

Korean perceptions of transboundary air pollution and domestic coal development: Two framing experiments

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ARTICLE INFO

Keywords:

Framing effects
Competitive frames
Korean air pollution
Public opinion
Pollution haven
Coal use

ABSTRACT

This paper examines how exposure to messages about the cause of seasonal air pollution in Korea influences the Korean public's satisfaction with efforts to address the problem. It also assesses the impact of frames that accentuate the costs and benefits of the nation's coal usage on individuals' support for coal-based energy development. It draws from framing theory to develop hypotheses tested in two distinct survey experiments that recruited a representative sample of residents living in the Seoul Metropolitan area. We find that frames that highlight the need for immediate policy action, by blaming China, Korea or both nations, decreases satisfaction with existing national efforts. Moreover, frames that attribute blame exclusively to China decrease satisfaction with China's efforts to combat the problem. On the domestic front, we find that Koreans' views toward increased coal use are a function of exposure to a coal-costs or coal-benefits frame; however, when the frames appear simultaneously in competition, considerations about the economic benefits overpower concerns about the negative health effects. The results emphasize how frames can shift perceptions about the need for policy action as well as in securing public support or opposition toward a specific "polluting" energy source.

1. Introduction

South Korea (henceforth, "Korea") regularly experiences hazardous air pollution. The Korean media's assignment of responsibility frequently targets China, yet there is little mention of the possibility that foreign investors in China are contributing to the problem, and that a significant portion of this investment originates in Korea (Shapiro, 2016). A dearth of studies addresses how exposure to frames transmitted via mass media affect public opinion regarding attributions of responsibility for the air pollution problem, or satisfaction with national efforts to address it. Accordingly, there has been very little research on Koreans' opinions about domestic and transboundary sources of air pollution, i.e. China-originating air pollution as well as air pollution produced from within Korea's borders.

Our focus is on the effects of messages that attribute blame to different sources of the pollution problem on the general public's satisfaction with Korea's and China's current policies, and, in a second study, how exposure to frames emphasizing competing considerations related to coal-based energy development affect the public's support for a reliance on this energy source. We employ two distinct survey experiments to consider how frames in isolation and in competition affect the Korean public's views about air pollution and the development of

coal-based energy.

More specifically, our first experiment assesses how satisfaction with national efforts to address the air pollution problem are affected by frames that attribute blame primarily to China or to Korea. Given the extent to which coal has been emphasized in Korea's energy portfolio (Park et al., 2013), we assess in the second experiment how a frame highlighting the negative public health consequences, the positive economic benefits of its usage (i.e., reduced energy costs), or both frames in competition shift individuals' overall support for the increased development of coal. Focusing on these issues across the two experiments allows us to expand the corpus of research on energy-related framing theory in one of the most energy-intensive areas of the world and ultimately demonstrate the viability of Koreans' support for policies addressing environmental coordination with China in light of changes in Korean coal consumption.

2. Issue framing effects

A voluminous literature across the social sciences has explored how exposure to frames in a communication affect individuals' attitudes and behaviors (Druckman, 2011; Entman, 1993; Goffman, 1974). Frames are an unavoidable reality of human communication in which

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information is compressed into meaningful chunks (Druckman and Lupia, 2017). Nisbet (2009, 15) explains, “There is no such thing as unframed information... audiences rely on frames to make sense of and discuss an issue; journalists use frames to craft interesting and appealing news reports; policymakers apply frames to define policy options and reach decisions; and experts employ frames to simplify technical details and make them persuasive.” According to Framing Theory, an individual-level emphasis (or issue) framing effect occurs when a communicator’s focus on a subset of the potentially relevant considerations toward an attitude object (e.g., through the use of frame devices such as words, phrases, symbols, or non-verbal cues) causes a listener or audience to privilege the emphasized consideration when forming an opinion (Chong and Druckman, 2007a; Druckman, 2001).

Media frames provide narratives and interpretive storylines that help individuals define social problems, understand who is responsible for it, and determine what should be done about it. Exposure to media frames that emphasize certain features or consequences of a social problem or issue can lead individuals to privilege those considerations in forming an overall opinion about the issue. In other words, the increase of accessibility and/or perceived applicability of a frame causes greater “weight” to be assigned to that consideration when one forms an overall evaluation. There are a number of studies focusing on energy-oriented frames in news discourse, including analyses of key events such as the Three Mile Island accident and how the media described it in the context of an out-of-control technology (Gamson and Modigliani, 1989), longitudinal analyses of media-based frames focusing on personal energy conservation (Bolsen, 2011), and descriptive analyses of clean energy and renewable energy technologies (Delshad and Raymond, 2013; Feldpausch-Parker, Burnham, Melnik, Callaghan, and Selfa, 2015; Langheim et al., 2014; Mallett, Jenger, Phillion, Reiber, and Rosenbloom, 2018; Sengers, Raven, and Van Venrooij, 2010; Skjolsvold, 2012). These frames have consequential effects on citizens’ energy-related opinions. Specifically, emphasis framing effects that highlight scientific consensus about the benefits of emergent energy technologies increase citizens’ support for the use of these technologies (Bolsen and Druckman, 2015; Bolsen et al., 2014b; Druckman and Bolsen, 2011).

2.1. Attribution of responsibility

We are particularly interested in studying emphasis frames focused on attributions of causal responsibility for Northeast Asian air pollution. Such frames that attribute responsibility for a social problem to different actors can have a powerful impact on an individual’s support for specific policies to address the problem (Iyengar, 1991; Malhotra and Kuo, 2007). Frames that attribute responsibility for dealing with a nation’s energy problems, either to the government or to individual citizens, for instance, have been shown to affect individuals’ beliefs about the importance of energy conservation in the U.S. and behavioral intentions to engage in personal conservation. That is, attributing responsibility for action on energy issues to the U.S. government decreased individuals’ willingness to engage in collective actions that involved taking steps to save energy (Bolsen et al., 2014a). Given that Koreans are regularly exposed to news reports that highlight China’s responsibility for Korea’s pollution, and given that solutions for transboundary air pollution are primarily framed in the context of providing information about how to avoid health-related consequences (e.g., donning dust masks and using air purifiers) rather than reducing the public’s impact Shapiro (2016), real solutions to this problem are being left in the hands of the Chinese and/or Korean leadership. In other words, prevailing media-based reports that employ frames attributing transboundary air pollution to Chinese and/or Korean leadership are expected to decrease engagement by the Korean public. Yet, we have yet to understand clearly the connection between perceptions about satisfaction with national efforts and the relative blame individuals assign toward different countries.

