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Estimating cost of fighting against fake news during catastrophic situations

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ABSTRACT

As the battle with COVID-19 continues, an Infodemic problem has been raised. Even though the distribution of false news in national disaster situations has been reported for a long time, little attention has been given to the quantitative research of the fake news problem from the audience's perspective. This study, therefore, aims to estimate how much tax taxpayers would gladly pay for a virtual public-run fact-checking system. Using a one-and-one-half bounded dichotomous choice contingent valuation method, a survey was conducted on 525 respondents in Korea, and the spike model was applied to distinguish zero willingness-to-pay (WTP). The results show that a household's WTP for the public fact-checking system is 10,652 KRW (9 USD), on average, in the form of income tax for five years. Given the amount is a regular payment in perpetuity, the total WTP is estimated at 23 billion KRW ($196 M) every year. The result also shows that an individual's WTP increases as his or her psychological damage caused by fake news is high, as well as his or her high reliance on news in a disaster situation.

1. Introduction

As the COVID-19 pandemic continues, the infodemic becomes a critical issue (Vaezi and Javanmard, 2020). At the Munich Security Conference on February 15th, 2020, WHO Director-General Tedros Adhanom Ghebreyesus stressed that as information spreads rapidly through social media, like the spread of virus, it has become as important to fight against the infodemic as to fight epidemics (WHO, 2020). Because of the long-run persistence of COVID-19, more and more information which should not be questioned are circulating easily and widely as the form of fake news through social media (Apuke and Omar, 2020). The head of Public Health Emergencies at UNICEF, Carlos Navarro pointed out that much incorrect information in social media comes from traditional mass media (Zarocostas, 2020). In this situation, some companies, such as Facebook, Twitter, Tencent, Pinterest, and Tiktok, working with WHO to track fake news, make an effort to provide evidence-based facts on their own platforms. Facebook, Twitter, and Google have even started cracking down on COVID-19 information not provided by reliable sources such as WHO website or the ministry of health.

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The fake news problem is not a sudden syndrome in the midst of the COVID-19 pandemic. There have been many studies on media reliability problems due to misinformation in various national disaster situations such as the Victoria bushfire, Haiti Earthquake, The Great East Japan Earthquake, and Hurricane Sandy (Abdullah et al., 2015). Given that fake news stimulates readers to disseminate the contents actively (Nielsen and Graves, 2017), studies on how to deal with fake news have been vigorously conducted.

However, although many studies have stressed the importance of the fake news problem and the need for response, little attention has been paid to the actual impact of fake news on audiences (Lazer et al., 2018; Egelhofer and Lecheler, 2019). To the best of our knowledge, the quantitative scale of prevalence and consequences of fake news remains unknown (Jang and Kim, 2018; Allen et al., 2020). Furthermore, while governments and companies increase their budget to deal with fake news, including the media literacy education program and institutes (Chapman and Insights 2016; IFCN, 2019), there is a controversy over public intervention against the fake news problem (McGonagle, 2017; Roozenbeek and Linden, 2018).

Therefore, this study aims to confirm the necessity of fake news policies from the receivers' perspective by using the contingent valuation method (CVM). According to the previous literature, we are well aware that studies on users' acceptance are important in supporting public policies. If the direction of the organization's new business corresponds to individuals' common values and their interests, a high level of trust will be built between them, leading to strong support of their business (Hurley, 2006) and affects positively on the operation of policy such as reducing the costs of implementation (Chanley et al., 2000). This applies equally to the fake news policy. In this study, a new media policy that supports to develop a technique tracking the fake news is considered as one of methods to deal with the fake news problem. By asking respondents' willingness-to-pay (WTP) for the new policy, especially in a disastrous situation, this study helps to identify correspondence between respondents' common values and the policy. As the quantitative amount of investment that the taxpayers actually want to pay is determined, the measured value can be used as the objective indicator of cost estimation for the relevant industries and public policies. Moreover, by analyzing the correlation between the characteristics of receivers and their payment, it can be used in the policy-making process that prevents fake news production and dissemination when national disaster strikes.

