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# Nationalizing a global phenomenon: A study of how the press in 45 countries and territories portrays climate change

Hong Tien Vu<sup>a,\*</sup>, Yuchen Liu<sup>a</sup>, Duc Vinh Tran<sup>b</sup>

<sup>a</sup> William White School of Journalism & Mass Communications, University of Kansas, Stauffer-Flint Hall, 1435 Jayhawk Blvd., Lawrence, 66045, KS, USA

<sup>b</sup> School of Information and Communication Technology, Hanoi University of Science and Technology, 1 Dai Co Viet Street, Hanoi, Viet Nam

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## ABSTRACT

This study investigates the news coverage of climate change in 45 different countries and territories. Using the news framing approach, this study identifies the connections between several national socioeconomic, governance, and environmental traits and the portrayals of climate change. Although climate change is a global issue that affects every country in the world, how the news media frame it varies from country to country. Such a variation is related to each country's economic development, climate severity, and governance. The findings of this study contribute to framing literature by assessing frame use in national contexts, filling in the gap in the application of this theoretical framework.

## 1. Introduction

Framing theorists have asserted that many factors such as bias, culture and ideology influence the construction of frames, shaping news messages (Entman, 2007). Media from different countries have also been known for framing the same issue differently (Akhavan-Majid and Ramaprasad, 1998). However, most comparative framing studies have focused on detecting differences in the output – the message, rather than empirically investigating the connection between socioeconomic and/or environmental factors that are inherent to a particular country and frame use.

This study focuses on how the media frame global warming/climate change; a transnational issue that has been in the world's news spotlight for some time (Boykoff and Boykoff, 2007; Nisbet and Myers, 2007). It assesses the relationship between media coverage of global warming/climate change and socioeconomic and environmental factors of 45 countries and territories (e.g., economic growth, governance, and climate severity), which may affect the way the press in these countries contextualizes this global phenomenon for their national audience. It has been demonstrated that most of the public rely on mass media for information, especially on scientific issues (Boykoff and Rajan, 2007). How the media cover global warming therefore does matter considerably, because such coverage can very well influence the public's perception of it, as well as policymaking regarding this global phenomenon (Anderson, 2009; Bolsen and Shapiro, 2018).

Given the magnitude of its impact on every country in the world,

numerous academic studies have researched the media's portrayal of global warming in a single country. Others have compared frame use in news coverage on climate change in media from different countries (Brossard et al., 2004; Dirikx and Gelders, 2010; Sampei and Aoyagi-Utsui, 2009). Despite the importance of this transnational issue, assessing factors that influence the media message on global warming has been understudied. The present research fills this void.

This study uses content analysis to compare media portrayals of climate change in 45 countries and territories from all continents in the world. More importantly, this study examines what roles a nation's socioeconomic and environmental factors (e.g., GDP per capita, loss by natural disasters, and CO2 emission amount among others) play in framing the news on global warming/climate change. This study uses original data obtained by analyzing the content of major publications in each of the 45 countries. Secondary data on the countries' environmental and socioeconomic factors were retrieved from global organizations such as the World Bank, Center for Research on the Epidemiology of Disasters, and Global Carbon Atlas.

Findings of this study contribute to the literature by empirically identifying the connection between structural variables representing the socioeconomic and environmental situations in each country and frame use in the media of that country when reporting climate change. Practically, its results could be used as a reference in designing national campaigns to reduce greenhouse gases.

\* Corresponding author.

E-mail addresses: [hongvu@ku.edu](mailto:hongvu@ku.edu) (H.T. Vu), [yuchenliu@ku.edu](mailto:yuchenliu@ku.edu) (Y. Liu), [ductv@soict.hust.edu.vn](mailto:ductv@soict.hust.edu.vn) (D.V. Tran).

## 2. Framing

Framing refers to the process of making some elements salient while obscuring others when producing content. Gamson and Modigliani (1989, p. 3) describe frames as “central organizing ideas or story lines that provide meaning on related events.” Entman (1993, p. 52) viewed this process as selecting “some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation of the item described.” For Entman, the two most important factors in frame construction are selection and salience (Scheufele, 1999). To provide theoretical and methodological clarifications for the “fractured paradigm,” of framing, Entman (1993) proposed four major dimensions of frames including defining problems, diagnosing causes, making moral judgements, and suggesting remedies.