2.2. Coal costs and benefits

We also study how exposure to frames that highlight either the health costs of coal usage or its relative economic benefits, or both simultaneously, shape Koreans’ views about whether to increase or decrease the country’s reliance on this energy source. Framing theory suggests that exposure to a single frame in isolation often shifts opinion in the direction of the frame. For instance, exposure to a frame highlighting the health costs of coal usage should decrease support for the development of this energy source, and vice versa for positive frames emphasizing the economic benefits of coal. When directionally opposing frames of equal strength are pitted against one another in a competitive framing context, they often cancel each other out, leaving opinions unmoved (Chong and Druckman, 2007a). However, when frames of different strength appear in competition, the stronger frame dominates the weaker frame, shifting overall opinion in the direction of the stronger frame (Chong and Druckman, 2007b, 2010). Despite claims that individuals eschew losses more than gains of equivalent value (see Tversky and Kahneman, 1981), updates to this line of research have confirmed that topic- and individual-specific factors play crucial conditioning roles.

Few studies focus on individual-level framing effects in competitive framing experiments focused on support for distinct energy sources. Among those that do engage this topic, evidence has been provided to show that competitive frames are presented in the media. Wright and Reid’s (2011) content analysis of *New York Times* articles, for example, showed that frames highlighting biofuels-related economic development dominated over content that framed biofuels in relation to their environmental and national security concerns. Similar analyses have been done with regard to wind energy (Stephens et al., 2009; Weiss, 2017) and geothermal energy (Romanach et al., 2015). Most appropriate for the present study is Aklin and Urpelainen (2013) experiment focusing on the effects arising from economic frames; i.e. pro-clean energy policy frames that highlighted the creation of new jobs and anti-clean energy policy frames that emphasized increases in energy prices. Given the extent to which coal is emphasized in Korea’s energy portfolio, we focus on the health effects of air pollution, representing approximately 80% of all air pollution costs (Pearce et al., 2006). In the U.S., research on the transition from fossil fuels toward renewable sources shows that an information-based frame highlighting the health costs of fossil fuel – that “pollution from coal burning power plants causes tens of thousands of premature deaths in the U.S. alone every year” (Goldfarb et al., 2016: p. 301) – increased support for renewable policies. Yet, costs do not universally produce a framing effect with regard to energy alternatives. Ansolabehere and Konisky’s (2014) examination of health and economic costs’ effects on support for renewables showed that health costs dominate over economic costs; yet, in other research, when presented with economic and environmental benefits and costs of fracking, only the benefits frame produced a significantly different effect from the control/no-frame group (Christenson et al., 2017).

3. Experiment 1: blame attribution frames

3.1. Design

This experiment employs two emphasis frames as well as their combination to highlight different actors’ responsibilities for the air pollution problem. All three invoke a fabricated news article from the Korean Newswire, *Yonhap News*. The first conveys a blame-China frame which states that “the majority of Korea’s air pollution comes from factories located in China.” Implications are also included: “In other words, China is to blame for Korea’s air pollution.” To establish credibility for this statement, the frames included language regarding the source of the information reported in the *Yonhap News* article, namely a report authored by “experts from the National Institute of

Environmental Research, the Korea Meteorological Administration, and Seoul National University.” The precise language for the blame-China frame is as follows:

The following news article was recently published:

“China Cause of Air Pollution in Korea”

– *Yonhap News Agency* –

A recent report finds that the majority of Korea's air pollution comes from factories located in China. In other words, China is to blame for Korea's air pollution. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University.

For the second frame, attribution is assigned to Korea in the form of the “pollution haven hypothesis,” which invokes theories of ecological economics and the international political economy to claim that foreign entities effectively export pollution by setting up production in regions where there are relatively weaker environmental standards. The costs for the pollution exporter are thus lower than those resulting from producing in their countries of origin.¹ As was the case for the blame-China frame (regarding China), the implications are stated clearly (i.e. “... Korea is to blame for Korea's air pollution.”). The exact language for the pollution haven frame is as follows:

The following news article was recently published:

“Korean-owned Factories Cause of Air Pollution”

– *Yonhap News Agency* –

A recent report finds that the majority of Korea's air pollution comes from factories owned by Koreans located in China. In other words, Korea is to blame for air pollution blowing from China. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University.

The third and final frame combines both frames in competition, i.e. placing blame on both China and Korea. The clarifying statement for the competitive frame states, “It other words, both countries are to blame for air pollution blowing from China.” Finally, each of these news articles convey the urgency of the problem, stating that “[t]he report also states that air pollution is getting worse and that action must be taken immediately to address this problem.” The wording for these frames in competition is as follows:

The following news article was recently published:

“Korea and China Cause of Air Pollution”

– *Yonhap News Agency* –

A recent report finds that the majority of Korea's air pollution comes

from China, but it is not all caused by China. The pollution comes from Chinese factories as well as Korean-owned factories in China. In other words, both countries are to blame for air pollution blowing from China. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University.

The dependent variables in this experiment are designed to measure the satisfaction Koreans have with regard to national efforts to address the air pollution problem, the first measuring Korea's efforts to reduce its air pollution (“To what extent are you satisfied with Korea's efforts to reduce its air pollution?”) and the second measuring China's efforts to reduce its air pollution (“To what extent are you satisfied with China's efforts to reduce its air pollution?”).² Given that all of the treatments make a call for immediate policy action, we expect that individuals that receive any of the three attribution of responsibility frames will have decreased satisfaction with the national efforts of either Korea or China relative to the control group. To that end, we propose the following hypothesis:

H1. *Satisfaction with national efforts decreases with exposure to an attribution of responsibility frame.*

We also expect that, when Korea is exclusively emphasized with the pollution haven condition, individuals will decrease their satisfaction with Korea's efforts to combat air pollution relative to the control group but also relative to the blame-China frame. Similarly, when China is exclusively emphasized with the blame-China condition, individuals will decrease their satisfaction with China's efforts to combat air pollution relative to the control group but also relative to the pollution haven frame. As such, we propose the following hypotheses:

H2. *Satisfaction with Korea's efforts decreases most with exposure to the pollution haven frame.*

H3. *Satisfaction with China's efforts decreases most with exposure to the blame-China frame.*

Finally, and addressing the possibility of there being more than a single attribution of responsibility in a frame, we propose the following research question regarding frames in competition:

RQ1. *What is the effect of the attribution of responsibility frames in competition on satisfaction with national efforts?*

3.2. Data and results

For this experiment we randomly assigned 500 individuals to one of four conditions: control ($n = 125$), blame-China ($n = 125$), pollution haven ($n = 125$), and a competitive frame ($n = 125$).³ Both experiments, [Experiment 1](#) and [Experiment 2](#) to follow, are based on nationally representative samples of the Korean population based on the Korean web survey agency, Macromill-Embrain, Inc. (“Embrain”).⁴ Respondents were recruited via computer-telephony integration/random digit dialing, voluntary registration on Embrain's panel site, word of mouth, or banner advertisements on portal sites. An individual

² These two dependent variables were randomly ordered to eliminate any potential bias created from the question ordering. The wording for all questions and responses can be found in the appendix.