The content of this study is as follows. In Section 2, we examine the overall concepts of fake news and the topics of previous studies to set the definition of fake news and the purpose of this study. Then, in Section 3, it explains the CVM and the statistical models which are used to measure respondents' willingness to pay for the policy by using the direct WTP question. Section 4 contains the details of the research process, including the composition of the questionnaire, and based on the empirical survey results, and we analyze whether the investment of fake news policy in South Korea is in line with the taxpayers' acceptable level. Finally, Section 5 summarizes the results and key findings of this study, and based on the results, suggests the considerations and directions of future fake news policy.

2. Literature reviews

There have been many studies conducted in the 'fake news' field. It can be classified into three parts: the definition of fake news, the effect of fake news, and technologies for detecting fake news.

First, previous studies have mostly focused on how people think about the 'fake news' and how to define it. They have studied the history of fake news, tried to define it, and to find patterns of fake news itself and its distribution. According to Burkhardt (2017), information sharing in groups have caused fake news problem from the preprinting era. As the internet is publicly provided, the scale of fake news has increased and spread faster. In this trend, discussions on how to define the term 'fake news' have been actively conducted, and scholars have reached an agreement that fake news can be categorized into six types; satire, parody, fabrication, manipulation, propaganda, and advertising (Tandoc et al., 2017). After establishing the definition of fake news, studies to determine the features of fake news have been conducted. Fake news has characteristics that are easy to assimilate emotionally and usually spread on social networks (Bakir and McStay, 2018; Vicario et al., 2016). Additionally, there are specific linguistic features that distinguish legitimate information from fake news (Clarke et al., 2019).

However, in this study, as Allcott and Gentzkow (2017) mentioned, the term 'fake news' is used as a definition of 'verifiable false coverage which intentionally misleads readers' in the narrow sense. This definition excludes other concepts of fake news; 1) unintentional reporting mistakes, 2) rumors not originated from a particular news media, 3) unverifiable conspiracy theory, 4) satire which is unlikely to mislead, 5) politician's false statement, and 6) slanted reports but not outright false. In brief, fake news in this study is a 'verifiable false report that intentionally misleads readers and originated from public news-press.'

Subsequently, there have been many studies about the impacts of fake news on society. According to the previous studies, there have been lots of fake news issues and numbers of people easily tend to be blinded by false news even if there are pieces of evidence telling the truth (Lewandowsky et al, 2012; van der Linden et al, 2020). Not only the controversial political issues but also the various fields of news including the public health issue have had difficulties in correcting widespread belief from the false news. Similarly, in the financial investment issue, it is revealed that fake news has less effect than real information, but it causes statistically significant abnormal transactions and can draw more attention than genuine news (Clarke et al., 2019). In other words, even though the outward effect of fake news is still less (some researchers even say that it is impossible to measure the influence of fake news itself), the previous studies have commonly agreed that the psychologically perceived effects of fake news are significant (Jang and Kim, 2018). Moreover, in terms of policy, people are less able to distinguish fake news and true information than they think, so researchers stressed that it is more appropriate for governments to support individuals to develop their media literacy skills instead of instituting stronger regulations (Tambini, 2017).

Lastly, a large body of research has given tremendous attention to a method to detect fake news. Given that most people are aware of the fake news problem and how fast it spreads, publishers have critically important roles in solving the fake news problem (Nielsen

and Graves, 2017). Therefore, many studies have focused on developing automated detection technologies. A study revealed that based on the imperfect and unformatted features of fake news, it is possible to detect them by using an individual's social network (Shu et al., 2017). Additionally, by learning the existing fake news data and linguistic features of fake news, it is possible to develop a highly accurate detection program (Wang, 2017). Using Twitter data related to the Moore Tornado and Hurricane Sandy in 2013, Rajdev and Lee (2015) established a highly accurate automated detection program of fake news through horizontal and vertical classifiers of users' behavior characteristics and linguistic features.

