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Writing Sample: A chapter from the applicant's dissertation, revised and submitted to the 2020 International Communication Association (ICA) annual conference.

Running Head: Media Framing of Climate Change in Korea

MEDIA FRAMING OF CLIMATE CHANGE IN KOREA:
A CONTENT ANALYSIS USING *K*-MEANS CLUSTERING, 2003 – 2017.

Abstract

This study examines the shift of news frames of climate change in Korea from 2003 to 2017 based on theoretical views of constructionist paradigm of media framing and political economy approach to global climate change discourse. News frames are conceptualized as associations of ideas, or words, which are inductively detected using *K*-means clustering. Employing non-parametric ANOVA (Kruskal-Wallis test), this study demonstrates that news frames of climate change have shifted over time to represent market-oriented views, marginalizing traditional views in environmentalism that has concerned about carrying capacity of ecosystems and blamed corporations and pro-business policies for causing the current environmental crises.

Keywords: News frames; Climate change; Political economy; *K*-means clustering; Non-parametric ANOVA

**Media Framing of Climate Change in Korea:
A Content Analysis using *K*-means Clustering, 2003 – 2017**

Climate change is a real environmental crisis. The data have shown that the average temperature has continuously increased along with the increase in carbon dioxide. The recent data even more clearly demonstrate that the amount of carbon dioxide at the atmosphere has increased associated with its emissions from fossil fuel use and land use, after controlling for those effects from the sun (IPCC, 2007, pp. 25-26), and the average temperature has increased with a much faster rate than the trend would have had if it were a natural cycle (IPCC, 2007, p. 37).

Land desertification, ocean desertification and acidification, and deforestation and cultivation of the rainforests are just a few examples of how disastrous the current situation is. Habitat losses and changes for animal and plant species, extinction rate of these species that is accelerating over time, and many more scientific observations, tests, and experiments have warned that we should act right now. Global efforts at the nation level have responded to these serious situations on the Earth and have suggested solutions; the Kyoto Protocol and the Paris Agreement are the results of the negotiations among the countries.

This study, however, suggests revisiting these solutions because there exist various worldviews regarding global environmental issues, but only some of them have been represented in the solutions suggested by the global convention(s). Considering that climate change is a global issue that cannot be properly handled by individual people, communities, or countries, the roles of international organizations have been emphasized and dealing with global issues through international organizations has been legitimized.

A problem is that this worldview conceptualizes the economic gains as motivation for facilitating the actions of and cooperation among countries (and those of corporations). As a result, the solutions following this worldview may strengthen the hegemonic order based on global market economy (Ashley, 1987; Cox, 1981, 1983). In this regard, political economists have argued that without having more strict interventions of states into the recent market-based solutions, these solutions would not slow down climate change but rather strengthen neoliberal ideology and widen the gap between the Global North and the Global South (Castree, 2014; McAfee, 2012).

The purpose of this study is to examine news frames of climate change in Korea to understand how Korea's environmental discourse has been shifted in responding to global discourse of climate change. Specifically, the aim of this study is to find statistical evidence of neoliberalization in Korea's climate change discourse examining and testing the shift of news frames from 2003 to 2017.

Background

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992, and the governing body of the convention, which is referred to the "Conference of the Parties" (COP), was formed to have annual meetings since 1995 (UNFCCC, 2019a). Two major achievements of the COP meeting were the Kyoto Protocol from the COP-3 in 1997 and the Paris Agreement from the COP-21 in 2015 (UNFCCC, 2019b).

The Kyoto Protocol entered into effect in 2005 and specified different emission reduction targets based on the two commitment periods. The first commitment period was from 2008 to 2012, targeting to reduce an average of five percent of GHG emissions compared to the 1990 level. The second commitment period is from 2013 to 2020, containing the commitment to

reduce an average of 18 percent of GHG emissions compared to the 1990 level (UNFCCC, 2019b).

The Paris Agreement, or “the Post-2020” climate action, entered into effect in 2016 (UNFCCC, 2019c). Unlike the Kyoto Protocol, which has been operated based on emissions reduction target set by the convention, the Post-2020 is operated based on reduction targets set by individual countries. These reduction targets are referred to “Intended Nationally Determined Contribution” (INDC), a goal of each country submitted to the convention to meet the goal of the convention targeting to keep a global temperature rise less than two degrees Celsius above pre-industrial level (UNFCCC, 2019c). Once approved, INDC changes to NDC (without “intended”).

The emission trading scheme and carbon offset schemes (e.g., CDM, the clean development mechanism) were mechanisms adopted by the convention to facilitate global cooperation as well as to encourage financial and technological supports from the Global North to the Global South (UNFCCC, 201d). According to the Coase theorem (Coase, 1960), due to clearly distinguished property rights, the price of the carbon emissions can be determined between the cost to reduce emissions and the cost to purchase other countries’ rights, and countries will actively participate in the market (negotiation) because of low transaction costs.

Many political economists, however, noticed that these market-oriented mechanisms promoted neoliberal ideology by commodifying nature, rather than promoting environmentalism (Bumpus & Liverman, 2008; Castree, 2003, 2014; Hepburn, 2007; MacKenzie, 2009; McAfee, 1999, 2012). For example, the market price of carbon emissions would be easily controlled by countries who have higher emissions (Hepburn, 2007), businesses and finances originated from the Global North would be easily expanded to the Global South (Bumpus & Liverman, 2008;

McAfee, 2012; Hepburn, 2007), and most of the carbon offset projects would be concentrated in profitable countries such as India and China (McAfee, 2012; Hepburn, 2007) without paying enough attention to the issues of biodiversity (Castree, 2003; McAfee, 1999, 2012) or the lives of local people (McAfee, 1999).

In this regard, McAfee (1999, 2012, 2015) argued that the global financial institutions, such as the World Bank, actively produced the global climate change discourse aligned with neoliberal ideology. Reading McAfee (2012) through Harvey (2005), first, the globally constructed discourse of climate change privatized and commodified the carbon emissions by enabling individual countries' or companies' property rights to the common asset. Second, through the financialization of the commodity, i.e., nature, the idea of 'self-regulated' market infiltrated the environmental discourse, primarily positioning global financial institutions in the discourse. Third, the discourse legitimized the market-oriented solution to overcome the environmental crises, as much as financial institutions became the dominant power through financial crises (Harvey, 2005), and the solution would direct the society to embrace neoliberalism while practicing environmentalism.

This issue has raised scholarly concerns in Korea when Lee Myung-Bak was elected as the 17th President of Korea in 2008 and introduced an environmental policy, the Framework Act on Low Carbon, Green Growth (hereafter, the LCGG policy). Although the LCGG policy led a huge societal attention to the issues of climate change in a positive sense, the directions of the policy including environmental discourse in general were incorporated into neoliberal ideology (M-R. Cho, 2013; H. Han, 2015; I. Heo, 2013; Y. Ju, 2013; E-S. Kim, 2016; H-C. Kim, Cho & Kim, 2011; Y. Lee, 2010). For instance, the actual operation of the LCGG policy was more likely to protect business interests rather than the environment (H. Han, 2015; I. Heo, 2013; E-S.