³ To eliminate systematic bias from the sample, respondents were randomly assigned to one of two possible frames-in-competition treatments. Half were assigned to a treatment that presented information about China before information about Korea while the other half were assigned to a treatment that reversed the order of information (i.e. Korea and then China).

⁴ Institutional Review Board approval granted by the Illinois Institute of Technology's IRB, Protocol # IRB2017-014.

¹ Production processes may of course also be set up in regions where there are enticements for the foreign firm besides weak environmental standards, such as cheaper labor costs, subsidies and tax benefits, or cheaper greenfield factory construction /brownfield factory modifications.

Table 1
Pairwise comparisons of all experimental conditions for Experiment 1.

Variable	Condition 1: mean	Condition 2: mean	Difference	One-sided <i>p</i> values from two-sample <i>t</i> -tests	Benjamini-Hochberg <i>p</i> values
Satisfaction with Korea	Control 2.81	Blame China 2.31	0.50	<i>p</i> = 0.00	<i>p</i> = 0.01**
Satisfaction with Korea	Control 2.81	Pollution haven 2.56	0.26	<i>p</i> = 0.06	<i>p</i> = 0.14*
Satisfaction with Korea	Control 2.81	Competitive 2.54	0.26	<i>p</i> = 0.05	<i>p</i> = 0.12*
Satisfaction with Korea	Blame China 2.31	Pollution haven 2.56	0.24	<i>p</i> = 0.07	<i>p</i> = 0.09*
Satisfaction with Korea	Blame China 2.31	Competitive 2.54	0.23	<i>p</i> = 0.07	<i>p</i> = 0.09*
Satisfaction with Korea	Pollution haven 2.56	Competitive 2.54	0.01	<i>p</i> = 0.48	<i>p</i> = 0.46
Satisfaction with China	Control 1.87	Blame China 1.54	0.33	<i>p</i> = 0.00	<i>p</i> = 0.03**
Satisfaction with China	Control 1.87	Pollution haven 1.84	0.03	<i>p</i> = 0.41	<i>p</i> = 0.45
Satisfaction with China	Control 1.87	Competitive 1.97	0.10	<i>p</i> = 0.25	<i>p</i> = 0.29
Satisfaction with China	Blame China 1.54	Pollution haven 1.84	0.30	<i>p</i> = 0.01	<i>p</i> = 0.02**
Satisfaction with China	Blame China 1.54	Competitive 1.97	0.42	<i>p</i> = 0.00	<i>p</i> = 0.01**
Satisfaction with China	Pollution haven 1.84	Competitive 1.97	0.13	<i>p</i> = 0.18	<i>p</i> = 0.31

Note: “Satisfaction with Korea” and “Satisfaction with China” coded so that 1 = “extremely unsatisfied” and 7 = “extremely satisfied”.

** indicates significant group differences via Conover-Iman test with a false discovery rate at 5%.

* indicates significant group differences with a false discovery rate at 20%.

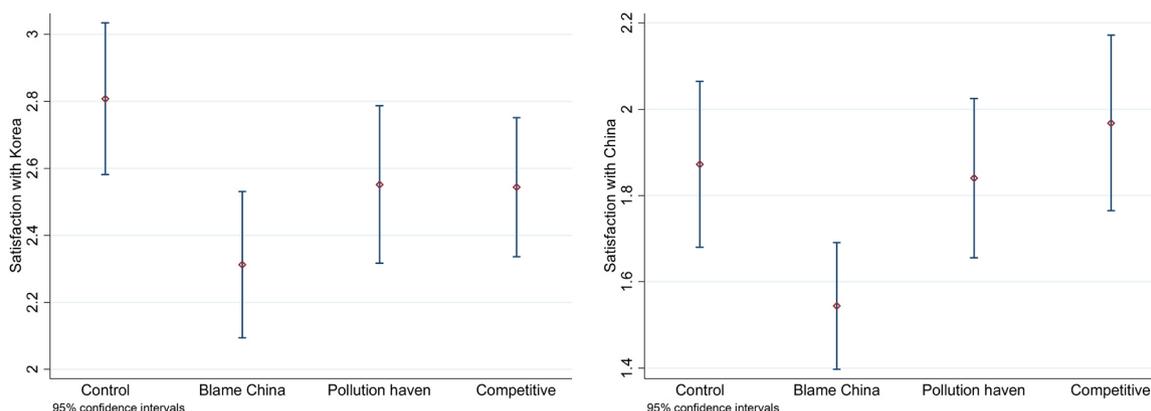


Fig. 1. Treatment effects on dependent measures for Experiment 1. Note: Dots represent group means, and error bars represent a 95% confidence interval.

must thus first request to be a panel member for Embrain, followed by an email sent from Embrain's Panel Management Team to request additional information to confirm the validity of the potential panel member's email. To finally confirm that the requesting individual is who s/he says s/he is, an Embrain Panel Management Team member contacts the individual via telephone. This process insures that heads of households are registering. Management of the panel is conducted by randomly sent invitations for participation in Internet surveys with monetary incentives for participation. The estimated monetary incentive for respondents participating in either Experiment 1 or 2 was approximately \$5.⁵

At the time of the survey's launch, Embrain's panel was comprised of 1.166 million people from which we took a quota sample based on Seoul Metropolitan Area residency as well as gender and age distributions consistent with Seoul-based representative samples. This sample was determined by population data from the Ministry of Government Administration and Home Affairs statistical database for April 2017.⁶ A quota sampling method was employed to limit bias and focus solely on a representative sample of the country's largest metropolis. The focus on the Seoul metropolitan area also eliminates variance in air pollution effects across South Korea. Ninety-eight percent of all data collection began on April 10 (Korea time) and ended on April 13, 2017.