As previous literature has mentioned, the biggest problem of fake news issue is that many people psychologically react more actively to fake news rather than legitimate news and that it spreads faster and wider (Vosoughi et al., 2018). Thus, many studies on how to solve the fake news problem have been conducted, and most of them focus on media literacy skills and detection technologies. However, the important thing is that the research on how much taxpayers are willing to pay and feel the necessity of the relevant technologies and policies is still lacking. In addition, although many researchers revealed that the fake news strongly stimulates and affects readers' cognition, the extent of their psychological damage remains unmeasured. Therefore, in this study, by using the CVM, we estimate WTP for the development of fake news technologies and policies in the shoes of real users. Furthermore, this study has significance for measuring the effect of fake news on readers' cognition and giving numerical evidence of future policies.

3. Methodology

To estimate the monetary value of non-market commodities, stated preference (SP) methodologies, such as CVM and choice experiment (CE), have been widely used (Ryan and Watson, 2009). CVM is often used to estimate the value of environmental or public goods which do not have a market price by asking the maximum willingness-to-payment that respondents would be willing to pay for the presented virtual policy scenario (Alberini et al., 1997). On the other hand, the CE method is a way to measure WTP indirectly by asking to choose between different alternatives that are various combinations of attributes and levels (Ryan, 2004). In this study, given that we ask respondents' interest in a specific policy scenario by asking a WTP directly, the CVM is more appropriate in this situation.

CVM can be estimated in two approaches. One is based on the indirect utility function of Hanemann (1984), and the other is based on the WTP function of Cameron and James (1987). Both methods can be applied because both are based on the consumer theory and their estimated results are the same. We estimated the value of fake news using Hanemann's utility difference function. In CVM, based on the utility difference model, respondents answer 'yes' if they are willing to pay the proposed cost, and otherwise, they answer 'no' (Kim et al., 2019). Random utility function can be shown as Eq. (1), where j means whether they would like to pay (1) or not (0), S represents respondents' characteristics, and y indicates respondents' income. The random utility function is constituted by the deterministic part v and the random component ϵ that is not observable. By using them, we estimate the utility function that maximizes users' utility u (Hanemann, 1984).

$$\mathrm{u(j,y;S)} = v(j,y;S) + \epsilon_j \quad (whenj = 0,1) \tag{1}$$

As shown in Eq (2), if the utility that will be given by paying A for the goods is larger than the utility of nonpayment, individuals answer 'yes,' and vice versa, if the utility from payment is less than the utility of nonpayment, people answer 'No'.

$$v(0,\mathrm{y:S}) + \epsilon_0 \le v(1,y-A;S) + \epsilon_1 \tag{2}$$

Based on Eq. (2), the utility difference defined as Δv and it can be described as shown in Eq (3) (Lee and Han, 2002). When a random variable to normalize the distribution of utility differences is $\eta = \epsilon_1 - \epsilon_0$, F_η is the cumulative distribution of variable η and it can be written as Eq (4). Describing a probability of willingness to pay A as $G_c(A)$, in the closed-ended question format, the probability that a respondent will pay equal to or greater than A can be written as Eq (5) (Hoyos and Mariel, 2010; Hanemann, 1984).

$$\Delta v = v(1,\mathrm{y-A;S}) - v(0,\mathrm{y;S}) + (\epsilon_1 - \epsilon_0) \tag{3}$$

$$P_0 = F_\eta(\Delta v) = G_c(A) \tag{4}$$

$$\Pr(\mathrm{WTP} \ge \mathrm{A}) = 1 - G_c(A) \tag{5}$$

Generally, depending on the question, CVM is classified as a single bounded dichotomous choice (SBDC), double bounded dichotomous choice (DBDC), and one-and-one-half bounded dichotomous choice (OOHBDC). In this study, by using OOHBDC, we would like to have both benefits of statistical efficiency and consistency from SBDC and DBDC and have less exposure to bias (Cooper et al., 2002). The OOHBDC model divides respondents into two groups and asks for their willingness to pay A^L(*Lower bid*) or A^U(*Upper bid*). In the first group, if a respondent is asked for A^L and he answered 'yes,' a researcher asks about A^U again, but if they say 'no,' there is no additional question. On the other hand, if they are asked for A^U and answered 'yes,' there is no additional question again, but if they answer 'no,' there will be an additional question for A^L. The types of respondents' answers can be written as Eq (6).

