Parental Response to Health Risk Information: A Lab Experiment on Evaluating Willingness-to-Pay for Safer Infant Milk Formula

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1 Introduction

Many producers offer a wide range of powdered infant milk formula in the market to satisfy the nutritional needs of infants and newborns that are not breast-fed. These infant milk formulas, however, are not sterile. They can contain, in low doses, microorganisms that can cause severe illnesses. The microorganism Enterobacter sakazakii (E. sakazakii) has been found to be a serious health hazard to newborns. Its presence in powered infant milk formula can cause sporadic cases of meningitis and necrotizing enterocolitis, an inflammatory disease of the gut. Consequently, in 2004, the FAO/WHO held an expert meeting to discuss the adverse health effects of E. sakazakii in powdered infant milk formula (FAO/WHO, 2004).

This study aims to investigate parents' willingness to pay (WTP) for safer infant milk formula with a quality assurance label. In addition, this study assesses the effect of provision of ambiguous risk information and safe-handling information on parent's WTP using experimental auctions (i.e., second price sealed bid auction). Our findings generally imply that parents significantly value a quality assurance label with or without clear incidence rate information. This valuation, however, is reduced by the provision of safe-handling information.

The paper is organised as follows. Section 2 provides background information on the microbiological risks of powdered infant milk formula, the marketing of breast-milk substitutes, and briefly outlines some aspects of ambiguity. The structure and design of the experiments are described in section 3. Section 4 presents and discusses the results focusing on the WTP measures, tests for ambiguity, and the effect of safe-handling information. The paper concludes in section 5.

2 Background

We aim to link the health risk associated with contaminated infant milk formula to the measurement of WTP for a quality assurance label indicating a safer product. In this section, we start with briefly discussing the health risks and we then describe the issue of ambiguity.

2.1 Microbial Risks of Powdered Infant Milk Formula

According to the current WHO feeding recommendations for developed countries, newborns should exclusively be breastfed within the first 4 to 6 month of their life (Kramer and Kakuma, 2002). Breast-feeding is the best and most natural way to nourish a baby. It is valuable in a nutritional context because breast milk provides the adequate content of nutrients to meet the newborns' requirements for growth and development (cf. Butte, Lopez-Alarcon, and Garza, 2002). Epidemiologic evidence suggests that breastfeeding protects infants against several diseases such as gastrointestinal and respiratory infection (Kramer and Kakuma, 2002). In cases when mothers cannot or do not want to breast-feed their children, a wide range of powdered infant milk formulas are commercially available. Powdered infant milk formulas, however, cannot be produced and packed sterile. It can contain low numbers of microorganisms, such as Enterobacter sakazakii (E. sakazakii), that can lead to foodborne diseases and serious health hazard to infants. E. sakazakii has a ubiquitous character. It is difficult to control because it is widespread and can be found in all environments. There is currently still a lack of knowledge regarding many aspects of E. sakazakii. More research is needed on its dose/response relationship in humans, the specific virulence mechanism, and the sources and vehicle of infection (EFSA, 2004). E. sakazakii has been found in various types of food, but only powdered infant milk formula has been linked to outbreaks of infection (Lehner and Stephan, 2004).

The occurrence of this pathogen in infant milk formula is especially dangerous for premature infants and newborns with low birth weight (≤ 2,000 g). Immuno-compromised infants and those who are medically debilitated are more likely to be susceptible to infections. E. sakazakii can cause neonatal sepsis, bacterial meningitis, and neonatal necrotizing enterocolitis, an inflammatory disease of the gut that can lead to death. The mortality rate for meningitis is 20 to 50 %. Children who survive often suffer from severe neurological disorders (FAO/WHO, 2004; Lehner and Stephan, 2004). Between 1961 and 2003, 48 cases of E.

sakazakii induced infections among infants were reported. According to the U.S. FoodNet 2002 survey, the infection rate with this pathogen in infants under 1 year of age is 1 per 100,000 infants. Among low-birth-weight newborns, however, the infection rate is 8.7 per 100,000. Consequently, not the frequency but the severity of the disease is a matter of concern (Lehner and Stephan, 2004). The WHO, however, states that there might be a significant underreporting of this disease in all countries (WHO, 2004). Adults with infections have milder outcomes whereas the elderly like the very young are particularly at risk (Lehner and Stephan, 2004; Lai, 2001).