Treatment effects are reported here as one-tailed *t*-tests, and we

⁵ Selection bias from targeting only Internet users is alleviated given the nearly 89.9% Internet penetration rate in Korea. This Internet penetration rate is based on 2015 data, according to the CIA World Factbook (<https://www.cia.gov/library/publications/the-world-factbook/geos/ks.html>).

⁶ The exact location for these data is the following website: http://rcps.egov.go.kr:8081/jsp/stat/pp1_stat_jf.jsp.

refer to the content of Table 1 when testing hypotheses relevant to Experiment 1.⁷ In addition to the *p*-values from two sample *t*-tests, we also present the Benjamini-Hochberg *p*-values, which are derived in light of the possibility that, for each set of comparisons, there exists the potential for an increase in false positives. We thus conduct the Conover-Iman test for error arising from multiple pairwise comparisons and present the results in the final column of Table 1 (Conover, 1999; Conover and Iman, 1979). For each of the dependent variables under consideration in Experiment 1 – i.e. satisfaction with Korea and satisfaction with China, respectively – a “Benjamini-Hochberg adjustment” has been applied based on a constant false discovery rate (Benjamini and Hochberg, 1995), or propensity for Type I error. When comparing both sets of *p*-values, we observe that the majority of the Benjamini-Hochberg-based *p*-values confirm the two-sample *t*-test-based *p*-values in terms of statistically significant differences between conditions.

Based on a 7-point scale where higher values are associated with greater satisfaction, H1 is partially confirmed. Specifically, while satisfaction with Korea's efforts consistently decreases with exposure to an attribution of responsibility frame (Control v. Blame China, diff. = 0.50, *p* < 0.01; Control v. Pollution Haven, diff. = 0.26, *p* < 0.010; Control v. Competitive, diff. = 0.26, *p* < 0.05), satisfaction with China's efforts significantly decreases relative to the control with regard to the blame-China frame (Control v. Blame China, diff. = 0.33, *p* < 0.01). H2 is rejected as the pollution haven frame does not decrease satisfaction more than the blame-China frame (Pollution Haven

⁷ Means, standard errors, and confidence intervals across the four groups for both dependent variables can be found in the appendix.

Table 2
Pairwise comparison of all experimental conditions for Experiment 2.

Variable	Condition 1: mean	Condition 2: mean	Difference	One-sided <i>p</i> values from two-sample <i>t</i> -tests	Benjamini-Hochberg <i>p</i> values
Increase Korea's coal	Control 2.68	Coal costs 2.20	0.48	<i>p</i> = 0.00	<i>p</i> = 0.00**
Increase Korea's coal	Control 2.68	Coal benefits 3.27	0.59	<i>p</i> = 0.00	<i>p</i> = 0.00**
Increase Korea's coal	Control 2.68	Competitive 3.06	0.38	<i>p</i> = 0.01	<i>p</i> = 0.03**
Increase Korea's coal	Coal costs 2.20	Coal benefits 3.27	1.07	<i>p</i> = 0.00	<i>p</i> = 0.00**
Increase Korea's coal	Coal costs 2.20	Competitive 3.06	0.86	<i>p</i> = 0.00	<i>p</i> = 0.00**
Increase Korea's coal	Coal benefits 3.27	Competitive 3.06	0.21	<i>p</i> = 0.14	<i>p</i> = 0.16
Coal increases prices	Control 4.11	Coal costs 4.16	0.05	<i>p</i> = 0.39	<i>p</i> = 0.44
Coal increases prices	Control 4.11	Coal benefits 3.45	0.66	<i>p</i> = 0.00	<i>p</i> = 0.00**
Coal increases prices	Control 4.11	Competitive 3.77	0.34	<i>p</i> = 0.02	<i>p</i> = 0.02**
Coal increases prices	Coal costs 4.16	Coal benefits 3.45	0.71	<i>p</i> = 0.00	<i>p</i> = 0.00**
Coal increases prices	Coal costs 4.16	Competitive 3.77	0.40	<i>p</i> = 0.01	<i>p</i> = 0.01**
Coal increases prices	Coal benefits 3.45	Competitive 3.77	0.32	<i>p</i> = 0.03	<i>p</i> = 0.04*
Coal increases health problems	Control 5.27	Coal costs 5.61	0.34	<i>p</i> = 0.01	<i>p</i> = 0.03*
Coal increases health problems	Control 5.27	Coal benefits 5.45	0.18	<i>p</i> = 0.15	<i>p</i> = 0.06
Coal increases health problems	Control 5.27	Competitive 5.26	0.02	<i>p</i> = 0.54	<i>p</i> = 0.50
Coal increases health problems	Coal costs 5.61	Coal benefits 5.45	0.16	<i>p</i> = 0.17	<i>p</i> = 0.32
Coal increases health problems	Coal costs 5.61	Competitive 5.26	0.35	<i>p</i> = 0.01	<i>p</i> = 0.05*
Coal increases health problems	Coal benefits 5.45	Competitive 5.26	0.19	<i>p</i> = 0.14	<i>p</i> = 0.08

Note: One-sided *p* values reported above. “Increase Korea's coal” coded so that 1 = “It should be extremely reduced” and 7 = “It should be extremely increased”; “Coal increases prices” coded so that 1 = “Extreme decrease in price of energy” and 7 = “Extreme increase in price of energy”; “Coal increases health problems” coded so that 1 = “Extreme decrease of health problems” and 7 = “Extreme increase of health problems”.

** indicates significant group differences via Conover-Iman test with a false discovery rate of 5%.

* indicates significant group differences with a false discovery rate of 10%.

v. Competitive, diff. = 0.13, not significant); indeed, the opposite is true and at the statistically significant level (Blame China v. Pollution Haven, diff. = 0.24, *p* < 0.10). H3 is confirmed as the blame-China frame decreases satisfaction with China's efforts more than either the pollution haven frame (Blame China v. Pollution Haven, diff. = 0.30, *p* < 0.01) as well as the competitive frame (Blame China v. Competitive, diff. = 0.42, *p* < 0.01).⁸

The effects of each frame on satisfaction with national efforts to reduce pollution are presented graphically in Fig. 1, displaying condition means and 95% confidence intervals. Regarding the research question for Experiment 1 RQ1) – i.e. the effect of the attribution of responsibility frame in competition on satisfaction with national efforts – we have already noted that satisfaction with Korea's efforts decreases relative to the control but that satisfaction with China's efforts does not decrease from the frame in competition relative to the control. We may also observe that the frame in competition is not significantly different from the pollution haven frame's effect on satisfaction with Korea (Pollution Haven v. Competitive, diff. = 0.01, *p* value not significant) or China (Pollution Haven v. Competitive, diff. = 0.13, *p* value not significant). Regardless of the target of national satisfaction, the frame in competition affects satisfaction on par with the pollution haven frame and, with regard to satisfaction with China, the control as well.