$$\begin{cases} I_i^{YY} : [Group1]\ respondent\ i\ answering & Yes-Yes & (willing\ to\ pay\ over\ A^U) \\ I_i^{YN} : [Group1]\ respondent\ i\ answering & Yes-No & (willing\ to\ pay\ A^L \sim A^U) \\ I_i^{N} : [Group1]\ respondent\ i\ answering & No & (willing\ to\ pay\ under\ A^L\ or\ not) \\ I_i^{Y} : [Group2]\ respondent\ i\ answering & Yes & (willing\ to\ pay\ over\ A^U) \\ I_i^{NY} : [Group2]\ respondent\ i\ answering & No-Yes & (willing\ to\ pay\ A^L \sim A^U) \\ I_i^{NN} : [Group2]\ respondent\ i\ answering & No-No & (willing\ to\ pay\ under\ A^L\ or\ not) \end{cases} \tag{6}$$

In addition, we use a Spike model to identify zero bidders who have a willingness to pay ($0 \sim A^L$) and log-likelihood function of our model is shown as Eq. (7), where α and β are coefficients (Kriström, 1997). Based on the estimation results, the mean WTP which only covers the value >0 is defined as Eq (8) (Kriström, 1997; Saz-Salazar and Garcia-Menendez, 2001).

$$\ln L = \sum_{i=1}^{N} \{ I_i^{YY} \ln\left[1 - G_c\left(A_i^U\right)\right] + I_i^{YN} \ln\left[G_c\left(A_i^U\right) - G_c\left(A_i^L\right)\right] + I_i^{N} \ln G_c\left(A_i^L\right) + I_i^{Y} \ln\left[1 - G_c\left(A_i^U\right)\right] + I_i^{NY} \ln\left[G_c\left(A_i^U\right) - G_c\left(A_i^L\right)\right] + I_i^{NN} \ln G_c\left(A_i^L\right) \} \tag{7}$$

$$\text{where } G_c(A) = \begin{cases} [1 + exp(\alpha - \beta A)]^{-1} & (if\ A > 0) \\ [1 + exp(\alpha)]^{-1} & (if\ A = 0) \\ 0 & (if\ A < 0) \end{cases}$$

$$\text{meanWTP} = \frac{1}{\beta} \ln[1 + \exp(\alpha)] \tag{8}$$

4. Empirical analysis

4.1. Data

In this study, the CVM is used to get SP data because the respondents were directly asked about the payment for a virtual policy scenario that does not exist, and that is a non-market value (Saz-Salazar and Garcia-Menendez, 2001; Loomis, 2014). The online pilot

Table 1
Respondents' demographic characteristics.

Category		Respondents	Percentage	Average
	Total	525	100.00	
Gender	Male	271	51.62	
	Female	254	48.38	
Age	20 s	103	19.62	43.1276
	30 s	117	22.29	
	40 s	118	22.48	
	50 s	114	21.71	
	60 s	73	13.90	
Education Level	~high school education	11	2.10	16.398 years
	~4-year course college education	153	29.14	
	Graduate School	361	68.76	
Average monthly income per household (10,000 Korean won)	<100	23	4.38	494.0381
	100 ~ 149	11	2.10	
	150 ~ 199	25	4.76	
	200 ~ 249	35	6.67	
	250 ~ 299	40	7.62	
	300 ~ 399	86	16.38	
	400 ~ 499	108	20.57	
	500 ~ 699	111	21.14	
	700 ~ 999	65	12.38	
	>1000	21	4.00	
Average monthly expense per household (10,000 Korean won)	<49	14	2.66	269.9448
	50 ~ 99	43	8.19	
	100 ~ 149	59	11.24	
	150 ~ 199	81	15.43	
	200 ~ 249	78	14.86	
	250 ~ 299	53	10.09	
	300 ~ 349	58	11.05	
	350 ~ 399	45	8.57	
	400 ~ 499	57	10.86	
	>500	37	7.05	