2.2 Ambiguity in Communicating Health Risk Information

Two dimensions are usually considered to determine a choice situation. The first one is the relative desirability of the possible pay-off, and the other one is the likelihood of the events that are affecting them. The third factor that could be added is the information somebody has about the relative likelihood of events (Ellsberg, 1961). The ambiguity of this information is "[…] a quality depending on the amount, type, reliability and "unanimity" of information, and gives rise to one's degree of "confidence" in an estimate of relative likelihoods" (Ellsberg, 1961, p. 657). Camerer and Weber (1992) applied the following definition of ambiguity: "Ambiguity is uncertainty about probability, created by missing information that is relevant and could be known" (p. 330).

Fox and Tversky (1995) argued that when people compare two events with having different levels of knowledge about them, then the less familiar bet is less attractive compared to the more familiar one. This is called the comparative ignorance hypothesis. That is, ambiguity aversion is assumed to be present when subjects evaluate clear and vague prospects jointly (within-subject design), but diminishes or disappears when the prospects are evaluated in isolation (between-subject design). The hypothesis predicts that the clear bet will be priced above the vague bet. This discrepancy is likely to be more pronounced when clear and vague bets are traded jointly than separately (Fox and Tversky, 1995). For example, Chow and Sarin

(2001) showed in their experiments that the clear bet is priced higher than the vague bet under both comparative and non-comparative conditions. In our study, we hypothesize that ambiguity in risk information influences WTP. The ambiguity is represented by the unclear incidence rate (i.e., unclear probability of occurrence of an E. sakazakii infection). The next section discusses the experimental design and treatments used to test ambiguity and safe-handling information effects.

3 Experimental Design

In November and December 2005, 84 mothers and fathers participated in our experiments using Vickrey auction in a city located in Northern Germany. Participants were randomly recruited either through flyer or personal communication. We were seeking parents who feed/ fed their newborns powdered infant milk formula and are responsible for purchasing the formula. During the recruitment, the participants were not provided information about the details of the study to avoid participation bias related to food safety aspects of powdered infant milk formula. The subjects were randomly assigned to one of three treatments discussed below. We conducted a total of eight experimental auction sessions with group sizes ranging from 6 to 14 participants. Prior to the actual experimental auction sessions, the respondents were asked to fill in an entry questionnaire containing questions about the milk formula they feed, information sources that they use concerning baby food, reasons for not breastfeeding, socio-economic questions and others.

3.1 Design to Test Ambiguity Effects

The experiment was programmed and conducted with the software z-Tree (Fischbacher, 1999) and involved three treatments. The first two treatments were designed to test between-sample ambiguity effects while the third treatment was designed to test within-sample ambiguity effects.

In Treatment 1, the participants received information about the pathogen but were not provided clear information about the incidence rate (called “Unclear” treatment). The

information about the pathogen included information on the microorganism E. sakazakii, the diseases, symptoms and adverse health effects it might cause, the population at risk, and the possibility that it can be found in powdered infant milk formula. In treatment 2, the participants also received the same information about the pathogen but unlike Treatment 1, they received clear or unambiguous information about the incidence rate (called "Clear" treatment). The unambiguous incidence rate mentioned was one child out of 100,000 under 1 year of age. Participants were thus asked to avoid a risk with known outcome (i.e. the symptoms) but known or unknown likelihood of occurrence (i.e. the incidence rate), respectively.

The auctions for these two treatments to test between-sample ambiguity effects involved 5 trials each. Treatment 3 (called "Both" treatment), designed to test within-sample ambiguity effects, involved two sets of 5 trials each. In the first set of trials, the clear or unambiguous incidence rate was not mentioned to the participants while in the second set of trials, the participants were informed of the unambiguous incidence rate. The participants were asked to bid for an infant milk formula with a quality assurance label that the producers intend to introduce. The label signifies the absence of the pathogen E. sakazakii and hence, the assurance of safety[1]. Then they bid for the certified milk formula and stated how much they are willing to pay more than 1.15 Euro (served as basic price level) per 100 grams. The auctions involved 5 trials or rounds of bids so that participants could incorporate market feedback into their valuations. Subjects were told that only one round would be randomly selected to be binding, to control for demand reduction or wealth effects, and that the winner would be the individual with the highest bid, with the winning auction price being the second highest price.