4. Experiment 2: coal-costs and coal-benefits frames

4.1. Design

Two emphasis frames as well as their combination are employed for this experiment, all invoking fabricated news articles from *Yonhap News*. To eliminate the positive or negative rhetoric surrounding coal use, a problem which can arise when either negative or positive imagery and rhetoric is used in the media and among members of the public about a given energy source (Druckman, 2013), we eschew the use of any potentially biased terms such as “clean coal,” “dirty coal,” or different coal types (e.g., metallurgical coal). The first frame thus conveys a coal-costs frame which states that “coal is a major cause of air pollution [... which] could mean many more instances of respiratory, eye, and skin problems when [one goes] outside.” As was the case for

Experiment 1, to establish credibility for this statement, language was included regarding the source of the information reported in the *Yonhap News* article. The exact language for the coal-costs frame is as follows:

The following news article was recently published:

“Costs of Using Coal Are High”

– *Yonhap News Agency* –

A recent report finds that coal is a major cause of air pollution and contributes to the global warming effect. For Koreans, this could mean many more instances of respiratory, eye, and skin problems when they go outside. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University.

The second frame conveys a coal-benefits frame, which states that “coal is the most inexpensive source of energy and will soon be the most inexpensive transportation fuel [..., leading to] lower energy and fuel costs for everyone.” The language for the coal-benefits frame is as follows:

The following news article was recently published:

“Benefits of Using Coal Are High”

– *Yonhap News Agency* –

A recent report finds that coal is the most inexpensive source of energy and will soon be the most inexpensive transportation fuel. For Koreans, this could mean lower energy and fuel costs for everyone. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University.

The third and final frame combines both of these frames in competition, highlighting both the costs of coal (in terms of health) as well as the benefits of coal (in terms of economics). The precise language for

⁸ A post hoc power analysis for Experiment 1 can be found in the appendix.

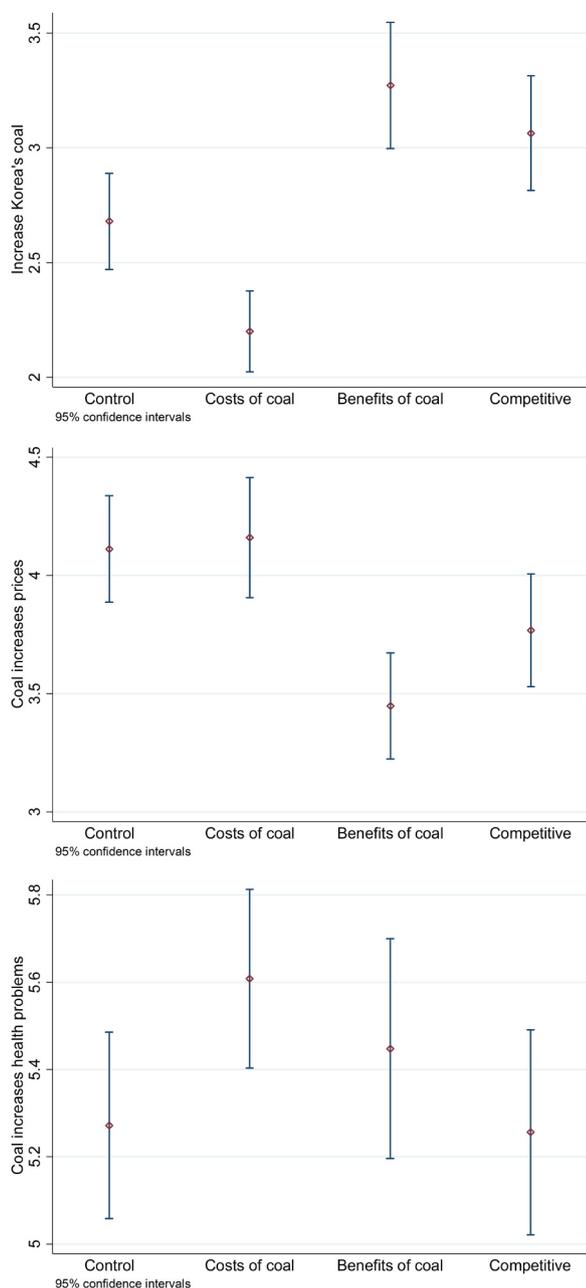


Fig. 2. Treatment effects on dependent measures for Experiment 2. Note: Dots represent group means, and error bars represent a 95% confidence interval.

the frames in competition is as follows:

The following news article was recently published:

“Debate Over the Costs and Benefits of Using Coal”

– Yonhap News Agency –

A recent report finds that coal is a major cause of air pollution and contributes to the global warming effect. For Koreans, this could mean many more instances of respiratory, eye, and skin problems when they go outside. At the same time, the same report finds that coal is the most inexpensive source of energy and will soon be the most inexpensive transportation fuel. For Koreans, this could mean

lower energy and fuel costs for everyone. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University.

There are three dependent variables considered in this experiment: views about whether Korea's coal use should increase or decrease (“What do you think about Korea's energy use of coal?”), views regarding the perceived impact of increased coal use on the price of energy in Korea (“To what extent would greater use of coal increase or decrease the price of energy in Korea?”), and views regarding the perceived impact of increased coal use on health problems in Korea (“To what extent would greater use of coal increase or decrease health problems in Korea?”). Thus, the second dependent variable contains an economic dimension, while the third dependent variable contains a health dimension,⁹ tapping into the various reasons for people to change their energy conservation behavior, as outlined in Nolan et al. (2008). The key dependent variable is overall support for the increased development of coal, i.e. views about whether Korea's coal use should increase or decrease. As such, the second and third dependent variables are designed to confirm that the coal-benefits and coal-costs frames are effective in shifting beliefs about, respectively, energy prices and health problems. Our primary hypotheses are as follows:

H4. Individuals who are exposed to the costs frame will prefer to decrease Korea's coal use.

