a dozen regular eggs and free-run eggs. The fourth column presents the paired differences by respondent (the premiums). Results show that participants were willing to pay more for free-run eggs than for regular eggs in both treatments. Results also indicate the presence of a hypothetical bias for regular eggs and free-run eggs. Participants hypothetically declared an average WTP of \$3.33 for regular eggs and \$4.59 for free-run eggs. However, when in a real

[7] It should be noted that the classification into groups is, to some extent, subjective since there is variability in the way people answered the question. A sample of answers under each category is given in the supplementary data SampleAnswers.doc.

Table 2. Mean bids (CDN$) for a dozen regular eggs, a dozen free-run eggs, and the difference for each respondent

Treatments	Regular eggs ($CDN)	Free-run eggs ($CDN)	M-W U test	Premiums (free-run − regular) ($CDN)
SP	3.33	4.59	p-value < 0.001	1.26
NHEA	2.21	3.24	p-value < 0.001	1.03
M-W U test	p-value < 0.001	p-value < 0.001		p-value > 0.1

Note: The Mann-Whitney U-test statistic for the null hypothesis that average bids are the same.

transaction setting, the average WTP dropped to $2.21 for regular eggs and to $3.24 for free-run eggs. Interestingly, when we consider the price premium calculated for each individual, no statistical differences are observed between the hypothetical setting and the NHEA. The ratio of hypothetical bids on nonhypothetical one is 1.51 for regular eggs, 1.42 for the free-run eggs, and 1.22 for the premium bids.[8] These results seem to indicate a lower level of hypothetical bias in the premium. We hypothesise that some behaviors that cause hypothetical bias have been removed by taking the differences. In other words, individuals in hypothetical situation may have consistent behavior across both products such that taking differences would cancel off these behaviors. In the following models, we examine if strategic bidding can account for some of these behaviors.

Identification of Strategic Biddings

To better understand the declared values, an OLS model was performed. Table 3 reports the result of the regression on regular and free-run eggs for both treatments.

The socioeconomic variables that influenced bid price are a university degree, in the case of regular eggs, and age, in the case of free-run eggs in the SP treatment. Participants with a university degree bid significantly higher for regular eggs in both treatments, while older participants bid significantly lower for free-run eggs in the SP treatment.

The P_PRICE coefficient is negative, as expected, across all models but is only significant ($p < 0.1$) in the NHEA treatment for free-run eggs at $−0.78. Note that the P_PRICE coefficients are much larger in the NHEA treatment than in the hypothetical ones. Larger price sensitivity toward free-run eggs seems also present, which is not surprising since it is a more expensive product. Also of interest is the smaller coefficients and nonsignificance of the variable P_ PRICE in the SP treatments relative to their NHEA counterparts, which suggests the absence of price sensitivity for hypothetical bids. In other words, respondents may not express their price sensitivity when placed in hypothetical situation.

The perception that the survey would be used for policy (FOR_POLICY) did not produce a statistically significant difference in bids. However, those participants who believed the survey would be used for prices (FOR_PRICE) underbid for both type of eggs in the hypothetical treatment ($−0.45 for regular eggs and $−0.49 for free-run eggs). This underbidding behavior was not present for participants who believed that the results

[8] These are comparable to the average ratio of 1.35 found over 83 studies in the meta-analysis of Murphy et al (2005).

Table 3. OLS parameter estimates and significance for a dozen normal egg and a dozen free-run eggs

Variable	Regular eggs bid SP ($n = 128$)	Regular eggs bid NHEA ($n = 122$)	Free-run eggs bid SP ($n = 128$)	Free-run eggs bid NHEA ($n = 122$)
Intercept	3.456900***	2.58405***	5.550073***	3.799324***
Age	−0.003534	−0.01384	−0.025150**	−0.013579
Gender	0.040555	0.02815	0.116262	0.465960
University degree	0.488236**	0.55150	0.235907	0.113560
Household > 2	0.075226	0.28262	0.066939	0.425604
Priority when making food purchases				
P_PRICE	−0.025176	−0.28709	−0.265977	−0.780617*
P_WELFARE	−0.014516	−0.60411	0.366848	−0.356659
The perceived use of the survey				
FOR_POLICY	−0.275374	0.16818	0.178310	0.177611
FOR_PRICE	−0.449218**	−0.04524	−0.494497*	0.059091
R-squared	0.12	0.07923	0.1762	0.0633
Adjusted R-squared	0.04858	0.006293	0.1083	−0.01082
F-statistic	0.1154	0.3789	0.01299	0.5577

Note: *p-value < 0.1;
**p-value < 0.05;
***p-value < 0.001.

would be used to set the price of the product in the NHEA treatment. Thus, the strategic behavior of *price signaling* is only manifested in the SP treatment, as predicted by theory.