Before the actual experiments, a coffee mug auction was conducted to familiarize the participants with the Vickrey auction procedure. The questionnaires and the experimental instructions are available from the corresponding author upon request.

[1] We did not show the participants a real label. The label and its meaning were just described to them. This was done to avoid biasing the results due to possible differences in participants' views about whether or not they like how the label was designed.

3.2 Design to Test Safe-Handling Information Effects

After the trials conducted to test ambiguity effects, the participants in all three treatments were given information on the preparation techniques that would enable them to control for the health risk. The risk of an infection of E. sakazakii can be decreased by several preparation techniques that parents apply when they reconstitute the milk powder. This knowledge puts parents in the position to self-control the health risk to their newborns. It is recommended, for example, that powdered infant milk formula should be prepared fresh immediately before the feeding, remnants should be discarded, reconstituted milk formula should not be kept warm in bottle heaters, and if the storage of prepared formula is necessary, the formula should be kept at 4°C for not more than 30 hours (Agostoni et al., 2004). This information about preparation techniques to reduce infection from E. sakazakii is used in this study to evaluate the effect of health risk reduction information on WTP values. The wordings of the preparation/safe-handling techniques used in the experiment are available from the corresponding author upon request. After the participants received this information, they then proceeded with another set of five trials of the experiment[2].

After all the trials, the participants filled in an exit questionnaire which included questions related to their support of the introduction of the label (see Table 2), their assessment of the risk that their child will get sick due to E. sakazakii, and the importance of risk reduction. Each participant then received a participation remittance of 20 Euro in cash. Additionally, we distributed a leaflet that summarized information on the "actual" situation of the E. sakazakii problem and the latest scientific findings. We also informed the participants of the internet address of the state authority that conducts risk assessment and offers information on this particular issue. The results of the lab experiment are described in detail in the next section.

[2] Despite the sensitiveness of the topic, we had no incidents of emotional panic or similar reactions in our experiments. All subjects finished the experiments and had the opportunity to ask questions afterwards. Technical questions or questions about the understanding of the procedure could be asked any time during the experiment but communication between the participants was not allowed.

Table 2. Selected sample characteristics.

Characteristics	Frequency	Percentage
Female	77	91.7
Male	7	8.3
Age in Years	Mean/Std. dev. 31.75/4.41	Percentile (25/50/75) 29.00/32.00/35.00
Household Monthly Net Income[1]		
< 920 Euro	2	2.4
920-1.500 Euro	7	8.3
1.501-2.500 Euro	41	48.8
2.501-3.500 Euro	24	28.6
3.501-4.500 Euro	6	7.1
4.501-6.500 Euro	2	2.4
6.501-8.500 Euro	1	1.2
8.501-10.500 Euro	0	0
10.501-12.500 Euro	0	0
>12.500 Euro	1	1.2
Household Size	Mean/Std. dev. 3.60/0.95	Percentile (25/50/75) 3/3/4
Price versus Food Safety[2]	Mean/Std. dev. 6.07/1.00	Percentile (25/50/75) 5/6/7
Do you support the introduction of the label?		
No, not at all	1	1.2
No	4	4.9
Partly	20	24.4
Yes	39	47.6
Strongly yes	18	22.0

Notes: [1] The income was expressed in numbers from 1 to 10 corresponding to the income category. [2] The respondents were asked to indicate their preference on a scale from 1 to 7 where 1 meant "low price over all" and 7 "highest food safety over all".

4 Results and Discussion

The subjects answered several questions about their reasons for not breast-feeding, their purchasing patterns, the use of information sources, their socio-demographic characteristics, etc. Selected sample characteristics are summarized in Table 2. Mainly mothers participated in the survey (91.7%). The participants were aged between 21 and 41. The mean age is 31.75 years. The households have an average size of 3.6.

4.1 Willingness-to-Pay

The elicited WTP amounts are summarized in Table 3. Average bid figures are for the last trials (i.e., 5th trial). Different bid levels are found in the different treatments. In treatment 1, we elicited a mean WTP of 91 Eurocents before the safe-handling information was given and an amount of 66 Eurocents after the safe-handling information was given.

The bids in treatment 2, when the participants were provided unambiguous incidence rate information, are generally lower than the bids in treatment 1, when participants were not provided unambiguous incidence rate information. In treatment 2, the mean WTP is 61 Eurocents before provision of safe-handling information and 39 Eurocents after the provision of safe-handling information.