H5. Individuals who are exposed to the benefits frame will prefer to increase Korea's coal use.

Addressing the possibility of there being more than a single coal-related frame, we propose the following research question regarding frames in competition:

RQ2. What is the effect of a coal-related frame in competition on preferences toward Korea's coal use?

4.2. Data and results

As before, for this experiment we randomly assigned 500 individuals to one of four conditions: control ($n = 125$), coal costs ($n = 125$), coal benefits ($n = 125$), and a competitive frame ($n = 125$).¹⁰ Treatment effects for Experiment 2 are reported here as one-tailed t -tests, the results of which are presented in Table 2.¹¹ As before, we compare the p -values from two sample t -tests with Benjamini-Hochberg p -values to determine whether corrections for multiple tests show that there are virtually no differences between the former and the latter. Based on a 7-point scale where higher values are associated with preferences for greater coal use, H4 is confirmed. Specifically, individuals in the coal-costs group decreased their preference for coal use relative to all three other groups (Control vs. Coal Costs, diff. = 0.48, $p < 0.01$; Coal Costs v. Coal Benefits, diff. = 1.07, $p < 0.01$; Coal Costs v. Competitive, diff. = 0.86, $p < 0.01$). H5 is confirmed for all inter-group comparisons concerning the coal-benefit group except for the competitive frame group (Control v. Coal Benefits, diff. = 0.59, $p < 0.01$; Coal Benefits v. Competitive, diff. = 0.21, not significant).¹²

The effects of each frame on preferences toward Korea's coal use for

⁹ The second and third dependent variables were randomly ordered to eliminate any potential bias created from the question ordering. The questions and responses can be found in the appendix.

¹⁰ To eliminate systematic bias from the sample, respondents were randomly assigned to one of two possible frames-in-competition treatments. Half were assigned to a treatment that presented information about the costs before information about the benefits while the other half were assigned to a treatment that reversed the order of information (i.e. benefits and then costs).

¹¹ Means, standard errors, and confidence intervals across the four groups for all three dependent variables can be found in the Appendix.

¹² A post hoc power analysis for Experiment 2 can be found in the Appendix.

its energy needs are presented graphically in Fig. 2, displaying condition means and 95% confidence intervals. With regard to the research question for Experiment 2 (RQ2) – i.e. the effect of the coal-related frame in competition on preferences toward Korea's coal use – we observe that the competitive frame is not significantly different from the coal-benefits frame while it is significantly difference from the coal-costs frame. Also included in Fig. 2 is the graphical presentation of the effects of each frame on the second and third dependent variables of Experiment 2, confirming that the coal-benefits and coal-costs frames are effective in shifting beliefs about, respectively, coal prices and health problems. We observe that there is a greater tendency, albeit not at a statistically significant level, for the competitive frame to reflect more closely the effects of the coal-benefits frame relative to the coal-costs frame. That is, the effects of the coal-benefits frame and the competitive frame are more alike than different with regard to the two dimension-specific dependent variables.

5. Conclusion

There is growing interest and awareness for the need to transform energy systems and reduce air pollution as a way to promote environmental sustainability. Public opinion is crucial given that re-elected oriented politicians are unlikely to support laws that are unpopular with their constituents (Druckman, 2013). Research on public opinion about energy alternatives and policies, however, “remains in an infancy phase” (Druckman, 2013, p. 617). This is the first-ever attempt to understand how and why Koreans approach air pollution given a seasonal media blitz on the subject as described in Shapiro (2016). We have attempted to understand precisely how different media-based frames impact people's perceptions of the air pollution problem as well as how

Appendix A. Survey content

Experiment 1	Experiment 2
<p>[Respondents are randomly assigned to one of the following five groups] [Control group, $n = 125$] [Blame China, $n = 125$] The following news article was recently published: “China Cause of Air Pollution in Korea” – <i>Yonhap News Agency</i> – A recent report finds that the majority of Korea's air pollution comes from factories located in China. In other words, China is to blame for Korea's air pollution. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University. 다음 기사는 최근에 발표된 것이다: “중국이 한국 대기오염의 원인” –연합뉴스– 국립환경과학원, 기상청과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 한국의 대기오염의 대부분은 중국 내 공장에서 발생하고 있는 것으로 나타났다. 다시 말해, 한국 대기오염의 원인은 중국이라는 것이다. 또한, 이 보고서에 따르면 대기 오염은 계속 악화되고 있으며, 이를 해결하기 위한 대책이 속히 마련되어야 한다. [Pollution haven, $n = 125$] The following news article was recently published: “Korean-owned Factories Cause of Air Pollution” – <i>Yonhap News Agency</i> – A recent report finds that the majority of Korea's air pollution comes from factories owned by Koreans located in China. In other words, Korea is to blame for air pollution blowing from China. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University. 다음 기사는 최근에 발표된 것이다: “중국주재 한국공장이 대기오염의 원인” –연합뉴스–</p>	<p>[Respondents are randomly assigned to one of the following five groups] [Control group, $n = 125$] [Coal costs, $n = 125$] The following news article was recently published: “Costs of Using Coal Are High” – <i>Yonhap News Agency</i> – A recent report finds that coal is a major cause of air pollution and contributes to the global warming effect. For Koreans, this could mean many more instances of respiratory, eye, and skin problems when they go outside. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University. 다음 기사는 최근에 발표된것이다: “석탄 사용의 높은 대가” –연합뉴스– 한국에너지기술연구원, 에너지경제연구원과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 석탄이 대기오염의 주원인이자 지구온난화에 기여한다. 즉, 한국인들은 외출 시 더 높은 확률로 호흡기질환, 안면질환, 피부 질환 등을 경험할 수 있다는 것이다. [Coal benefits, $n = 125$] The following news article was recently published: “Benefits of Using Coal Are High” – <i>Yonhap News Agency</i> – A recent report finds that coal is the most inexpensive source of energy and will soon be the most inexpensive transportation fuel. For Koreans, this could mean lower energy and fuel costs for everyone. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University. 다음 기사는 최근에 발표된것이다: “고혜택의 석탄 사용” –연합뉴스–</p>

competing frames shape support for the nation's reliance on coal as an energy source. The results we report accentuate the power of framing as a mechanism for shifting individuals' beliefs about the need for policy leaders to take action to address air pollution. In Experiment 1, highlighting the inadequacy of existing national efforts to address the air pollution problem increased dissatisfaction with policy efforts. Additionally, attributing blame for the pollution problem to China decreased Koreans' satisfaction with their neighbor's efforts to combat the problem. In Experiment 2, we show that framed communications can shift individuals' support for a reliance on coal as an energy resource. Messages highlighting negative health effects shift support away from its development, while exposure to frames highlighting the relative economic benefits increased support for its usage. In competition, considerations about economic benefits associated with coal appear to overpower concerns about the negative health implications. Of course, this is only one study, and much more work is needed to understand how frames highlighting causal responsibility for air pollution, as well as the costs and benefits of a reliance on different energy sources, shape the public's view across countries. In this light, this is but the beginning of what we expect will be a shifting focus toward Asia to improve our understanding of cross-national differences and to properly prescribe policies.