Kim, 2016) and the media coverage of climate change more importantly represented the voices of global and local financial institutions, multinational corporations, business research institutions, and business forums, marginalizing the voices of environmental groups and the general citizens (Y. Ju, 2013; H-C. Kim et al., 2011; S-J. Yun, Ku, Park, & Han, 2012).

Literature Review

This section begins with a review of the constructionist paradigm of media framing, followed by Clapp and Dauvergne's (2011) categorization of worldviews in regard to global environmental discourse, which is adopted as a theoretical framework in this study. This section ends with a proposal of three time periods based on political context in Korea.

Media Framing

Constructionists have argued that media framing is a cultural product reflecting journalistic practices and norms existing in a given culture (Gamson & Modigliani, 1989; Durham, 2001). From more a critical view, media framing is an ideological product considering that the news gathering processes are already ideologically structured (Tuchman, 1979; Reese, 2001) and the emergence, existence, and persistence of media frames are explained by how the issues are viewed based on dominant capitalistic ideology (Castells, 2013; Entman, 1993; Gitlin, 1980). Thus, media frames function to reproduce dominant capitalistic ideology by hierarchically referring to ruling groups' voices and naturalizing institutional ideology in the discourse (Durham, 2001, 2007; Entman, 2004; Gitlin, 1980; Reese, 2001).

Media framing is continuous negotiations that took place between the prior knowledge of individuals and the mode of presentation in the text (Kahneman & Tversky, 1984), but importantly, the prior knowledge of individuals does not exist independent of the news frames and is continuously updated and modified as they frequently, recently, and/or persistently

encounter particular news frames (D'Angelo, 2002). In this vein, the constructionist paradigm focuses on a cultural mechanism or an institutional intention that makes a certain frame more salient, dominant, and persistent, reflecting the unequal power dynamics representing ideologies that exist in a society (Durham, 2001; Entman, 2004).

Explaining the cultural and historical processes of media framing, Gamson and Modigliani (1989) emphasized the combination of cultural resonance, sponsor activities, and media norms and practices. To tell a story effectively, journalists tend to frame an issue by using the most accessible, as well as the most applicable, frames that culturally and psychologically resonate with society (Ettema, 2005), thus making the interpretations of issues, or the ways to make sense of the world, persist within ranges that are taken for granted over time (Entman, 2004; Gitlin, 1980; Reese, 2001). In this regard, although “most journalists [do not] try to spin a story or deceive their audience” (Scheufele & Tewksbury, 2007, p. 12), counter frames or alternative frames are either mostly absent in the real news coverage of issues (Castells, 2013; Entman, 1993), hardly challenge the dominant frames (Entman, 2004), or are easily incorporated into dominant frames (Gitlin, 1980; Reese, 2001).

Four Worldviews in Global Environmental Discourse

This study conceptualizes news frames as the association of words that align with the political, economic, and cultural contexts to construct an issue culture. To interpret the associations of words as news frames, this study adopts Clapp and Dauvergne's (2011) categorization of environmental discourse in the context of globalization. Climate change is no longer a local issue based on social morality because the issue has been put into a context, requiring globally organized actions (see background of the present study).

Clapp and Dauvergne (2011) identified four different worldviews associated with four different groups: 1) the market liberals, 2) the institutionalists, 3) the bio-environmentalists, and 4) the social greens. The market liberals focus on modern science- and market-oriented economies and approach global environmental issues from the perspective of their incorporation into the global free market. The institutionalists believe that a global environmental crisis is a problem that can be controlled by international organizations (IOs), stimulating cooperation among countries. The bio-environmentalists also stress the importance of IOs, but they focus more on the carrying capacity of the ecosystem, asserting that the role of IOs is to regulate the consumption and exploitation of resources. Finally, the social greens focus on problems of inequality and injustice induced by global capitalism, claiming that the restoration of the local community can resolve the global environmental crises (Clapp & Dauvergne, 2011).

To elaborate upon these four worldviews associated with the purpose of the present study, related paradigms from international politics are reviewed and synthesized within the context of the four worldviews. Broadly speaking, three paradigms exist in the scholarship of international relations: 1) realism, 2) liberal institutionalism, and 3) critical theorists.

A genuine cooperation among countries is practically impossible from the theoretical view of realists because the primary purpose of the state is to secure its own sovereignty by enhancing its military power (Mearsheimer, 1994-1995, 2001; Waltz, 1979, 2008). Thus, balance of power is the only condition for peace (Waltz, 1979).

Meanwhile, liberal institutionalists believe that states are willing to cooperate with each other as long as gaining of something is guaranteed, which is always better than gaining nothing. This concept is referred to “relative gain,” which is a concept that destroys the balance of power, according to realists (Mearsheimer, 1994-1995), but for liberal institutionalists, it is a driving

force for cooperation because transparent information provided through IOs is a safeguard for individual states not to be cheated (Keohane, 1995). In other words, the function of IOs is to guarantee national interests by reducing transaction cost (e.g., cost for information not to be cheated), and therefore, cooperation is a ‘rational choice’ for individual states (Keohane, 1995).

Having a hugely different view toward the roles of IOs, critical theorists focus on their functions to establish dominant structure of the international politics (e.g., liberal economic orders) (Ashley, 1987; Cox, 1981). Moreover, dominant power in the international political system has been maintained and their ways of dealing issues have been legitimized and normalized as more and more international issues have been dealt through IOs (Cox, 1983).

The present study synthesizes these paradigms with the four worldviews mentioned above and conceptualizes the worldviews associated with the market liberals and institutionalists based on the liberal institutionalism. To be specific, this study considers that market liberals’ worldviews might be represented in related news coverage in terms of focusing on the possibilities of constructing markets contextualized with financial values of information, technologies, corporations, and countries with an emphasis on roles of financial institutions and corporations facing environmental crises.

The institutionalists’ worldview in the news coverage might emphasize the possibilities of transparent information to facilitate cooperation among countries to act on global issues, but the cooperation among countries per se would be emphasized without a specific contextualization of its importance regarding the purpose of slowing down climate change.

The worldviews associated with the bio-environmentalists and the social greens are conceptualized along with critical theorists’ approach toward international politics. When it comes to IOs, the bio-environmentalists might consider an organization’s role in facilitating

cooperation among countries as important. Nevertheless, this consideration may also be put into different contexts, placing more emphasis on the organizations' role to regulate the exploitation of natural resources.