Table 3. Summary statistics of bids in the different treatments.

Treatment	1	2	3		1	2	3
	(Without unam-biguous incidence rate)	(With unam-biguous incidence rate)	(Without and with unambiguous incidence rate)		(After providing information on preparation techniques to decrease the health risk)		
Description	**Unclear**[1]	**Clear**[2]	**Both**[3]$_{\text{Unclear}}$	**Both**$_{\text{Clear}}$	**Unclear**	**Clear**	**Both**
Auction, Trial 5:							
Average bid	91 (94)[4]	61 (69)	129 (138)	133 (138)	66 (71)	39 (48)	69 (89)
Median bid	65	50	93	85	50	40	60
Second- highest bid	200	150	350	351	150	115	185
Standard deviation	70.59	50.82	112.78	123.31	55.32	34.87	69.39
No. of zero bids	1	3	2	1	2	5	7
No. of respondents	26	27	31	31	26	27	31

Notes: [1]Unclear means that the unambiguous incidence rate is not provided/ [2]Clear means that the unambiguous incidence rate is provided/ [3]Both means that the unambiguous incidence rate is not mentioned before the first 5 trials are made and is then mentioned before the next 5 trials follow/ [4]Average without zero bids in parenthesis.

The bids in the "Both" treatment (treatment 3) are higher than in the other two treatments. Specifically, we obtained a mean WTP of 129 Eurocents per 100 grams before the unambiguous incidence rate was mentioned (i.e., first set of 5 trials) and 133 Eurocents after they were informed of the unambiguous incidence rate (i.e., second set of 5 trials).

In our experiment, we asked the participants to state their WTP for a labelled product that is not consumed by them but by their children. In the exit questionnaire, we told the participants to imagine if their own health would have been the matter of concern, not their children. We wanted to know if they would have bid more, equally or less. Interestingly, 47% of the respondents indicated that they would have stated a lower WTP, 51.8% answered they would have bid the same amount, and only 1.2% said that they would have paid more. In a related study by Dickie and Messman (2004), a stated preference approach was used to evaluate parents' preferences to ease symptoms of acute illnesses for their own and their children. It was found that parents value illness attributes of their children twice as highly as their own. This effect was more pronounced for younger children. These results were interpreted to reflect parental altruism rather than differences between parents and children in initial health or illness costs. Since almost half of the survey population in our study would have behaved differently if they were personally affected, we suggest that altruism plays a role in WTP valuations.

4.2 Testing for the Ambiguity Effect

The statistical tests conducted to examine the ambiguity effects are presented in Table 4. The first test we conducted was to examine the null hypothesis in treatment 3 that the bid distribution in the 5th trial between the group given the unambiguous incidence rate and the group that was not given the unambiguous incidence rate is identical using Wilcoxon's signed-rank test. The test result indicates that there is no difference statistically (p=0.436). Hence, we found no significant ambiguity effects in the within-sample design of the experiment.

Table 4. Testing for the ambiguity and information effect.

Hypothesis[1]	Test	p-Value	Description	Effect
$H_0 : F_{Unclear}^{Both} = F_{Clear}^{Both}$	Wilcoxon's signed-rank test	0.436	5th trial versus 5th trial	Cannot reject H_0. No significant ambiguity effect.
	Wilcoxon's signed-rank test	0.013**	5th trial versus 1st trial	H_0 can be rejected at the 0.05 significance level. Ambiguity effect present.
$H_0 : F_{Unclear}^{Unclear} = F_{Unclear}^{Both}$	Kolmogorov-Smirnov two-sample test	0.303	5th trial versus 5th trial	Cannot reject H_0. No significant ambiguity effect.
$H_0 : F_{\Pr ep}^{Unclear} = F_{\Pr ep}^{Both}$	Kolmogorov-Smirnov two-sample test	0.247	5th trial versus 5th trial	Cannot reject H_0. No significant ambiguity effect.
$H_0 : F_{Clear}^{Clear} = F_{Clear}^{Both}$	Kolmogorov-Smirnov two-sample test	0.111	5th trial versus 5th trial	Cannot reject H_0. No significant ambiguity effect.
$H_0 : F_{\Pr ep}^{Clear} = F_{\Pr ep}^{Both}$	Kolmogorov-Smirnov two-sample test	0.077*	5th trial versus 5th trial	H_0 can be rejected at the 0.10 significance level. Ambiguity effect present.
$H_0 : F_{Clear}^{Clear} = F_{Unclear}^{Unclear}$	Kolmogorov-Smirnov two-sample test	0.292	5th trial versus 5th trial	Cannot reject H_0. No significant ambiguity effect.
$H_0 : F_{\Pr ep}^{Clear} = F_{\Pr ep}^{Unclear}$	Kolmogorov-Smirnov two-sample test	0.163	5th trial versus 5th trial	Cannot reject H_0. No significant ambiguity effect.
$H_0 : F_{Clear}^{Both} = F_{\Pr ep}^{Both}$	Wilcoxon's signed-rank test	0.000***	5th trial versus 5th trial	H_0 can be rejected at the 0.01 significance level. Significant information effect present.
$H_0 : F_{Clear}^{Clear} = F_{\Pr ep}^{Clear}$	Wilcoxon's signed-rank test	0.000***	5th trial versus 5th trial	
$H_0 : F_{Unclear}^{Unclear} = F_{\Pr ep}^{Unclear}$	Wilcoxon's signed-rank test	0.005***	5th trial versus 5th trial	H_0 can be rejected at the 0.01 significance level. Significant information effect present.