Acknowledgements

This project was made possible through funding from the EWHA-KACA Research Award of the Ewha Womans University, Division of Communication and Media (EWHA) and the Korea American Communication Association (KACA). The authors are grateful for translation assistance from Jiwon Kim and Suyang Kang.

국립환경과학원, 기상청과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 한국 대기오염의 대부분은 중국 내의 한국기업소유공장장에서 발생하고 있는 것으로 나타난다. 중국발 대기오염물질은 사실 한국기업들에 의해 발생한다는 것이다. 다시 말해, 중국발 대기 오염의 원인은 한국이다. 또한, 이 보고서에 따르면 대기오염은 계속 악화되고 있으며, 이를 해결하기 위한 대책이 속히 마련되어야 한다.

[Blame China + pollution haven (version 1), n = 63]

The following news article was recently published:

“Korea and China Cause of Air Pollution”

– Yonhap News Agency –

A recent report finds that the majority of Korea’s air pollution comes from China, but it is not all caused by China. The pollution comes from Chinese factories as well as Korean-owned factories in China. In other words, both countries are to blame for air pollution blowing from China. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University.

다음 기사는 최근에 발표된 것이다:

“한국과 중국이 대기오염의 원인”

–연합뉴스–

국립환경과학원, 기상청과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 한국 대기오염의 대부분은 중국에서 발생하고 있지만, 중국이 유일한 원인은 아니다. 대기오염물질은 중국 내의 한국기업소유공장뿐만 아니라 중국기업소유공장에서도 발생하고 있다고 한다. 다시 말해, 중국발 대기오염물질에 대한 책임은 양국이 공유한다는 것이다. 또한, 이 보고서에 따르면 대기오염은 계속 악화되고 있으며, 이를 해결하기 위한 대책이 속히 마련되어야 한다.

[Blame China + pollution haven (version 2), n = 62]

The following news article was recently published:

“China and Korea Cause of Air Pollution”

– Yonhap News Agency –

A recent report finds that the majority of Korea’s air pollution comes from China, but it is not all caused by China. The pollution comes from Korean-owned factories in China and as well as Chinese factories. In other words, both countries are to blame for air pollution blowing from China. The report also states that air pollution is getting worse and that action must be taken immediately to address this problem. The report was authored by experts from the National Institute of Environmental Research, the Korea Meteorological Administration, and Seoul National University.

다음 기사는 최근에 발표된 것이다:

“중국과 한국이 대기오염의 원인”

–연합뉴스–

국립환경과학원, 기상청과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 한국 대기오염의 대부분은 중국에서 발생하고 있지만, 중국이 유일한 원인은 아니다. 대기오염물질은 중국기업소유공장뿐만 아니라 중국 내의 한국기업소유공장에서도 발생하고 있다고 한다. 다시 말해, 중국발 대기오염물질에 대한 책임은 양국이 공유한다는 것이다. 또한, 이 보고서에 따르면 대기오염은 계속 악화되고 있으며, 이를 해결하기 위한 대책이 속히 마련되어야 한다.

Experiment 1 Post-treatment questions, randomly ordered

To what extent are you satisfied with Korea’s efforts to reduce its air pollution? 대기오염 감축을 위한 한국의 노력에 어느정도 만족하십니까?

Extremely unsatisfied 매우 불만족

Very unsatisfied 불만족

Somewhat unsatisfied 다소 불만족

Neutral 중간

Somewhat satisfied 다소 만족

Very satisfied 만족

Extremely satisfied 매우 만족

To what extent are you satisfied with China’s efforts to reduce its air pollution? 대기오염 감축을 위한 중국의 노력에 어느정도 만족하십니까?

Extremely unsatisfied 매우 불만족

Very unsatisfied 불만족

Somewhat unsatisfied 다소 불만족

Neutral 중간

Somewhat satisfied 다소 만족

Very satisfied 만족

Extremely satisfied 매우 만족

Experiment 2 Post-treatment questions, second and third questions randomly ordered

What do you think about Korea’s energy use of coal? 한국의 에너지원으로서의 석탄사용에 대해 어떻게 생각하십니까?

It should be extremely reduced. 매우 감소시켜야 한다.

It should be reduced. 감소시켜야 한다.

It should be slightly reduced. 조금 감소시켜야 한다.

No change 그대로 유지한다

It should be slightly increased. 조금 증가시켜야 한다.

It should be increased. 증가시켜야 한다.

It should be extremely increased. 매우 증가시켜야 한다.

To what extent would greater use of coal increase or decrease the price of energy in Korea? 석탄사용의 증가는 한국의 연료비에 어떤 영향을 미친다고 생각하십니까?

Extreme decrease in price of energy 매우 감소시킨다.

Large decrease in price of energy 감소시킨다.

Slight decrease in price of energy 조금 감소시킨다.

No change 영향을 미치지 않는다.

Slight increase in price of energy 조금 증가시킨다.

한국에너지기술연구원, 에너지경제연구원과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 석탄은 가장 값싼 연료이고, 가까운 미래에 가장 값싼 교통수단 연료가 될 것으로 예측된다. 한국인의 연료비가 감소할 것이라는 것이다.

[Coal costs and benefits debate (version 1), n = 63]

The following news article was recently published:

“Debate Over the Costs and Benefits of Using Coal”

– Yonhap News Agency –

A recent report finds that coal is a major cause of air pollution and contributes to the global warming effect. For Koreans, this could mean many more instances of respiratory, eye, and skin problems when they go outside. At the same time, the same report finds that coal is the most inexpensive source of energy and will soon be the most inexpensive transportation fuel. For Koreans, this could mean lower energy and fuel costs for everyone. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University.