Similarly, where the social greens identify the problems inherent in capitalism as the main cause for the current environmental crisis, they focus more on issues of inequality and injustice, taking a relatively distant stance from solutions based on modern technology or those based on market economy. Thus, much greater emphasis on various contexts of global environmental issues as well as environmental groups would be detected. For instance, water scarcity in the Global South, the change and loss of habitat, and extinction of animals and plants might be given as contexts of the issue.

The four worldviews discussed here are not exhaustive of all views toward climate change that exist in the world, "climate change deniers," for instance. However, this study mainly focuses on the four worldviews mentioned above because they best encompass the "issue culture" of the Korean context (Gamson & Modigliani, 1989).

Political and Economic Contexts of Korea's Environmental Discourse

To understand the construction of news frames in Korea regarding the issues of climate change, this study proposes three distinct time periods. These are denoted as, respectively, Time 1 from 2003 to 2007, representing the Roh Moo-Hyun administration, Time 2 from 2008 to 2012, representing the Lee Myung-Bak administration, and Time 3 from 2013 to 2017, representing the Park Geun-Hye administration. Although Park Geun-Hye was impeached on March 10, 2017, for completeness this study considers the full year 2017 in order to treat all three categories of time period equal.

This study considers Time 1 as a period for the emergence of idea of sustainable development. According to Y. Lee (2010), there was no noticeable environmental policies in Korea before the Roh administration, even though the Presidential Commission on Sustainable Development (PCSD) was established in 2000. The roles of the PCSD were expanded in 2003 to have additional functions to establish and implement major environmental policies (Y-K. Chung & Hwang, 2006). In 2007, the New National Strategy Responding to Climate Change was announced and the first carbon market¹ in Korea opened (Y. Lee, 2010).

Time 2 is considered as a period for neoliberalization (or cooptation) of news frames in environmentalism. In 2008, Lee Myung-Bak was elected, and the conservative political party gained a majority of the seats. The LCGG policy was approved in 2008 despite many criticisms from academia and environmental groups. In December 2007, the COP-13 was held in Bali, Indonesia where the Bali Road Map was adopted. The Bali Road Map emphasized technology and financing and clarified the market mechanisms of the Kyoto Protocol (UNFCCC, 2007). According to Y. Lee (2010), the idea of sustainable development should include concerns of social development and encourage social participation, but the LCGG policy only emphasized the competitiveness of Korea in global markets.

Time 3 is considered as a period of persistence in dominant news frames aligned with neoliberal ideology. Conservative political party maintained a majority of the seats supporting Park Geun-Hye's pro-business policies. The Park administration submitted Korea's INDC to UNFCCC, which was largely criticized by global experts because its calculation of emissions reduction target based on Business-as-Usual (BAU) scenario (G. Kim, 2015, Dec. 3). The BAU

¹ The first carbon market of the Roh administration was characteristically different from the carbon markets introduced during the Lee administration under the LCGG policy (Y. Lee, 2010).

scenario is rarely adopted by countries to set their INDC because its loose estimation to set targets. Even worse, the Park administration's INDC was impractical considering its environmental policy that overly protected industrial interests (J. Kim, 2015, Jul. 8).

With regard to these three time periods, this study examines the shift of each news frame representing each of four worldviews, suggesting the following research question and corresponding hypotheses:

RQ: How do news frames of climate change in Korean newspapers shift over time?

H1: News frames representing the worldviews associated with the market liberals and the institutionalists will increase over time.

H2: News frames representing the worldviews associated with the bio-environmentalists and the social greens will decrease over time.

Methods

Methodological approach of this study can be summarized into the following three steps: 1) web scraping and natural language processing were employed to collect and prepare the data for the analyses that follow, 2) *K*-means clustering was conducted to detect the associations of words (i.e., news frames) as well as to label each news article with the detected news frames, and 3) Kruskal-Wallis (non-parametric ANOVA) was used in order to test the shift of news frames of climate change in Korea.

Data Collection

Time span of this study was from 2003 to 2017 as mentioned above. Within this time span, data were collected from four major Korean daily newspapers. To represent conservative views of newspaper industry in Korea, *Chosun Ilbo* and the *Maeil Business Newspaper* were

selected, which in this study were denoted CI and MK, respectively. To represent the progressive views in Korea, *Hankyoreh* and *Kyunghyang Shinmun* were selected, which were denoted as HAN and KS, respectively in this study.

With regard to collecting the data, web scraping, a technique to drag data from websites and extract necessary information from them, was used. Two search terms, ‘기후변화’ (‘Climate Change’ without a white space between two words) and ‘온난화’ (‘Warming’ without ‘Global’), were used in Python coding.

The data for CI and MK were directly collected from the papers’ websites. However, the data for HAN and KS were scraped from a Korean search engine, “NAVER” (www.naver.com). This was because news articles with the search terms only appeared from the year 2005 on their websites.² Web scraping to extract published date and the body of each news story yielded 5,253 news articles from CI, 7,141 news articles from MK, 5,136 news articles from HAN, and 6,327 news articles from KS. In all, 12,394 news articles were collected for conservative newspapers, and 11,463 news articles were collected for progressive newspapers. The data showed that the number of news articles in all four newspapers sharply increased in 2007, peaked in 2009, and relatively decreased until 2014 but rebounded in 2015 when the Paris Agreement was adopted in COP-21. Figure 1 displayed the frequency of news articles over time.

[FIGURE 1 ABOUT HERE]

In advance to natural language processing, synonyms and polysemic words were treated in pre- and post- treatment processes. Stop words were also filtered. Korean Natural Language

² This study is an extension of the author’s unpublished study, and data from 2016 to 2017 were newly added. When the data were appended, the search function on the MK website did not work correctly. Thus, NAVER was also used for web scraping of MK data from 2016 to 2017.

Processing in Python (KoNLPy), a package for natural language processing for Korean languages, was used. Using part of speech tags, nouns such as common nouns, proper nouns, and pronouns were exclusively selected. All the results, originally in Korean, were translated into English using a Python dictionary manually created for this study. The size of the corpus of conservative newspapers was 2,900,512 words (tokens), and that of progressive newspapers was 2,780,272 words.

***K*-means Clustering**

Unsupervised machine learning, such as *K*-means clustering, detects the most probable patterns considering features of each object (Müller & Guido, 2017; Wagstaff, Cardie, Rogers, & Schroedl, 2001). To simply put, clustering techniques including *K*-means clustering calculate the most probable word-features that are more likely to appear in the same document. In this study, each object was a news article, features of each object were tokens (words) of each news article, and probability of the same groups of words (associations of words) to appear in the same news articles was calculated.

This logic of *K*-means clustering implies that a news article is assumed to contain only one topic, which may raise some questions. First, this underlying assumption may be considered a limitation because most news articles contain more than one topic. However, this assumption may be an advantage for statistical tests because each topic assigned to a single news article is mutually exclusive to other topics.