Most framing studies have focused on detecting the presence of frames in texts. Others have used experiments to examine the influence of frames on the audience (Kahneman and Tversky, 1984; Lück et al., 2018; O’Neill et al., 2015). However, academic attention paid to the influence on frame construction/production is surprisingly limited. In her meta-analysis, Borah (2011) found that of the 379 framing studies published in all communication journals in the ISI list between 1997 and 2007, only eight (2.3%) researched the production process.

Scholars have argued that various factors can affect journalists’ gatekeeping, thus shaping news content (Hackett, 1984; Shoemaker and Reese, 1996; Shoemaker and Vos, 2009). These factors range from micro (individual journalists), meso (news organization) to macro (society, national culture, politics and economics) (Hackett, 1984; Shoemaker and Reese, 1996). For example, at the micro level, Vu (2014) found individual journalists’ education can affect journalists’ editorial decision-making. Focusing on the meso level, Hackett (1984) suggested that journalistic routines, strategies, and expectations affect media content, causing bias in the news. Maslog et al. (2006) examined how news media from five Asian countries cover of the Iraq War to discover that religion plays an important role in shaping news content. Specifically, media from non-Muslim countries had stronger war journalism framing than those from Muslim nations. Saguy et al. (2010) found that cultural differences between France and the U.S. influence the way the media from these two countries report on obesity.

Journalism or media structures do not operate in a vacuum. They are the results of interaction between social systems, and most of all with “economics and politics” (Mancini, 2000). But scholars have lamented about the limited amount of research that properly and empirically investigates the influence of structural factors and news frame construction (Carragee and Roefs, 2004). Vliegthart and van Zoonen (2011) pointed out that comparative framing studies across countries tend to assume that differences in national media systems and news cultures affect news frames without identifying exactly how and when the influence becomes operational. Often, the link between the political, religious and cultural contexts of a nation and how media frames were created is implied or interpreted instead of providing empirical evidence of it.

A limited amount of research has attempted to examine the connection of structural variables representing economic and political contexts of countries in the world and media portrayal of short-lived events. For example, Chang et al. (2009) examined the influence of such socioeconomic factors as GDP per capita, trade volume, foreign direct investment, number of SARS (Severe acute respiratory syndrome) cases, and political control on the way the media from four countries including the U.S., Canada, Singapore, and China portray the epidemic. This study takes a similar approach and investigates the link between socioeconomic and environmental factors of a country where climate change frames are formed. In so doing this research provides better understanding of the framing process, thus expanding its theoretical literature.

## 3. Climate change and news media

Climate change, or global warming, refers to the global increase of temperature caused by escalating greenhouse gas emission (Weart, 2008). The cause of global warming has mainly been attributed to human activities such as excessive use of fossil fuels and deforestation (Maslin, 2009). But more than half a century since scientists began to warn the public about global warming, much controversy still revolves around the issue of climate change regarding its existence or effects, which involve various political, economic, and scientific complexities (Rice et al., 2018; Schafer & O’Neil, 2017).

Over the past three decades, scientific evidence to support claims that climate change is man-made and will have significantly negative impacts on the environment has accumulated. However, the increase of evidence has not resulted in a proportional increase of news coverage (DiPeso, 2006). In explaining the media’s indifference toward climate change, Former BBC journalist Kirby said, “Alarming or not, climate change is becoming an increasingly hard subject to sell in much of the media ... Editors are simply bored with what they think is an old story they have heard before” (see Anderson, 2009, p.168). If the most important function of the media is to inform the audience on various social realities, this apathy of the press toward climate change may very well be causing limited understanding of the phenomenon among the public (Nisbet and Myers, 2007). The mass media have a vital role in shaping the public’s understanding of scientific issues (Friedman et al., 1986; Nisbet et al., 2002). Heightened media attention to scientific issues can influence how science is translated into policy (Boykoff and Rajan, 2007; Hart, 2011; Stromberg, 2001). The lack of journalism and public concerns on climate change would take away the ability of the media and the public to influence policymaking regarding such an issue.