Note. USD $1 = KRW ₩1,158.8 (2020.10.07)

survey was conducted by a professional polling firm, Gallup Korea, from April 13th to April 20th, 2020. Three hundred respondents participated in the pilot survey. On the other hand, the main survey was also conducted by Gallup Korea in the form of an online survey, from May 12th to May 22nd, 2020. The demographic composition of the 525 respondents who participated in the main survey is shown in Table 1.

The survey questionnaire consisted of four parts. To establish the respondents' interest in fake news issues and identify their usual media literacy skills, Part A presented five real articles to distinguish fake news and legitimate news. All five articles were stories about actual national disaster events taking place in Korea in the past and three of them were fake news.

Part B defined the terms of national disaster and fake news in this study and presented the purpose of this research, thereby enhancing the respondents' understanding of the survey and making to response under the same background knowledge.

Part C is a set of questions to see respondents' opinions of news in actual disaster situations and fake news problems. By asking the seriousness of disaster situations depending on the types of them, we tried to avoid temporal selection bias due to the recent occurrence of COVID-19. In addition, we asked the forms of news media they prefer to use in disaster situations and the average amount of time for checking news per day. The reliability of news, the psychological damage caused by fake news and the seriousness of fake news problem respondents felt are asked as a form of 5-point Likert scale.

Finally, part D described a virtual scenario of public business to prevent a fake news problem and asked respondents' WTP. Reflecting the previous studies that indirect regulation supporting media literacy skills is more appropriate than legal restrictions (Jang and Kim, 2018; Tambini, 2017), we described a reliability warning program of news sites or articles by referencing the French press *Le Monde*'s fact-checking widget '*Les Décodeurs*' as a virtual scenario (Les Décodeurs, 2017; Declambre, 2017; Bathke, 2016). Additionally, we used the annual income tax for five years as a payment vehicle in that it is used to prevent fake news in 'national disaster situations'. For the WTP questions, we used open-ended questions for the pilot survey, and the main survey was designed with 1.5 bounded dichotomous choice questions (OOHBDC) like Fig. 1 (see the Appendix A for the CVM questionnaire).

4.2. Results

Table 2 is the distribution of 525 WTP responses by asking respondents to pay for the fake news policy for five years. The proposed initial value in the main survey was set in seven sections, as shown in Table 2, based on the results of the pilot survey. It shows that the larger amount of bid proposed, the fewer people answered 'yes.'

Table 3 shows the results of the OOHBDC model. Model 1 is a result without covariates, and Model 2 is the coefficient estimates for the explanatory variables. At first, Model 1 indicates that the estimated coefficient of the bid is negative, and the estimated coefficient of alpha is positive, which are statistically significant. In particular, according to the distribution of responses depending on proposed value, as shown in Table 2, it can be confirmed that the negative coefficient of the bid is reasonably estimated.

On the other hand, Model 2 shows that income has a positive correlation with WTP, but regarding age, younger respondents are willing to pay higher WTP for the policy. Given that the virtual scenario is about the program for the online news content, it is consistent with the media consumption pattern that younger people are more likely to pay for the online news media (Goyanes, 2014; Fletcher and Nielsen, 2017). Meanwhile, the education level is not statistically significant. The meaningful result is that the degree of psychological damage has a significant influence on their willingness-to-payment. Moreover, in disaster situations, the higher credibility of news media people have, the more WTP they are willing to pay; in other words, in a disaster situation, the higher reliance on mass media they have, the more sensitive to psychological damage they are due to a fake news problem. This reflects that in national disaster situations, the role of news content and media becomes more important than usual because they change audiences' attitudes about national hazards, increasing their ability to prepare and media work as communication tools connecting the affected areas and others in terms of reducing high level of uncertainty. (Perez-Lugo, 2004; Cheng et al., 2015). Lastly, they think the seriousness of fake news problems and the disaster situation also have a positive correlation with their WTP.