Another possible question is that a single word may be used in different contexts signifying different meanings. Then the same word should not be treated as the same word. Indeed, such question has long been a concern in text analytics, and one of techniques to manage such issues is referred to Term Frequency Inverse Document Frequency (TF-IDF). Although this

technique does not fully resolve problems (Blei, Ng, & Jordan, 2003), it is generally used for unsupervised machine learning (e.g., Erra, Senatore, Minnella, & Caggianese, 2015). TF-IDF is to give higher weights to those word-features that appear frequently within a small number of documents while giving lower weights to word-features that rarely appear in the whole data set or that commonly appears in many documents.

This study transformed the data into TF-IDF matrix and then employed *K*-means clustering, considering the data sets of conservative and progressive newspapers separately. That is to say, in this study, the associations of words (topics or clusters) found in conservative newspapers were not compatible to those found in progressive newspapers. This was because, first, comparisons between conservative and progressive newspapers were not the main focus of this study, and second, similar to the reasons to TF-IDF, it was to avoid potential problems regarding the computation process. In other words, the same word—for instance, nuclear power—could be used in positive contexts in conservative newspapers but in negative contexts in progressive newspapers. Then both positive and negative words would be detected together with the word—nuclear power—to construct the same topic.

When creating TF-IDF matrix, this study excluded the words that appeared in more than 50 percent or less than 0.5 percent of the total number of news articles. Under the condition, there were 4,208 word-features for conservative newspapers and 4,323 word-features for progressive newspapers employed for *K*-means clustering.

The number of topics needs to be set before the computation process, but there is no standard way to determine the optimal number of topics to be set in the process. The number of topics was decided by reviewing the results of the topics by testing the number of topics from $k =$

50, $k = 25$, $k = 10$, to $k = 5$. The number of topic best fit the data of this study was $k = 10$. The labels of topic from Topic 0 to Topic 9 were assigned to each news article.

Interpretation of Topics

The worldview associated with the market liberals was expected to suggest solutions to the environmental crises based on modern science- and technology-based as well as market-oriented solutions. Thus, topics, which consisted of keywords related to market economy and modern science-based technology (e.g., corporation, investment, industry, nuclear power, and technology), were interpreted as a representation of the market liberals' worldview.

The worldview associated with the institutionalists was expected to emphasize the roles of IOs and importance of cooperation among countries. In order to distinguish the institutionalists' worldview from the bio-environmentalists' worldview, this study selected topics with keywords relevant to international politics (e.g., bodies of global and local politics and names of countries) without having keywords related to the convention on climate change (e.g., carbon dioxide and greenhouse gas).

With regard to the worldview associated with the bio-environmentalists, this study focused on the keywords related to emissions reduction targets that could indicate the importance of IOs, emphasizing their roles to protect the carrying capacity of ecosystems (e.g., Kyoto Protocol, Paris Agreement, and obligations of countries).

The social greens criticized market economy and modern technology for causing the current environmental crises. However, these criticisms of capitalism were hard to be determined simply examining the keywords of each topic. Despite the possible limitation, this study focused on topics consisted with keywords relevant to genuine environmental concerns (e.g.,

temperature, sea level, arctic, tree, nature, botany, and Earth) to determine the social greens' worldview.

Analysis

Two categorical variables were considered: 1) Time periods (Time 1, Time 2, and Time 3) and 2) Topics (from Topic 0 to Topic 9). To conduct the mean comparison, dummy variables were created for the variable—Topics. Thus, the unit of analysis was individual news articles. Independent variable was three time periods, and dependent variable was each topic, which was conceptualized as news frames associated with one of the four worldviews.

A critical problem in this study, however, was news coverage of climate change in Korea that rapidly increased from 2007 (see Figure 1). Normality assumption was tested by examining residuals of each topic across three time periods, and all topics were non-normal based on Kolmogorov-Smirnov statistic. In addition, for all topics except for Topic 1 in progressive newspapers, variance of each group did not satisfy the homogeneity of variance assumption (see Table 1 and Table 2). This was tested based on the Brown-Forsythe test because, under the non-normal condition, the test was known to be more accurate than Levene's test (Brown & Forsythe, 1974; Nordstokke, Zumbo, Cairns, & Saklofske, 2011).

As an alternative to ANOVA, non-parametric test was considered, despite it being known to have less power, i.e., higher chances for Type II error to conclude that there were no differences among groups even though in fact the differences existed (Howell, 2010). The Kruskal-Wallis test were chosen to test differences of the median among groups, not the mean differences. SPSS was used for the Kruskal-Wallis test. The Bonferroni error correction, which was a built-in test in SPSS in regard to the Kruskal-Wallis test, was employed for a post hoc comparison.

Results

The research question of this study was addressed to reveal and understand problems of environmental discourse in Korea. By testing the hypotheses, this study showed that neoliberal ideology was deeply infiltrated into environmental discourse and strengthened over time. The analyses of this study did not intend to test the differences between conservative and progressive newspapers. However, the results implied that the worldviews associated with the bio-environmentalists and the social greens were less prevalent in conservative newspapers than in progressive newspapers. Also, opposite implication was found in regard to the worldviews associated with the market liberals and the institutionalists.

Regardless of the differences, however, the results of this study indicated that the worldviews associated with the market liberals and the institutionalists became more prevalent in the later time period(s) than in the earlier time period. This section presents the results of the Kruskal-Wallis test as well as those of post hoc comparison to verify the shift (or change) of frames in different time periods.³

Conservative Newspapers

Topic 2 ($n=900$) and Topic 4 ($n=1,480$) were interpreted as a representation of the market liberals' worldview. The representative keywords for Topic 2 were 'energy,' 'nuclear power,' and 'technology,' and those for Topic 4 were 'corporation,' 'investment,' and 'growth.'

Topic 3 ($n=916$) and Topic 6 ($n=1,889$) were categorized into the institutionalists' worldview. The representative keywords for Topic 3 were 'president,' 'prime minister,'

³ With regard to the results of *K*-means clustering, see Appendix of this study. Each of four worldviews that each topic represented was interpreted based on the representative keywords for each topic by following the interpretation process mentioned above.

‘cooperation,’ and names of countries. For Topic 6, ‘economy,’ ‘international,’ ‘environment,’ and names of countries were detected.

Topic 1 ($n=765$) was considered as a representation of the bio-environmentalists’ worldview, which was determined based on representative keywords of ‘greenhouse gas,’ ‘Kyoto Protocol,’ and ‘obligation.’

Topic 0 ($n=740$) and Topic 5 ($n=4,943$) were interpreted as a representation of the social greens’ worldview. Representative keywords for Topic 0 were ‘temperature,’ ‘rise,’ and ‘Earth,’ and those for Topic 5 were ‘Earth,’ ‘Environment,’ and ‘Human.’