Notes: [1]Superscript = treatment, Subscript = trial, ***Significance level = 0.01/ ** Significance level = 0.05/ * Significance level = 0.10

This result is confirmed by the summary statistics in Table 3 as well. Clearly, the information about the unambiguous incidence rate did not significantly affect the level of the

bids in treatment 3. However, comparing the fifth trial before the unambiguous incidence rate was mentioned and the first trial after the unambiguous incidence rate was mentioned, the difference between the mean WTP is statistically different at the 5% level (p=0.013). The unambiguous incidence rate information clearly decreased the mean WTP significantly from 129 to 87 Eurocents (see Figure 2). This can be interpreted as being an ambiguity effect since the new information about the unambiguous incidence rate significantly diminished the WTP in the trial right after the unambiguous information was provided.

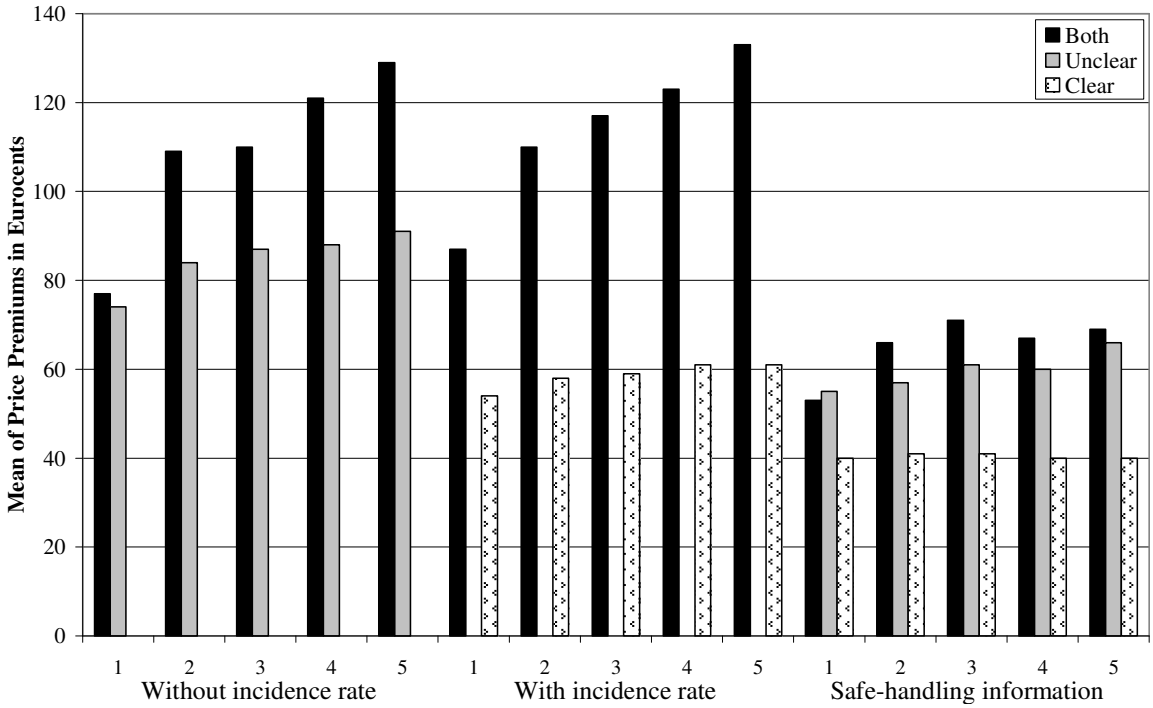

Figure 2. Comparison of trials for the different treatments.