Academically, extensive research has been done on how the media cover climate change (Schafer & O’Neil, 2017). Not only are there differences in news volume at different times, how climate change is portrayed in different countries also varies. For example, Zehr (2000) found scientific uncertainty a dominant frame in the discourse of four major U.S. newspapers regarding global warming. Olausson’s (2009) analysis of three Swedish newspapers showed that the collective action frame was most popular, and that Swedish media were reluctant to use the frame of uncertainty. Billett’s (2010) research on media’s portrayal of climate change in India demonstrated a totally contrast picture to that of developed countries. By emphasizing the environmental rather than scientific aspects of climate change the Indian press set up “a strongly nationalistic position on climate change that divides the issue along both developmental and postcolonial lines” (Billett, 2010, p. 1). These studies are often done independently from one another, using different coding schemes, which makes a cross-culture comparison of the media’s frame use difficult. The present study overcomes these limitations to provide a big picture of how the media frame climate change in a large scale, by adopting common frames that have been used by studies on this environmental phenomenon.

Studies generally explore the issue of global warming framing using a set of common frames. For example, scholars have found that the news media often framed climate change as a scientific issue, presenting new scientific findings, as well as emphasizing scientific controversy revolving around this environmental phenomenon. Articles using this frame may also refer to whether advances in science and technology would be able to help mitigate the effects of climate change (Antilla, 2005; McCright and Dunlap, 2000; Nisbet, 2009).

Direct effects of climate change refer to the natural impact of this environmental phenomenon. These effects include melting glaciers, sea level rise, increase in global temperature, and more frequent disasters among others. In the event of recent natural disasters, media discussions revolving around climate change have often focused on whether these extreme weather changes could be linked to climate change. Hart and Feldman (2014) also discovered that the news media frequently

report on natural impacts of climate change, presenting it as a threat.

Economic impact is another commonly adopted frame in the media discourse regarding climate change/global warming (Antilla, 2005; McCright and Dunlap, 2000; Nisbet, 2009; Trumbo, 1996). For this frame, the media tend to focus on how much this environmental phenomenon and solutions to mitigate it would cost governments and industries.

Much of the debate on climate change revolves around the issue of energy, as human use of fossil fuel plays a major role in causing the greenhouse effects on the earth. In addition, seeking clean energy to protect our planet has been central to preventing further atmospheric damages. Therefore, framing climate change as an issue of energy has been popular in the news media (Doyle, 2011; Stephens et al., 2009).

Domestic politics and regulatory process frame refers to discussions in the media on links between climate change and domestic politics and policymaking within a nation. For example, the news media have frequently report on new policies on climate change; how climate change becomes an issue that influences elections, national security, or policy discussions of a nation (Bomberg and Super, 2009; Fletcher, 2009).

As a global issue that needs joint efforts from all the countries, the international relations aspect of climate change has also received substantial attention from the media. This frame emphasizes such aspects of climate change as international work to battle climate change, national commitments to international agreements on greenhouse gas reduction and climate change mitigation among others (Boykoff and Roberts, 2007; Olausson, 2009).

In recent years, the media have also employed the social progress frame (Boykoff and Rajan, 2007; Chetty et al., 2015; Hart, 2008; Nisbet and Mooney, 2009), which according to Nisbet (2009, p.18), refers to climate change as “a means of improving quality of life or solving problems; alternative interpretation as a way to be in harmony with nature instead of mastering it.”

This study adapted the coding scheme from several studies including Nisbet’s (2009) and Sinaga (2011) research, which combines the common frames mentioned above. Because this research studied media portrayals of climate change from 45 countries and territories with different political environment, cultures, and levels of development, these broad frames would be helpful for such a large-scale comparison. For example, skepticism would be a popular frame in the U.S. news media (Nisbet, 2009). It would not, however, be pertinent to non-partisan media and political systems. The question: “What is the story about climate change in the global news media flow” is an important one as it provides some insights into the overall portrayal of climate change at the global level. Taking advantage of its scope-spanning 45 countries - this study asks about climate change frame use in the news globally:

RQ1: Overall, what are the popular frames used in the media from 45 countries and territories?

Studies have focused on how media from two different countries portray climate change. Boykoff and Rajan (2007) compared the portrayal of climate change in the U.S.’s and the U.K.’s media. Using the issue-cycles approach Bossard et al. (2004) assessed the differences in coverage of global warming between U.S. and French newspapers. Dirix and Gelders (2010), in contrasting the media coverage of climate change between France and the Netherlands, suggested that ideological cultures play an important role in how the media cover the issue. An important point to note here is: scholars have often been more enthusiastic to compare press coverage of climate change between developed nations. Again, developing countries are often left out in the academic focus. Schafer and O’Neil (2017, p. 22) posit that studies in this specific area need to “go beyond the ‘usual suspects’” in examining climate communications in and across (trans)national contexts.” This study includes a number of developing countries in its comparative loop.