According to the spike model, the proportion of zero bidders is 46.11% of the total, and the mean WTP is estimated to be 10,652 Korean won (9.19 US dollars). The 95% confidence interval of WTP is 8,992 to 12,311 in Korean won, which is approximately 7.76 dollars to 10.63 dollars. The number of households in South Korea totaled 20,891,348 in 2019 (KOSIS, 2020). By excluding 45.9% who

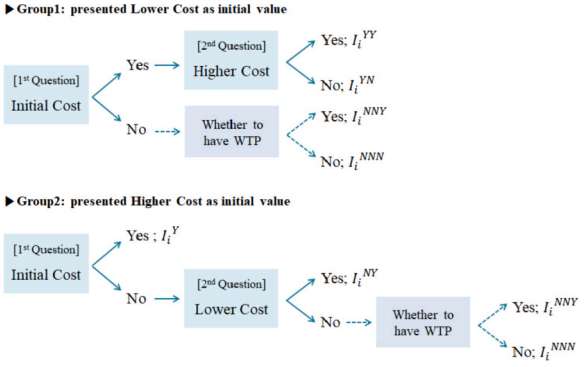

Fig. 1. Structure of OOHBDC questionnaire with a spike model.

Table 2
Distribution of responses by the bid amount.

Bid amount (KRW)		Lower bid is presented as the first bid				Simple size
A^L	A^U	Yes-Yes	Yes-No	No-Yes	No-No	
1,000	5,000	18	9	4	15	46
3,000	7,000	10	8	2	16	36
5,000	10,000	7	7	1	17	32
7,000	13,000	8	1	4	27	20
10,000	16,000	12	3	2	24	41
13,000	21,000	10	8	8	27	43
16,000	26,000	5	6	5	14	30
Total		70	42	26	130	268
Bid amount (KRW)		**Upper bid is presented as the first bid**				**Simple size**
A^L	A^U	**Yes**	**No-Yes**	**No-No-Yes**	**No-No-No**	
1,000	5,000	16	5	1	13	35
3,000	7,000	15	6	2	20	43
5,000	10,000	14	7	3	12	36
7,000	13,000	11	7	4	11	33
10,000	16,000	5	5	4	20	34
13,000	21,000	14	4	3	19	39
16,000	26,000	9	6	6	16	37
Total		84	39	23	111	257

Note. USD $1 = KRW ₩1,158.8 (2020.10.07)

Table 3
Result of CVM Analysis.

Variables	Model 1			Model 2		
	Means		Std.error	Means		Std.error
Constant	0.1557	*	0.0873	−2.0970	**	0.9995
Bid	−0.0001	***	0.00001	−0.0001	***	0.00001
Age		–		−0.0124	*	0.0073
Income		–		0.0007	**	0.0003
Education		–		−0.0056		0.0352
Psychological damage		–		0.1652	***	0.0470
Seriousness of fake news they feel		–		0.5830	**	0.2350
Exposure time for news		–		0.0679		0.0905
Preference for new media		–		0.0568		0.0629
Seriousness of disaster situation they feel		–		0.2700	*	0.1589
Credibility of news in disaster situation		–		0.6019	***	0.2008
Spike		0.4611			–	
Mean WTP	₩10,652 ($9.19)	***	846.69		–	
2.5% 97.5%	₩8,992 ($7.76)		₩12,311 ($10. 63)		–	
Observations			525			
Log-likelihood		−660.7798			−632.9801	

Note. ***, **, and * refer to statistically significant levels of 0.01, 0.05, and 0.1, respectively.

refuse to pay, the final number of households for payment is 11,302,219. As shown in Table 4, calculating the total WTP, the 95% interval is 101.63 billion KRW (87 million US dollars) to 139.14 billion KRW (120 million US dollars).