From the econometric model results, we conclude that strategic behaviors identified as *price signaling* and *policy signaling* are not present in the NHEA, but that *price signaling* is present and significant in the hypothetical treatment. Therefore, the inclusion of these variables in the econometric model allows the identification and the quantification of a source of hypothetical bias.[9]

Premium Model

We performed an OLS model on the premiums to pursue previous hypothesis that the price premium seems exempt of hypothetical bias. Recall that premiums are calculated at the individual level as the difference between the declared values for free-run and regular eggs.[10]

[9] The models were also estimated without the strategic parameters, a test for nested models indicate that the strategic response variables improve the SP model, but not the NHEA model.

[10] Note that nine respondents have negative premium bids. This implies seeing disutility in free range eggs. For example, one could believe that since free range eggs are more exposed to feces, they have a lower level of food safety than regular eggs. Reversal of preferences for animal welfare caused by food safety issues has been previously observed by Liljenstolpe (2008).

Table 4. OLS estimate of coefficients for the premium given to free-run eggs, with significance levels

Variable	Premiums (free-run − regular) SP ($n = 128$)	NHEA ($n = 122$)
Intercept	2.124151***	1.2152695*
Age	−0.021615**	0.0002614
Gender	0.128356	0.4378063
Household > 2	0.185164	−0.1690603
University degree	−0.43201	−0.1258963
Priority when making food purchases		
P_WELFARE	0.436422*	0.2474501
P_PRICE	−0.290262	−0.4935229*
The perceived use of the survey		
FOR_POLICY	0.495500*	0.0094270
FOR_PRICE	−0.054945	0.1043272
R-Squared	0.1449	0.06718
Adjusted R-Squared	0.06478	−0.06707
F-statistic	1.801*	0.9092

Note: *p-value < 0.1;
**p-value < 0.05;
***p-value < 0.001.

Results from the premium econometric model (Table 4) indicate that age is the only sociodemographic variable that is significant in the SP treatment. More specifically, older respondents have smaller premiums in the SP treatment (−0.022 per year of age).

Parameters related to priorities when making purchases have the expected signs, negative for those who prioritize price and positive for those who value animal welfare. However, only the price priority (P_PRICE) in the NHEA treatment is significant, supporting the view that NHEAs induce values that closely match those of a real transaction.

Consistent with theory and our previous results, no strategic bidding is identified in the price premium model for the NHEA treatment (Table 4). Moreover, results of the premium model do not indicate the presence of strategic *price signaling* as in the two previous models (Table 3). This is explained by the fact that the strategy of *price signaling* was found in both free-run and regular eggs (Table 3), therefore canceling out when differences are calculated. However, as opposed to the previous models, the premium model does find a statistically significant strategy of *policy signaling* (FOR_POLICY) as an overbid of \$0.496 ($p < 0.1$).

Note that respondents who want to promote animal welfare policy can strategically bid in two ways. They can strategically underbid for the regular eggs, since they do not support this type of production and/or they can strategically overbid for free-run eggs, showing support for this production system. These counteracting behaviors could explain why we have not found a statistically significant effect in the FOR_POLICY in

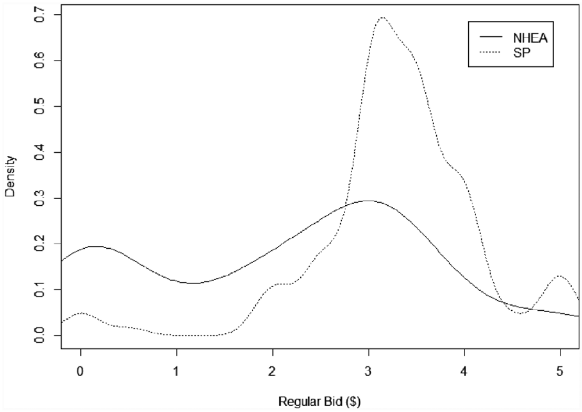

Figure 1. Density plots comparing declared values for a dozen regular eggs for the NHEA and the SP treatments

both regular and free-run eggs (table 3).[11] Taking the differences in bids regroups these two strategies into the premiums and results in a significant value for the FOR_POLICY of \$0.496 (p-value < 0.1).