Scholars contend that public engagement with issues that are often caught in political gridlock like climate change depends on how the

news media frame them. Media coverage of controversial issues has a great impact on changing the mass attitude, and would ultimately affect policymakers (Nisbet, 2009). The media framing process is, on the other hand, influenced by many factors emerged from or represented a nation’s broader political and socioeconomic landscape. But, how do we include these factors in our analysis of influences on media content quantitatively, especially for cross-nations comparative framing studies? This study used macro variables that play important roles in a country’s political and socioeconomic landscape.

This research investigates the influence of nationally macro variables on how the press frames climate change. The variables include: environment (e.g., natural disasters, carbon dependency), economic (e.g., GDP per capita, GDP growth), and governance and media system (e.g., government effectiveness, press freedom). These factors represent different aspects of the sociological ecology of a country in which the news media operate. Schmidt et al. (2013), for example, argue that environmental factors related to carbon dependency and climate severity influence the amount of press coverage global warming receives. Other studies have also found the effects of national macro factors including economic development and media systems on how the news media cover public affairs issues (Schäfer et al., 2013; Vu et al., 2018). But, to date, no paper has investigated the possible connection between media frames and the aforementioned factors. Theoretically, linking media frame use with such national factors would extend the literature to include contextual aspects in studying frame use, especially for cross-nations comparative research. Practically, it helps better discern how the press negotiates its role in its complex relationship with governments and the public when portraying climate change.

This study asks:

RQ2: What factors predict frame use in the press from the 45 countries and territories?

## 4. Method

### 4.1. Sample

This study focused on the media from 45 countries and territories. The selection of those countries and territories was based on several factors. First, they represent different levels of economic development and a variety of weather types (e.g., tropical, Mediterranean, etc.) and energy consumption. Second, availability of data is an important factor. Third, language skills of the research team (i.e., English, French, Spanish, and Portuguese) were considered because we analyzed content in the official language of a country. The variety in the economic, political, and environmental contexts make them ideal to study the relationship between structural variables of the nations and how their media frame climate change.

*Time frame* was five years starting from 2011 to 2015. We selected 2011 as our starting year because it was long enough after the notorious climategate, which happened in late 2009 and early 2010. During this time the media focused heavily on the controversy related to climate scientists and ethical climate change research rather than climate change issues (Holliman, 2011). Global discussions on climate change in these years were important with the culmination of the Paris Agreement event in December 2015 being another important global event for the discussion on climate change (Gurwitt et al., 2017). Data accessibility was also another issue that did not allow us to go back too far in time for many countries, thus affecting the longitudinal aspect of this study.

*Publication selection* was based on several factors including popularity (e.g., high readership, nationally circulated), the variety of the publications’ political leaning (e.g., representing countries’ major political ideologies) as well as data accessibility (e.g., whether they can be accessed through databases such as LexisNexis, Access World News, Factiva or their own archiving systems). For example, in the U.S. three newspapers, representing different political ideologies were selected



including *The New York Times* (liberal leaning), *Wall Street Journal* (conservative leaning), and *USA Today* (center). A total of 84 publications were selected. Many countries in the sample are developing nations with poor archiving systems of publications. Therefore, for some countries, we could only access one publication (e.g. Tanzania, Sierra Leon, Papua New Guinea among others). Often, those are the most popular newspaper.<sup>1</sup>

**Media content:** All articles containing the keywords “greenhouse gas,” “climate change,” and/or “global warming” or the equivalent of these search terms in the other three languages in either leads or headlines were included. This study did not exclude opinion or editorial pieces, because previous research showed editorial and essay writers frame personalities, events, and issues in the same way that reporters and editors do (Ryan, 2001).

The search results yielded a text corpus of 37,670 news articles with nearly 23 million words from the 84 publications over the five-year period. A computer program using Python codes was created for the preprocessing step in which all the junk words that were used to archive these articles in the databases were deleted. Only words that were parts of the articles’ body text were kept.

#### 4.2. Content analysis

We combined two methods including computational and manual to analyze the corpus of news media content.