With regard to Topics 7, 8, and 9, the associated worldviews were not interpreted. Considering the keywords, Topic 7 ($n=260$) was related to news articles about personnel transfer in the administration, and Topic 8 ($n=224$) and Topic 9 ($n=277$) were news articles specifically oriented to Time 3. Topic 8 was about President Trump’s withdrawal of the Paris Agreement, and Topic 9 was about the impeached President Park’s keynote speech at the UN conference in New York.

The results showed that news frames associated with the worldviews of the bio-environmentalists and the social greens were relatively decreased over time, whereas those associated with the market liberals and the institutionalists were relatively increased over time.

Table 1 presented the results of the Kruskal-Wallis test.

[TABLE 1 ABOUT HERE]

Topic 0 (the social greens) consisted of the keywords such as ‘temperature,’ ‘meteorological office,’ ‘average,’ ‘rise,’ ‘weather,’ ‘phenomenon,’ ‘typhoon,’ and ‘Earth.’ These words indicated concerns of environmental phenomena, such as rise of average temperature, unpredictable weather, and frequently occurring typhoon. A total of 740 news articles was

assigned to this topic, and post hoc test indicated that this topic was used significantly less in Time 2 and Time 3, compared to in Time 1. Also, the use of the topic significantly increased from Time 2 to Time 3.

Topic 1 (the bio-environmentalists) consisted of the keywords such as ‘greenhouse gas,’ ‘reduction,’ ‘emissions,’ ‘carbon,’ ‘Kyoto Protocol,’ and ‘obligation.’ These words indicated the emissions reduction targets as well as obligations of countries. A total of 765 news articles was assigned to this topic, and the use of this topic decreased significantly over time, from Time 1 to Time 2, from Time 1 to Time 3, and from Time 2 to Time 3.

Topic 2 (the market liberals) consisted of the keywords such as ‘energy,’ ‘nuclear power,’ ‘electric power,’ ‘advancement,’ ‘solar-light power,’ ‘technology,’ and ‘renewable energy.’ These keywords were related to solutions based on modern science and market economy. In addition, despite the controversies, the word ‘nuclear power’ was captured together with ‘renewable energy’ and ‘solar-light power,’ implying that renewable energy was more likely discussed in the context of economic concerns rather than environmental concerns. A total of 900 news articles were assigned to this topic. Post hoc test showed that the use of Topic 2 significantly decreased in Time 3 from Time 2, and comparisons with Time 1 showed no significant differences.

Topic 3 (the institutionalists) consisted of the keywords such as ‘president,’ ‘United States,’ ‘North Korea,’ ‘China,’ ‘prime minister,’ ‘cooperation,’ and ‘summit.’ Post hoc test verified that the use of Topic 3 significantly increased from Time 1 to Time 2, from Time 1 to Time 3, and from Time 2 to Time 3.

Topic 4 (the market liberals) consisted of the keywords such as ‘corporation,’ ‘green,’ ‘environment,’ business management,’ ‘technology,’ ‘investment,’ ‘industry,’ ‘growth,’ and

‘project.’ Although there were some words relevant to environmental concerns, these words were contextualized with market-oriented terms. Furthermore, expanding the keywords for this topic to the top-15 words, ‘stock fund,’ ‘market,’ and ‘product’ were captured together. This topic was used significantly more in Time 2 compared to Time 1 or Time 3.

Topic 5 (the social greens) comprised of the keywords such as ‘Earth,’ ‘environment,’ ‘human,’ ‘region,’ ‘research,’ and ‘world.’ Although Topic 5 was the dominant topic in conservative newspapers for the entire time span, this topic was used significantly less in Time 2 and Time 3, compared to the use of the topic in Time 1.

Topic 6 (the institutionalists and the market liberals) consisted of the keywords such as ‘economy,’ ‘world,’ ‘Korea,’ ‘China,’ ‘international,’ ‘host,’ ‘United States,’ and ‘environment.’ Although this topic was more closely related to the institutionalists’ worldview, emphasizing cooperation among countries, this study considered it importantly that ‘economy’ was the word showing the closest distance to the center of the topic. In this regard, the worldview associated with the market liberals were also considered for Topic 6. Post hoc test showed that the use of this topic significantly increased in Time 2 from Time 1 and then decreased in Time 3.

The worldview cannot be determined with Topic 7. In regard to Topic 8, zero variance was included in groups being compared. The representative keywords for Topic 9 were related to the institutionalists’ worldview, but this topic was closely related to a specific event oriented to Time 3 and was not found in Time 1 and Time 2. Key findings from conservative newspapers were summarized in Table 2.

[TABLE 2 ABOUT HERE]

Progressive Newspapers

Topic 1 ($n=868$) and Topic 3 ($n=1,374$) were determined to represent the market liberals' worldview. The representative keywords for Topic 1 were 'energy,' 'nuclear power,' and 'coal,' and those for Topic 3 were 'city,' 'environment,' and 'green.' Although the worldview associated with Topic 3 was hard to determine simply based on the keywords, the topic was closely related to the "Green City" project started in the Lee administration under the LCGG policy, emphasizing huge construction projects focusing on re-development of housing.

Topic 2 ($n=793$) was a representation of the institutionalists' worldview. The representative keywords for Topic 2 were 'president,' 'cooperation,' 'summit,' and names of countries.

Topic 0 ($n=2,257$) and Topic 5 ($n=776$) were categorized to the bio-environmentalists' worldview. Representative keywords for Topic 0 were 'society,' 'problem,' 'world,' 'corporation,' 'human,' 'environment,' and 'government.' This study interpreted these keywords as an emphasis on global and local politics to regulate corporations to protect human and environment. Topic 5 was determined based on representative keywords of 'reduction,' 'greenhouse gas,' and 'Kyoto Protocol.'

Topic 4 ($n=4,059$) and Topic 6 ($n=661$) were considered as a representation of the social greens' worldview. Topic 4 was determined based on representative keywords such as 'Earth,' 'botany,' and 'nature,' and Topic 6 was decided based on 'temperature,' 'rise,' and 'heat wave.'

Topics 7, 8, and 9 were not interpreted because of the similar reason discussed regarding conservative newspapers. Topic 7 ($n=249$) was related to news articles about personnel transfer in the administration and Topic 9 ($n=247$) was about President Trump's withdrawal of the Paris Agreement. Topic 8 ($n=179$) was closely related to the social greens' worldview in terms of

criticizing the Four Major River project of the Lee administration. However, this topic was specifically oriented to Time 2 and hard to be compared with other two time periods.

Although news frames associated with the bio-environmentalists' worldview was more prevalent in progressive newspapers than in conservative newspapers, the results in regard to the shift of frames were similar. News frames associated with the worldviews of the bio-environmentalists and the social greens relatively decreased over time, whereas those associated with the market liberals and the institutionalists relatively increased over time or stayed in status quo in progressive newspapers. Table 3 presented the results of the Kruskal-Wallis test.