Given that the premium model considers individuals' changes in bids between products (free-run and regular eggs), one can argue that biases that are constant across treatments would cancel out.

Distribution of Bids

Given the presence of heterogeneity in behaviors within each model, we examined the distribution of bids for regular and free-run eggs in order to support our claim that a price premium model allows us to identify and thus potentially correct for hypothetical bias.

The distribution of bids for regular eggs (Figure 1) provides some interesting insight into treatment effects. The NHEA distribution of bids can be divided into two groups. The first is centered near zero and represents the bid of respondents who did not wish to participate in the regular egg auction.[12] Given that an incentive compatible auction mechanism was used (BDM auction), low bids should represent the true WTP of those bidders. The second mode is centered near the given market price for regular eggs (\$3.10). Bids significantly larger than the market price are associated to bidding errors due to incomprehension of the BDM mechanism and low probability of a bad outcome resulting from overbidding (Rondeau et al 2015). The SP distribution has much higher participation with the majority of bids centered near the given market price of \$3.10. The distribution also shows numerous bids much higher than the market price, which likely reflects the inconsequential nature of bids in a hypothetical setting.

[11] While not statistically significant, we do observe opposite signs in (Table 3) with negative coefficient for regular egg bids and positive coefficients for free range egg bids, which provides support to the view that strategies for each type of eggs is opposing.
[12] Participants were instructed to enter a bid of zero if they did not wish to participate in the auction.

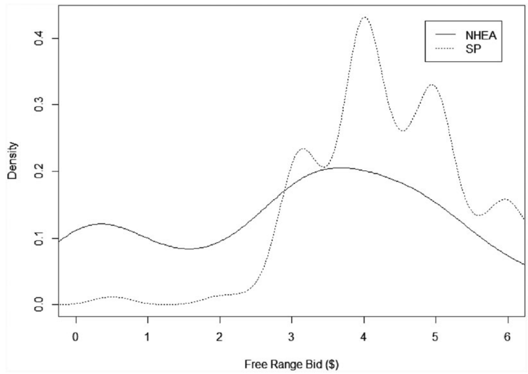

Figure 2. Density plots comparing declared values for a dozen free-run eggs for the NHEA treatment and the SP treatments

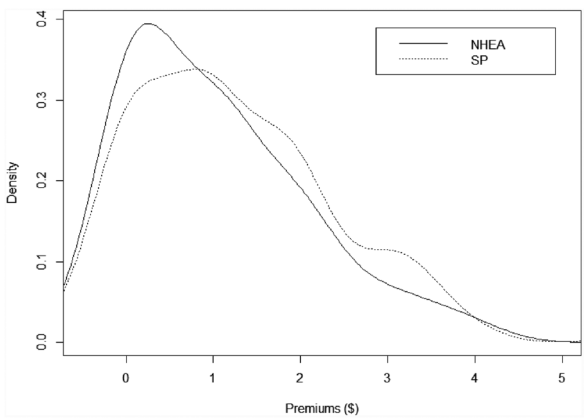

Figure 3. Density plots comparing calculated premiums per individual for the NHEA and the SP treatments

Figure 2 shows the distribution of bids for free-run eggs. The NHEA treatment for free-run eggs shows a similar distribution to that of regular eggs (Figure 1). We see a low price for a subgroup of the sample, with the remainder of the distribution slightly extended to higher values compared to regular eggs. This reflects the significantly higher WTP for free-run eggs. The SP distribution of bids is irregular with the presence of spikes that could be explained by the presence of heterogeneous behavior responses. Combining these observations with the results of our model for free-run eggs (Table 3), it appears that the lower spike would be caused by *price signaling* while the upper spike by *policy signaling*. We cannot rule out that other factors may also contribute to the observed heterogeneity. While comparing both distributions, we observe that the NHEA distribution is smoother, with a dominating value, while the SP distribution is more erratic and difficult to interpret.