Using the Kolmogorov-Smirnov two-sample test, we tested the null hypothesis that the population distributions of the bids between the different treatments are identical. We tested if treatment 1 bids differ from treatment 3 bids before provision of the unambiguous incidence rate information. The null hypothesis cannot be rejected (p=0.303) suggesting that we could not find ambiguity effects between the two treatments. We also tested if treatment 2 bids differ from treatment 3 bids after the provision of the unambiguous incidence rate information. The null hypothesis of this test also cannot be rejected.

Using the last trials, the distribution of the bids in treatment 1 was compared with the distribution of the bids in treatment 2. We could not find an ambiguity effect either between the treatments (p=0.292). In summary, no ambiguity effects were generally found in our experiments either from the within-sample treatment (treatment 3) or from the between-sample treatments (treatments 1 and 2). The only exception is when comparing the last trial before the provision of the unambiguous incidence rate information and the first trial after the provision of the unambiguous incidence rate information in treatment 3. It is not clear why ambiguity in incidence rate information does not generally have a significant effect on WTP. However, it is possible that parents do not care about the clearness or ambiguity of incidence rate because this is in regard to the health of their child. This is consistent with Kahneman and Tversky's (1979) finding that people tend to be risk-averse when they are faced with a small chance of losing a large amount. This behaviour is generally referred to as the "overweighting of small probabilities".

4.3 Testing for the Effect of Safe-Handling Information

We hypothesized that the safe-handling information we provided decreases the WTP because parents can then self-control the health risk. To investigate this, we tested the null hypothesis that the population distributions within each treatment are identical using Wilcoxon's signed-rank test. We used the last trial of the different treatments for the test. In all the three treatments, the effect of the information was found to be statistically significant (see Table 4). In treatment 1, the WTP reduction is statistically significant at the 5% level while in treatments 2 and 3, the decrease in WTP is statistically significant at the 1% level. Hence, information on the preparation techniques significantly reduced participants' valuation of the label (also see Figure 2).

In summary, the key finding that emerges from our experiment is the significant effect of the provision of safe-handling information. Providing information to the participants on the preparation techniques that helps to decrease the health risk influences the WTP and leads to a

significant decrease in WTP, as expected. Interestingly, the WTP did not decline to zero with the provision of the safe-handling information. It is, however noteworthy that we had five zero bids in treatment 2 and seven zero bids in treatment 3 when the information on the preparation techniques was provided. These results may suggest that the information on the unambiguous incidence rate made it easier for the respondents to calculate the risk and to value the information on the preparation techniques. In treatment 1 ("Unclear"), we just had 2 zero bids.

5 Conclusion

This study assessed parents' WTP for quality assurance labelled powdered infant milk formula. Using experimental auctions, our results indicate that the mean price premiums parents were willing to pay ranges from 61 to 133 Eurocents, given a basic price level of 115 Eurocents per 100 grams of powdered infant milk formula. This result means that parents are willing to pay price premiums from 53% to 116% of the base price per 100 grams. Our experiments also examined if ambiguous information about health risk (i.e., incidence rate) as well as information about safe-preparation techniques affect WTP. Our results generally suggest no significant ambiguity effects but substantial safe-handling information effects on WTP. The WTP declined by 39 to 69 Eurocents after the provision of information about the preparation techniques. This finding suggests that our subjects attached a lot of importance to safe food handling techniques that could reduce the health risk.

Our findings imply that parents indeed significantly value a quality assurance label with or without clear incidence rate information. Parents' valuation of this label, however, is reduced with the provision of safe-handling information. It may then be prudent for the infant milk formula industry to provide both a quality assurance label and the information on safe-handling preparation techniques. Future studies should, however, replicate our study to assess the robustness of our findings in other countries. Analyzing the welfare effects of our findings is also warranted given data availability.

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