By using a social discount rate of 4.5% (PIMAC, 2017) and the mean WTP 10,652KRW (9.19 USD), the total value of five years of payment is estimated at about 528 billion in Korean won, which is approximately 456 million US dollars. If the amount is regular payment forever, people are willing to pay an additional 22.76 billion won (196 million dollars) to prevent the distribution of fake news every year; an individual is willing to pay approximately an additional 1,089 KRW (0.94 dollars) in income tax every year.

In 2020, among the public policies related to the fake news problem in Korea, the Korea Communications Commission is planning to spend 610 million Korean won (0.53 million dollars) on the 'Establishing a fact-checking infrastructures to develop reliability in the

Table 4
Number of households and Total WTP in 95%

	Household	**2.5%***	**97.5%***
Total	20,891,348	₩101,634,189,567 ($87,729,123)	₩139,141,621,408 ($120,104,981)

*Total WTP in 95% = (Num of Household) × (1 −Proportion of zero bidders) × (Mean WTP)
where the proportion of protesters is the sum of respondents who answer 'No-No' or 'No-No-No'in Table 2.

online environment' project (Korea Communications Commission, 2020). In addition, according to a business conducted by the Korea Press Foundation (2020), they allocated 60 million won (51.8 thousand dollars) to support startup companies in the fact-check program business in 2020. As mentioned above, people are willing to pay 22.76 billion won (196 million dollars) which surpasses the current budget, so it seems that the government needs to conduct related business projects building fact-checking infrastructure more actively to meet public demand.

5. Conclusions and remarks

As mentioned above, the urgency of the fake news problem, the governments' intervention, and the effects of policies against fake news have been controversial (McGonagle, 2017; Katsirea, 2018). However, previous studies have commonly agreed about the seriousness of the fake news problem in public and the importance of news media in a disaster situation (Jang and Kim, 2018; Roozenbeek and Linden, 2018; Perez-Lugo, 2004). In addition, there is still controversy over the regulation of fake news; many studies have agreed that in the process of solving the fake news problem, some interventions by authorities are necessary (Tambini, 2017; Jang and Kim, 2018; Katsirea, 2018; Morgan, 2018).

Under these circumstances, this study used CVM to estimate public needs for fake news policies in national disaster situations. To have more statistical efficiency and less bias, a one-and-one-half bounded dichotomous model was used. As a result of the analysis, an individual is willing to pay 10,652 KRW (9.19 US dollars), on average, for the policy of fact-checking systems to prevent the distribution of false news; the total amount of bid is estimated to 528 billion KRW (456 M dollars). Given that a person pays an additional 1,089 KRW (0.94 dollars) for the fake news policy every year, it is possible to get an annual 22.76 billion KRW (196 M dollars) funding. As the amount of total WTP surpasses the budget implemented by the Korean Government in 2020, approximately 670 million KRW (0.58 M dollars), it confirms that the audiences are more likely to support the development of fact-checking programs in public. According to the analysis with explanatory variables, the personal experience of psychological damage due to fake news has a positive correlation with WTP. Moreover, it shows that a respondent who has higher credibility of news in national hazards requires the government to play an active role in dealing with fake news problem in disaster situations.

Meanwhile, with regard to fake news policies by regions, some countries such as Germany, France, and Russia approved legislation against false stories, but others such as Belgium and Canada are responding indirectly to the fake news problem, for example, by using media literacy education (Haciyakupoglu et al., 2018; Martynov and Bundin, 2020; Audenhove et al., 2018). Owing to the controversies around fake news issues, such as freedom of speech and urgency of its regulation, fake news policies are challenging in terms of intervention by the government (Claussen, 2018; Verstraete et al., 2017; Allen et al., 2020). Accordingly, media companies and technology companies are pressured to institute a technological response to fake news by developing detecting programs (Haciyakupoglu et al., 2018; Vasu et al., 2018). For now, South Korea is one of the few countries trying to invest in the development of computational infrastructure to deal with fake news as a public response. In this respect, the result of this study provides the empirical evidence whether the policies technologically responding to fake news are in line with public needs.