**Topic modeling** with Latent Dirichlet Allocation (LDA) is an unsupervised probabilistic method that could be used to detect topic models using “algorithms for discovering the main themes that pervade a large and otherwise unstructured collection of documents” (Blei, 2012, p. 77). LDA draws “on the notion of distributional semantics and particularly make use of the so-called bag of words assumption,” (Maier et al., 2018, p. 95). This computational content-analysis technique has been used widely to study news and social media texts (DiMaggio et al., 2013; Jacobi et al., 2016) for it is a valuable tool for analyzing large scale content. Basically, its algorithms look for latent patterns of word co-occurrence in a collection of documents and provide outputs as clusters of words that appear together in those documents. These clusters could be inferred as representing the categorization of frame use in the text (Jacobi et al., 2016). Mallet, a java-based program developed by McCallum (2002) was adopted. Mallet’s LDA component has been used widely for text analysis. In analyzing the data, the hyperparameter optimization option was selected, which according to the Mallet website would allow “the model to better fit the data by allowing some topics to be more prominent than others. Optimization every 10 iterations is reasonable.”

Several steps were taken to come to the mathematically “right” number of topics that would best describe the data. First, all 37,670 articles were used to test the topic modeling on our data. Second, we began with selecting five topics in the outputs. The similarity of topics is calculated using Jaccard similarity. The Jaccard similarity value of sets (topics) is the ratio of the size of the intersection of the sets to the size of the union (Leskovec et al., 2014). If the Jaccard similarity value between two topics is equal 1.0, they are exactly the same. The lower the Jaccard similarity value between two topics is the more they differ from one another. We then continued to increase the number of topics until no Jaccard similarity value between any two of the topics was higher than 0.4, the cutoff point by topic modeling scholars (Leskovec et al., 2014). The testing of the data analysis landed us at 20 topics from the content of each of the countries for one year, with each topic being represented by a set of words that co-occurred. The outputs included 20 numerical values of how large each topic was in the content unit. As Jacobi et al. (2016) argued that even with sound mathematical

calculations being used to identify the “right” number of topics, some of them would still be irrelevant or would not make sense. It is, therefore, “up to the researcher to interpret the results of the model and to set up the analysis in such a way that the results are useful to the study at hand,” (Jacobi et al., 2016, p. 2).

**Manual coding:** After finishing analyzing the texts using LDA, a codebook was developed with nine items including general information on the year and the country the data were collected from, the seven broad frames, and an option of other. These variables were coded by adding the “weight” values of the topics. However, several years of data from some of the countries were missing including Sierra Leon (missing 2013); Tanzania (missing 2011 and 2012); Zambia (missing 2012); Morocco (missing 2011), and; Brazil (missing 2015).

This study used the issue-specific approach suggested by Gamson (1988) in operationalizing frames. As Schafer and O’Neil (2017) pointed out, this issue-specific approach is the most prevalent in detecting frames through content analysis. It, therefore, worked particularly well for this research, a project that dealt with a large amount of data spanning multiple countries. Although Entman (1993)’s understanding of frames might be more prominent in the literature, Gamson (1988)’s method is appropriate for LDA’s text analysis method, which allows for detecting frames that are not internally structured. Coders were instructed to look for words or catchphrases representing each of the frames. The list of frames to code included (1) *Scientific Evidence* (e.g., scientific, research, existence, researcher, study, evidence, scientist, panel, etc.); (2) *Energy* (e.g., oil, fuel, energy, coal, gas, electricity, wind power, green energy, renewable, etc.) *Natural Impact* (e.g., melting, temperature, glaciers, sea-level, weather, storm, disaster, habitats, species, etc.); *Economic Impact* (e.g., financial, cost, businesses, market, tax, debt, budget, loss of harvest, tourism, etc.); *Domestic Politics/Regulatory Process* (e.g., national security, policy, party, conservative, voting, greenhouse gases, politics, policymaking, law, regulation, etc.); *International Relations* (e.g., U.N. conferences; bilateral, multi-lateral, partnership, intergovernmental, cabinet, treaties, foreign aid, COP, agreements, etc.); *Social Progress*, (e.g., saving, lifestyle, children, environmental, eco-living, ecological, water, forest, environmental-friendly, educational, green, lifestyle etc.). Those that do not fit in the above-mentioned six frames will be coded to *Other/Unclear* (See Fig. 1 for sample coding).