[TABLE 3 ABOUT HERE]

Topic 0 (the bio-environmentalists) consisted of the keywords such as 'society,' 'problem,' 'world,' 'corporation,' 'economy,' 'human,' 'environment,' and 'government.' These words indicated the importance of environmental concerns seeking solutions through global and local politics. A total of 2,257 news articles was assigned to this topic. The use of this topic was significantly less in Time 2 than in Time 1, and it was also significantly less in Time 3 than in Time 1.

Topic 1 (the market liberals) consisted of the keywords such as 'energy,' 'nuclear power,' 'electric power,' 'advancement,' 'solar-light power,' and 'coal.' A total of 868 news articles were assigned to this topic. However, Kruskal-Wallis test showed that there were no significant differences among groups. ANOVA was also given as Topic 1 showed that variance of groups was statistically assumed to be equal, but ANOVA also verified that there were no significant differences among groups ($F = 1.492, p = .225$).

Topic 2 (the institutionalists) included the keywords such as 'president,' 'China,' 'United States,' 'North Korea,' 'cooperation,' 'relationship,' and 'summit.' A total of 793 news articles

was assigned to this topic. Post hoc test showed that the use of this topic was significantly higher in Time 2 than in Time 1 as well as significantly higher in Time 3 than in Time 1.

Topic 3 (the market liberals) comprised of the keywords such as ‘city,’ ‘environment,’ ‘green,’ ‘Yeosu,’ ‘citizen,’ and ‘education.’ Post hoc test showed that Topic 3 was used significantly more in Time 2 and Time 3 than in Time 1. Further, there was significantly more use of this topic in Time 2 compared to in Time 3.

Reading the results for Topic 3, however, required special care even though the result supported the research questions of this study. In the consideration of the keywords for Topic 3, the main theme of this topic was related to the EXPO 2012 Yeosu as well as the Green City project. International Exposition (EXPO) is an international fair showcasing industrial, scientific, and cultural achievements of a country. It was held in Yeosu, Korea in 2012, and the Lee administration attempted to promote the LCGG policy as well as the Green City project through the exhibition. However, despite the fact that the topic was specifically oriented to Time 2, it was found comparatively frequent in Time 1 and in Time 3. In this regard, this study suspected that some of keywords for Topic 3 may have been used in different contexts but clustered together here. More details on polysemic words in text analytics are discussed later.

Topic 4 (the social greens) consisted of the keywords such as ‘Earth,’ ‘Environment,’ ‘Tree,’ ‘Human,’ ‘Sea,’ ‘Botany,’ and ‘Nature.’ Topic 4 was the dominant topic used in progressive newspapers for an entire time span of this study, and a total of 4,059 news articles were assigned to this topic. Post hoc test verified that the use of this topic significantly lower in Time 2 than in Time 1 as well as significantly lower in Time 3 than in Time 1.

Topic 5 (the bio-environmentalists) consisted of the keywords such as ‘reduction,’ ‘greenhouse gas,’ ‘emission,’ ‘Kyoto Protocol,’ and ‘carbon.’ A total of 776 news articles were

assigned to this topic, and the use of this topic was significantly dropped from Time 1 to Time 2, from Time 1 to Time 3, and from Time 2 to Time 3.

Topic 6 (the social greens) consisted of the keywords such as ‘temperature,’ ‘average,’ ‘rise,’ ‘Earth,’ ‘temperature,’ ‘heat wave,’ and ‘Arctic.’ A total of 661 news articles were assigned to this topic, and the use of this topic was used significantly lower in Time 2 than in Time 1 as well as lower in Time 3 than in Time 1.

The worldview cannot be determined with Topic 7. In regard to Topics 8 and 9, zero variance was included. Key findings from progressive newspapers were summarized in Table 4.

[TABLE 4 ABOUT HERE]

Discussion

This study examines the process of neoliberalization of climate change discourse in Korean media. The shift of news frames over time reveals that the issues of climate change in Korea have been increasingly contextualized with market-oriented ideas representing the worldviews associated with the market liberals and the institutionalists, as well as marginalizing their counterpart worldviews, i.e., the worldviews associated with the bio-environmentalists and the social greens. More seriously, progressive newspapers are not much different from conservative newspapers showing the same direction of the shift of frames, which this study suggests as the evidence of neoliberalization of climate change discourse in Korean newspapers.

There are several limitations. As mentioned above, *K*-means clustering has a limitation for dealing with polysemic words. Pan and Kosicki (1993) distinguish a theme from a topic, explaining that a topic is a summary of a story at the concrete level, whereas a theme is a synthetic level of connecting semantic elements to produce meanings. That is to say, news frames operationalized based on the probability of words to appear in the same news articles may

not be a valid approach because this approach is limited to show how those words are selected and structured in which contexts. In a similar context, the same word in one time period may not be structured in a way that they are structured in different time periods, representing different meaning. However, news articles throughout the entire time span are put into “one bag” to calculate the probability. These limitations are inevitable choice in this study in the consideration to show the existence of a problem at the ontological level. For the future study, representative news articles regarding each topic are needed to be qualitatively analyzed focusing on themes or meanings produced through framing devices.

Despite the limitations, the contribution of this study is to call for attention the direction of the climate change discourse structuring “nature” in their texts, as Harvey (2007) emphasizes to pay attention to how “freedom” is structured in neoliberal discourses. Castree (2014) criticizes that representation of nature is a purposeful invention to serve the interests and worldviews of those who are doing the representation. Similarly, McAfee (2012) argues that the environmental market “can support a no-regrets climate policy that enables continued economic growth” (p. 110), and in order to ensure sustainability, it “must be supported and constrained by state interventions” (McAfee, 2015, p. 240). The future research may approach this topic more in detail examining representative news articles for each topic. For instance, latent Dirichlet allocation (LDA) topic modeling, which considers both documents (i.e., news articles) and each word in a document for computation process to assign topics, can be employed. This clustering technique detects representative news articles for each topic based on the percentage of each topic included in each news article, and then the syntactic structure of texts incorporating ‘nature’ into a neoliberal contexts can be qualitatively analyzed to understand and explain the process of neoliberalization of news frames of climate change.

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APPENDIX

Appendix 1. Topics of the conservative newspapers and the top-10 representative words.