The contributions of this study are as follows. Firstly, there has been little attention to the effect of fake news and the necessity of public response for real users. In this respect, this study is important because it confirms the necessity of the fake news policy from the position of real taxpayers. Secondly, the results of this research can be highly utilized because it presents the value of the policy in quantitative way. Given that individuals are willing to pay additional 1,089 KRW (0.94 dollars) for a fake news policy every year, the total amount of its funding, 22.76 billion KRW (196 million dollars) is 0.27% of total income tax levied by government in 2019 which is approximately 83.6 trillion won (72.21 billion dollars) (Korea National Tax Service, 2020). In this way, it is helpful to measure its value compared with other numerical figures in the policy-making process. Lastly, as the psychological damage makes people more sensitive to the fake news problem in national disaster situations, we can confirm that proactive policies are more important than reactive policies.

On the other hand, there are also some limits to this study. Firstly, we need to notice that as the estimated value, willingness-to-pay for the fake news policy in this study is based on stated preference data, so it does not mean the quantitative scale of actual effects of fake news. In addition, since there are various ways for the government to respond to fake news, such as legislation, media literacy education, fact-checking institutions, and so on, the policy-makers should consider the possibility of changes on how much taxpayers are willing to pay and support the policy depending on the ways of response. Lastly, the study asked respondents to pay for the policy of preventing the spread of fake news in a narrow sense, national disaster situations. However, given that the interest and requirements of fake news policy have increased due to the prolonged national disaster situations with COVID-19, the audiences' needs for public action to regulate fake news are noteworthy.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. CVM questionnaire

The following questions ask about your willingness to payment for the media policy preventing the dissemination of fake news. Please be cautious with the following instructions.
As the questions are based on the virtual policy scenario, even if it does not keep with the reality, please answer for this hypothetical offer.
If you don't pay any additional cost for the policy, the exposure of fake news could be maintained at the current level.
Please concern about the fact that your income is limited and it has to be spent for various purposes.
According to the result of related analysis, a household's expected additional cost per year is estimated at [Lower bid] KRW to [Higher bid] KRW.
※ Half of respondents presented [Lower bid] (Q1, Q2); the others presented [Higher bid] (Q3, Q4).

Questions	Responses
Q1. If the fact-checking system is useful in preventing the dissemination of fake news, are you willing to pay an additional [Lower bid] KRW per year through the income tax for the next five years?	1. Willing to Pay (Go to Q2) 2. Not Willing to Pay (Go to Q5)
Q2. Then, if the fact-checking system is useful in preventing the dissemination of fake news, are you willing to pay an additional [Higher bid] KRW per year through the income tax for the next five years?	1. Willing to Pay 2. Not Willing to Pay
Q3. If the fact-checking system is useful in preventing the dissemination of fake news, are you willing to pay an additional [Higher bid] KRW per year through the income tax for the next five years?	1. Willing to Pay 2. Not Willing to Pay (Go to Q4)
Q4. Then, if the fact-checking system is useful in preventing the dissemination of fake news, are you willing to pay an additional [Lower bid] KRW per year through the income tax for the next five years?	1. Willing to Pay 2. Not Willing to Pay (Go to Q5)
Q5. Even if the fact-checking system is useful in preventing the dissemination of fake news, aren't you willing to pay any additional cost per year through the income tax for the next five years?	1. Willing to Pay 2. Not Willing to Pay at all (Go to Q6)
Q6. Why aren't you willing to pay any additional cost for the fact-checking system preventing the dissemination of fake news?	1. I can't afford to pay for it. 2. There is insufficient information to judge. 3. I don't feel the necessity of preventing the dissemination of fake news. 4. I don't agree to prevent the dissemination of fake news. 5. I already pay enough tax and it should be covered by existing budget. 6. I doubt whether the fact-checking system would prevent the fake news problem. 7. Other (please respond specifically)

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