Figure 3 shows the density plots for the premium model in both the SP and NHEA treatments. The premium model eliminates much of the discrepancies that existed between the two treatments. In fact, biases that were consistent between products (regular and free-run eggs) have been eliminated by the calculation of premiums at the individual level. This seems to suggest that most underlying behavior, including strategic behaviors and other exogenous variables that caused discrepancies between bids from hypothetical and nonhypothetical settings, is consistent across the products used in this study. The strategy FOR_POLICY can however be observed in the premium bids as identified in our model and is reflected in Figure 3 by the slight distribution of bids above those observed in NHEA.

Note that the presence of *policy signaling* did not make the average bids of premiums from the hypothetical treatment deviate statistically from the average bids of premiums from the nonhypothetical treatment (Table 2). This could be explained by the fact that only a fourth of the sample believed the survey would affect policy, therefore this strategic bias did not create a significant effect on overall averages. However, products with greater engagement could provoke stronger strategic behavior (Lusk et al 2007) and may lead to statistically different averages. Nevertheless, this bias could be identified and measured, which opens the door to a correction strategy.

CONCLUSION

This experiment found evidence of strategic behaviors in the SP treatments consistent with the results of Lusk et al (2007). These behaviors were identified using an open-ended question that did not provide explicit information on how the survey would be used by researchers. More specifically, in the premium model participants who perceived that their answers would influence animal welfare policy indicated higher values for free-run eggs, while participants who perceived that their answers would influence pricing responded with lower bids for both regular and free-run eggs. The NHEA treatment was free from strategic bidding and was sensitive to the declared priorities when making food purchases, supporting the belief that values elicited using incentive compatible auctions with a binding outcome reproduce real purchase intentions.

The current study design does not directly address selection bias caused by endogeneity, in the sense that characteristics of people who believe the survey will be used for price may correlate positively with people willing to pay less.[13] Another concern could be that the strategic response may be caused by reverse causality, for example, people with lower values for eggs may care about its price more and be more likely to engage in price strategic behavior. However, by including in the model the variables on purchasing priorities, which include priorities for price and hen welfare, we believe that this partially addressed the issue.[14] Finally, the direct causality of perceived consequence on WTP should not be dismissed since its rational lies on the utility maximization assumption from microeconomic theory.

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[13] To identify this type of selection bias that would arise from endogeneity of price (policy), one could use a split-sample approach by adding a treatment where it is explicitly stated that the survey would be used for prices (policy), allowing to identify and correct selection bias caused by endogeneity (Herriges et al 2010).

[14] Our results indicate that purchasing priorities do not matter in hypothetical setting and should not impact strategic responses. However, in the nonhypothetical situation the results are reversed with the purchasing priorities influencing declared values. This is evidence that what is measured in strategic responses is directly caused by how the respondents perceived the survey would be used.

By including the expected strategy as a variable in our models, we were able to measure strategic responses in hypothetical situation (none were detected in the NHEA) that contributed to hypothetical bias. Then, by constructing an econometric model based on premiums (WTP for free-run eggs minus WTP for regular eggs) at the individual level, we were able to isolate the hypothetical bias related to strategic behaviors. More specifically, the strategic behavior related to price signaling is significantly reduced, while the strategic behavior related to policy signaling is identified and measured in the premium model.

Previous studies observed that marginal WTP for attributes are free of hypothetical bias (Harrison 2006; Vossler et al 2012). These results differ from our study since they have been observed in discrete choice experiments where respondents make a choice between two or more goods. In our case, values are elicited using an open-ended question for a good, as opposed to specific attributes. Although we do obtain a marginal value for the free-run eggs when calculating the premium, respondents were not asked to make choices from which a marginal value is then derived. This detail, that may seem negligible at first, has important implication on how experimental design should be conducted to minimize hypothetical bias.

In addition to significantly reduce hypothetical bias, our results also have implications for hypothetical SP survey design. In hypothetical settings, several sources of bias such as "warm glow" or "social desirability" have been observed. Since these behaviors are heterogeneous across respondents, a within sample experimental design that ask declared values for two goods vertically differentiated could eliminate these sources of bias when calculating premiums, assuming that biases are consistent across goods.

Our results also stress the importance for researchers to understand how respondents are mentally framing the questions asked. Supplementary questions on perceived consequence, as has been done in this study, can be used to better interpret respondents' answers. How to properly ask such questions and include them in the analysis, remain a subject of ongoing research.

Finally, further studies would be needed to replicate our results. It might also be of interest to look at the robustness of our results by using a private good with attributes associated with stronger beliefs (i.e., genetically modified food).

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