Topics	N	Words associated with the topic
Topic 0	740	Temperature (synonym); Meteorological Office; Average; Rise; Weather; Phenomenon; Typhoon; Temperature; Earth; Weather (synonym)
Topic 1	765	Greenhouse Gas; Reduction; Emissions; Quantity of Emissions; Carbon; Carbon Credit; Target; Kyoto Protocol; Trade; Obligation
Topic 2	900	Energy; Nuclear Power Plant; Electric Power; Nuclear Power; Advancement; Solar-light Power; Technology; Renewable Energy; Project; Electricity
Topic 3	916	President; Obama; United States; North Korea; China; Prime Minister; Two Countries; Cooperation; Summit Conference; Summit
Topic 4	1,480	Corporation; Green; Environment; Business Management; Technology; Investment; Industry; Growth; Project; Ecofriendly
Topic 5	4,943	Earth; Environment; Human; Region; Research; World; Changes; United States; Climate; Problem
Topic 6	1,889	Economy; World; Korea; Forum; China; International; Host; United States; Topic; Environment
Topic 7	260	Team Leader; Manager; Superintendent; Personnel Transfer; Promotion; Planning; Head Quarter; Dean; Section Chief; Director of Bureau
Topic 8	224	Trump; President; United States; Paris; Withdrawal; Treaty; Obama; Donald; Convention; Hilary
Topic 9	277	Secretary-General; UN; UN Secretary-General; President; Ban Ki-Moon; Conference; New York; North Korea; Attendance; Visit

Notes. The order of the words followed the distance of each word from the center of each topic. The originals in Korean were translated by the author.

Appendix 2. Topics of the progressive newspapers and the top-10 representative words.

Topics	N	Words associated with the topic
Topic 0	2,257	Society; Problem; United States; World; Corporation; Economy; Human; President; Environment; Government
Topic 1	868	Energy; Nuclear Power Plant; Electric Power; Electricity; Nuclear Power; Advancement; Solar-light Power; Power Plant; Production; Coal
Topic 2	793	President; China; Obama; United States; North Korea; Cooperation; Relationship; Two Countries; Problem; Summit
Topic 3	1,374	City; Environment; Green; Ceremony; Yeosu; Seoul; Topic; Citizen; Conference; Education
Topic 4	4,059	Earth; Research; Region; Environment; Tree; Human; Sea; Humane; Botany; Nature
Topic 5	776	Reduction; Greenhouse Gas; Quantity of Emissions; Emissions; Target; Kyoto Protocol; Advanced Countries; Carbon; Developing Countries (synonym); Meeting
Topic 6	661	Temperature (synonym); Average; Rise; Meteorological Office; Earth; Temperature; Heat Wave; Arctic; Region; Average Year
Topic 7	249	Team Leader; Manager; Planning; Personnel Transfer; Promotion; Superintendent; Head Quarter; Support; Official in Charge; Director of Bureau
Topic 8	179	Four Major River; Project; Nakdong River; Government; Flood; Dredge; (Green) Algae; Stream; President; Invigoration
Topic 9	247	Trump; United States; President; Treaty; Paris; Withdrawal; Donald; Obama; Presidential Election; White House

Notes. The order of the words followed the distance of each word from the center of each topic. The originals in Korean were translated by the author.

Tables and Figures

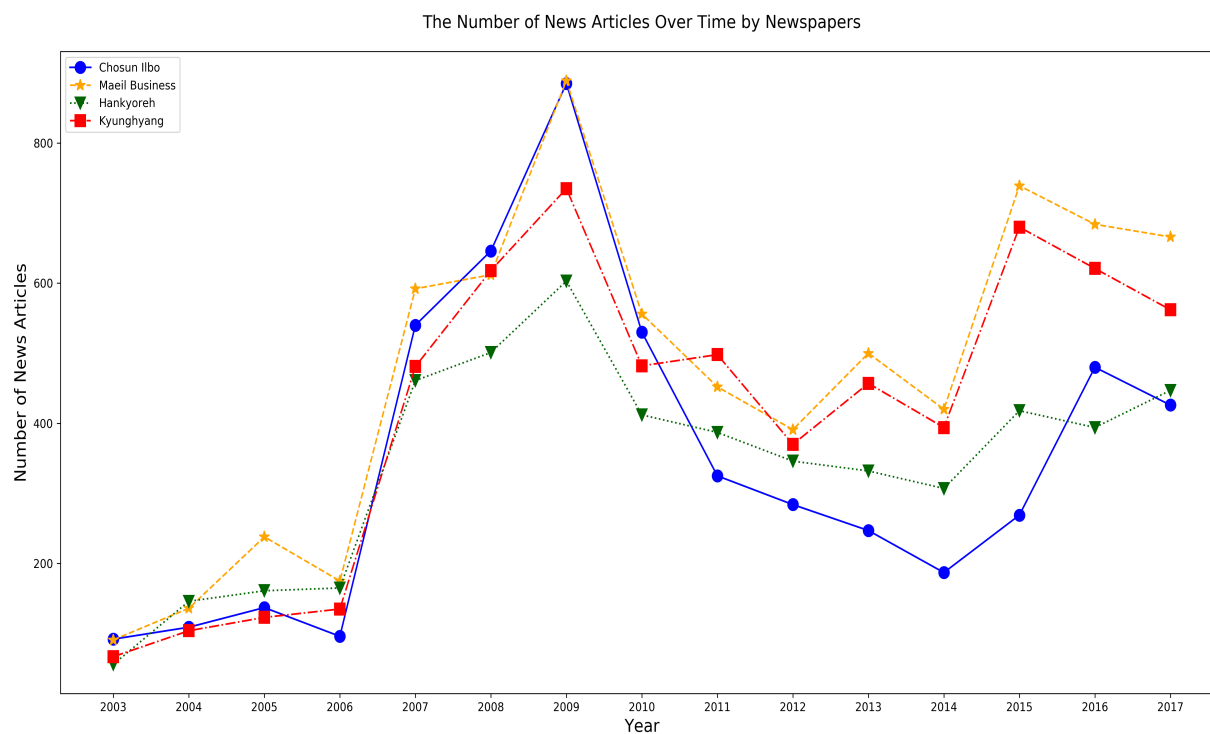


Figure 1. The number of news articles over time by newspapers (2003 – 2017).

Table 1. The results of the Kruskal-Wallis test for conservative newspapers.

Topics	<i>df</i>	Time 1 (<i>n</i> =2,206)	Time 2 (<i>n</i> =5,570)	Time 3 (<i>n</i> =4,618)	Brown- Forsythe	Kruskal-Wallis <i>H</i> -Statistics
Topic 0	2	.1074 _a (.3097)	.0418 _b (.2002)	.0585 _c (.2347)	50.28 (.000)	121.33** (.000)
Topic 1	2	.1029 _a (.3039)	.0632 _b (.2433)	.0403 _c (.1966)	44.26 (.000)	101.46** (.000)
Topic 2	2	.0748 _{ab} (.2631)	.0801 _a (.2714)	.0626 _b (.2422)	5.85 (.003)	11.66** (.003)
Topic 3	2	.0367 _a (.1881)	.0727 _b (.2597)	.0931 _c (.2906)	39.95 (.000)	69.58** (.000)
Topic 4	2	.0943 _a (.2923)	.1415 _b (.3485)	.1048 _a (.3063)	25.96 (.000)	48.38** (.000)
Topic 5	2	.4316 _a (.4954)	.3864 _b (.4870)	.3982 _b (.4896)	6.69 (.001)	13.47** (.001)
Topic 6	2	.1296 _a (.3360)	.1767 _b (.3814)	.1340 _a (.3407)	24.32 (.000)	46.26** (.000)
Topic 7	2	.0118 _a (.1080)	.0259 _b (.1587)	.0195 _{ab} (.1383)	9.28 (.000)	16.02** (.000)
Topic 8	2	.0000 _a (.0000)	.0000 _a (.0000)	.0485 _b (.2149)	N/A	384.09** (.000)
Topic 9	2	.0109 _a (.1038)	.0118 _a (.1082)	.0405 _b (.1971)	61.11 (.000)	110.96** (.000)

Notes. Standard deviation was given in parentheses under each mean.