다음 기사는 최근에 발표된 것이다:

“석탄사용의 대가와 혜택에 대한 논쟁”

–연합뉴스–

한국에너지기술연구원, 에너지경제연구원과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 석탄이 대기오염의 주원인이나 지구온난화의 원인 중 하나이다. 즉, 한국인들은 외출 시 더 높은 확률로 호흡기질환, 안면질환, 피부 질환 등을 경험할 수 있다는 것이다. 반면에 같은 보고서에 의하면 석탄은 가장 값싼 연료이고, 가까운 미래에 가장 값싼 교통수단 연료가 될 것으로 예측된다. 한국인의 연료비가 감소할 것이라는 것이다.

[Coal costs and benefits debate (version 2), n = 62]

The following news article was recently published:

“Debate Over the Benefits and Costs of Using Coal”

– Yonhap News Agency –

A recent report finds that coal is the most inexpensive source of energy and will soon be the most inexpensive transportation fuel. For Koreans, this could mean lower energy and fuel costs for everyone. At the same time, the same report finds that coal is a major cause of air pollution and contributes to the global warming effect. For Koreans, this could mean many more instances of respiratory, eye, and skin problems when they go outside. The report was authored by experts from the Korea Institute of Energy Research, the Korea Energy Economics Institute, and Seoul National University.

다음 기사는 최근에 발표된 것이다:

“석탄사용의 혜택과 대가에 대한 논쟁”

–연합뉴스–

한국에너지기술연구원, 에너지경제연구원과 서울대학교 소속 전문가들에 의해 최근 작성된 한 보고서에 따르면 석탄은 가장 값싼 연료이고, 가까운 미래에 가장 값싼 교통수단 연료가 될 것으로 예측된다. 즉, 한국인의 연료비가 감소할 것이라는 것이다. 반면에 같은 보고서에 의하면, 석탄이 대기오염의 주원인이나 지구온난화의 원인 중 하나이다. 한국인들은 외출 시 더 높은 확률로 호흡기질환, 안면질환, 피부 질환 등을 경험할 수 있다는 것이다.

Large increase in price of energy 증가시킨다.

Extreme increase in price of energy 매우 증가시킨다.

To what extent would greater use of coal increase or decrease health problems in Korea? 석탄사용의 증가는 한국의 건강 문제에 어떤 영향을 미친다고 생각하십니까?

Extreme decrease of health problems 매우 감소시킨다.

Large decrease of health problems 감소시킨다.

Slight decrease of health problems 조금 감소시킨다.

No change 영향을 미치지 않는다.

Slight increase of health problems 조금 증가시킨다.

Large increase of health problems 증가시킨다.

Extreme increase of health problems 매우 증가시킨다.

Appendix B. Experiment 1 descriptive statistics by treatment group

	Satisfaction with Korea			Satisfaction with China		
	Mean	S.D.	95% Conf. Interval	Mean	S.D.	95% Conf. Interval
Control (n = 125)	2.808	0.115	2.581–3.035	1.872	0.097	1.680–2.06
Blame China (n = 125)	2.312	0.110	2.094–2.530	1.544	0.074	1.397–1.691
Poll. haven (n = 125)	2.552	0.119	2.317–2.787	1.840	0.093	1.655–2.024
Competitive (n = 125)	2.544	0.105	2.336–2.751	1.968	0.103	1.764–2.172

Appendix C. Experiment 1 post hoc power analysis

Dependent Variable	Comparison	N per Condition (power = 0.8)
Satisfaction with Korea	Control v. Blame China	81
Satisfaction with Korea	Control v. Pollution haven	323
Satisfaction with Korea	Control v. Competitive	269
Satisfaction with Korea	Blame China v. Pollution haven	354
Satisfaction with Korea	Blame China v. Competitive	307
Satisfaction with Korea	Pollution haven v. Competitive	–
Satisfaction with China	Control v. Blame China	108
Satisfaction with China	Control v. Pollution haven	–
Satisfaction with China	Control v. Competitive	1678
Satisfaction with China	Blame China v. Pollution haven	127
Satisfaction with China	Blame China v. Competitive	70
Satisfaction with China	Pollution haven v. Competitive	911

Note: For each calculation ($\alpha = 0.05$), the effect sizes for each calculation are conditional on the group comparisons. Due to unreasonably large sample sizes given no significant differences in the results reported in Table 1, some estimates were omitted.

Appendix D. Experiment 2 descriptive statistics by treatment group

	Increase Korea's coal			Coal increases prices			Coal increases health probs.		
	Mean	S.D.	95% Conf. Interval	Mean	S.D.	95% Conf. Interval	Mean	S.D.	95% Conf. Interval
Control (n = 125)	2.680	0.106	2.470–2.889	4.112	0.114	3.887–4.337	5.272	0.108	5.058–5.486
Coal costs (n = 125)	2.200	0.089	2.023–2.377	4.160	0.128	3.906–4.414	5.608	0.103	5.403–5.813
Coal benef. (n = 125)	3.272	0.139	2.997–3.547	3.448	0.113	3.224–3.672	5.448	0.127	5.196–5.700
Competitive (n = 125)	3.064	0.126	2.814–3.314	3.768	0.120	3.530–4.006	5.256	0.119	5.021–5.491

Appendix E. Experiment 2 post hoc power analysis

Dependent variable	Comparison	N per condition (power = 0.8)
Increase Korea's coal	Control v. Coal costs	66
Increase Korea's coal	Control v. Coal benefits	68
Increase Korea's coal	Control v. Competitive	143
Increase Korea's coal	Coal costs v. Coal benefits	20
Increase Korea's coal	Coal costs v. Competitive	26
Increase Korea's coal	Coal benefits v. Competitive	631
Coal increases prices	Control v. Coal costs	–
Coal increases prices	Control v. Coal benefits	46
Coal increases prices	Control v. Competitive	180
Coal increases prices	Coal costs v. Coal benefits	46
Coal increases prices	Coal costs v. Competitive	157
Coal increases prices	Coal benefits v. Competitive	207
Coal increases health problems	Control v. Coal costs	154

Coal increases health problems	Control v. Coal benefits	696
Coal increases health problems	Control v. Competitive	–
Coal increases health problems	Coal costs v. Coal benefits	813
Coal increases health problems	Coal costs v. Competitive	156
Coal increases health problems	Coal benefits v. Competitive	635

Note: For each calculation ($\alpha = 0.05$), the effect sizes for each calculation are conditional on the group comparisons. Due to unreasonably large sample sizes given no significant differences in the results reported in Table 2, some estimates were omitted.

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