Topic 8 was not available for the Brown-Forsythe test because of the groups with zero variance.

Alternatively, the Levene's test based on median, a compatible test to the Brown-Forsythe test, was conducted to reject the null hypothesis ($F = 198.16$, $p = .000$).

Medians (mean-ranking) of each group were tested based on Kruskal-Wallis test, and medians that do not share subscripts differ by $p < .05$ according to the Bonferroni correction for multiple tests.

Asymptotic significances (2-sided tests) were given in parentheses under each *H*-statistic.

* $p < .05$, ** $p < .01$

Table 2. Summary of the results for conservative newspapers.

Topics	Worldview	Selected keywords	Post hoc
Topic 0 (<i>n</i> =740)	Social Greens	Temperature Rise Earth	Time 1 > Time 2 Time 1 > Time 3 Time 2 < Time 3
Topic 1 (<i>n</i> =765)	Bio-environmentalists	Greenhouse Gas Kyoto Protocol Obligation	Time 1 > Time 2 Time 1 > Time 3 Time 2 > Time 3
Topic 2 (<i>n</i> =900)	Market Liberals	Energy Nuclear Power Technology	Time 2 > Time 3
Topic 3 (<i>n</i> =916)	Institutionalists	President Prime Minister Cooperation	Time 1 < Time 2 Time 1 < Time 3 Time 2 < Time 3
Topic 4 (<i>n</i> =1,480)	Market Liberals	Corporation Investment Growth	Time 1 < Time 2 Time 2 > Time 3
Topic 5 (<i>n</i> =4,943)	Social Greens	Earth Environment Human	Time 1 > Time 2 Time 1 > Time 3
Topic 6 (<i>n</i> =1,889)	Institutionalists (Market Liberals)	Economy International Environment	Time 1 < Time 2 Time 2 > Time 3

Notes. Among the top-10 keywords for each topic, three relevant keywords were selected by the author. The *n* number given under each topic indicated the total number of news articles assigned to that particular topic.

Table 3. The results of the Kruskal-Wallis test for progressive newspapers.

Topics	<i>df</i>	Time 1 (<i>n</i> =1,899)	Time 2 (<i>n</i> =4,952)	Time 3 (<i>n</i> =4,612)	Brown- Forsythe	Kruskal-Wallis <i>H</i> -Statistics
Topic 0	2	.2227 _a (.4162)	.1914 _b (.3935)	.1921 _b (.3940)	4.68 (.009)	9.63** (.008)
Topic 1	2	.0732 (.2605)	.0806 (.2722)	.0716 (.2578)	1.51 (.221)	2.98 (.225)
Topic 2	2	.0305 _a (.1721)	.0759 _b (.2649)	.0778 _b (.2680)	31.69 (.000)	52.90** (.000)
Topic 3	2	.0563 _a (.2307)	.1478 _b (.3550)	.1160 _c (.3203)	65.45 (.000)	109.95** (.000)
Topic 4	2	.4097 _a (.4919)	.3346 _b (.4719)	.3521 _b (.4777)	16.71 (.000)	33.96** (.000)
Topic 5	2	.1053 _a (.3070)	.0697 _b (.2546)	.0501 _c (.2182)	28.75 (.000)	65.55** (.000)
Topic 6	2	.0885 _a (.2841)	.0473 _b (.2122)	.0562 _b (.2303)	18.86 (.000)	43.23** (.000)
Topic 7	2	.0137 _a (.1162)	.0248 _b (.1557)	.0217 _{ab} (.1457)	4.52 (.011)	8.03* (.018)
Topic 8	2	.0000 _a (.0000)	.0279 _b (.1646)	.0089 _c (.0939)	N/A	92.05** (.000)
Topic 9	2	.0000 _a (.0000)	.0000 _a (.0000)	.0536 _b (.2252)	N/A	374.96** (.000)

Notes. Standard deviation was given in parentheses under each mean.

The homogeneity of variance assumption was satisfied for Topic 1. A result of ANOVA was reported inside the text.

Topics 8 and 9 were not available for the Brown-Forsythe test because of the groups with zero variance. Alternatively, the Levene's test based on median, a compatible test to the Brown-Forsythe test, was conducted to reject the null hypothesis, respectively, Topic 8 ($F = 46.39, p = .000$) and Topic 9 ($F = 193.79, p = .000$).

Medians (mean-ranking) of each group were tested based on Kruskal-Wallis test, and medians that do not share subscripts differ by $p < .05$ according to the Bonferroni correction for multiple tests.

Asymptotic significances (2-sided tests) were given in parentheses under each *H*-statistic.

* $p < .05$, ** $p < .01$

Table 4. Summary of the results for progressive newspapers.

Topics	Worldview	Selected keywords	Post hoc
Topic 0 (<i>n</i> =2,257)	Bio-environmentalists	Society World Environment	Time 1 > Time 2 Time 1 > Time 3
Topic 1 (<i>n</i> =868)	Market Liberals	Energy Nuclear Power Coal	N/A
Topic 2 (<i>n</i> =793)	Institutionalists	President Cooperation Summit	Time 1 < Time 2 Time 1 < Time 3
Topic 3 (<i>n</i> =1,374)	Market Liberals	City Environment Green	Time 1 < Time 2 Time 1 < Time 3 Time 2 > Time 3
Topic 4 (<i>n</i> =4,059)	Social Greens	Earth Botany Nature	Time 1 > Time 2 Time 1 > Time 3
Topic 5 (<i>n</i> =776)	Bio-environmentalists	Reduction Greenhouse Gas Kyoto Protocol	Time 1 > Time 2 Time 1 > Time 3 Time 2 > Time 3
Topic 6 (<i>n</i> =661)	Social Greens	Temperature Rise Heat Wave	Time 1 > Time 2 Time 1 > Time 3

Notes. Among the top-10 keywords for each topic, three relevant keywords were selected by the author. The *n* number given under each topic indicated the total number of news articles assigned to that particular topic.