Four pairs of coders who are either native speakers or fluent in one of the four languages (e.g. English, French, Spanish, and Portuguese) coded a shared amount which were equivalent to at least 10% of the respective languages for intercoder reliability calculations. Specifically, English language coders coded five years of data for three countries (11.1%); Portuguese coders coded one year of data for Brazil (20%); French coders coded five years of data for one country (14.29%), and; Spanish coders coded five years of data for one randomly selected country (10%). Seven variables required coders to make decision. Those are the frame variables. Coder reliability coefficients, which were calculated using Krippendorff’s alpha, reached average satisfactory levels of 0.89 for English language data; 1.00 for Portuguese data; 0.88 for French data, and 0.77 for Spanish language data.

#### 4.3. Independent variables

This study used several independent variables from online databases of renowned global organizations including the World Bank, the Center for Research on the Epidemiology of Disasters, the Global Carbon Atlas Project, and Freedom House. All are non-government organizations working either in development or specifically on climate change. Selection was based on the fact that these variables are either directly or indirectly related to how climate change may be portrayed in the media (Baettig et al., 2007).

**Climate variables:** We included two climate related variables including *CO2 Emission* amount and *Climate Severity*. *Climate Severity* was compiled from four annual figures in each of the affected countries; (1)

<sup>1</sup> Due to their extensive length, details on the selected publications, numbers of articles and words by each publication by year are available upon request.

0.07403 sea ice level paper rise rate research century arctic ocean sea-level antarctic disaster rises found extent cold temperature acceleration record natural northern year cycles levels water antarctica ozone increase melting (Scientific Evidence)

0.18325 energy gas electricity renewable power carbon industry emissions market prices cent coal costs clean cost companies wind including investment solar higher australia's sector demand development target future economy dioxide generation (Energy)

0.3477 carbon tax climate government change emissions law policy action scheme australia minister coalition regulation increase trading abbot direct government's cut cent australian target labor australia's meeting million greg repeal reduction (Domestic Politics/Regulatory Process)

0.08674 profit budget debt spending coalition pay tax years financial dollars swan fund economy public capital banks cuts election taxpayers million business palmer wayne states treasurer treasury hold assets billion commission (Economic Impact)

0.08227 china australia australian international chinese productivity environmental gillard trade china's growth strategic soil foreign relationship countries partnership leaders deal security development meetings country week foreign exports region order meeting agreement (International Relations)

0.02956 climate man young film great kids gordon richard book science ashamed educational power tree civilisation fiction green children car evil series protect future australian teach absolutely woman education technology environment (Social Progress)

0.04175 council year rise beach sea-level thorium great hot coastal house based life local effects state nsw submerge gore land boomerang companies subject historical home planning smoking parsons absolute rate predictions (Natural Impact)

0.05291 war cricket day christmas team howard words violence heard match university parents bit asked play england thing mitchell peace temperature test clarke latest misogyny arms victims pool robson australians family (Other/Unclear)

Fig. 1. Sample data coding.

number of natural disasters, (2) death tolls, (3) number of affected people, and (4) financial loss caused by those disasters. The figures were downloaded from the database of the [Center for Research on the Epidemiology of Disasters](#) (2018). The four items were transformed into z-scores. An index of severity was computed by adding the four items. Reliability tests showed acceptable internal consistency between the items (Cronbach's alpha = .75).

*CO2 Emission* was obtained from the [Global Carbon Atlas](#) (2018), which tracks carbon emission into the atmosphere by countries. The variable was measured by metric tons of carbon dioxide. *Economic development variables*: This study used two variables that represent a relatively comprehensive picture of economic development of a country both in short and long terms. They were *GDP per capita* and *GDP Growth* ([The World Bank](#), 2018).

*Governance and social development variables*: For this group, we used three variables including *Government Effectiveness* and *Press Freedom*. *Government Effectiveness* was retrieved from [the World Bank](#) (2018), which measures several aspects of governance including civil service and government independence from political pressures, policy formulation and implementation, and government's commitment to such policies. The index ranks countries from 0 to 100, with higher scores demonstrating stronger effectiveness. *Press Freedom* was adopted from [Freedom House](#) (2017), an organization that monitors and ranks the freedom of the press in 196 countries in the world. Higher scores indicate less freedom.

#### 4.4. Analysis strategy

Unit of analysis is news coverage of climate change in a year. To answer RQ1, which inquired about the use of frames across 45 countries and territories, we employed repeated measures analysis of variance (ANOVA) with Greenhouse-Geisser and Bonferroni's corrections. With comparisons between seven factors, using these two statistical procedures is expected to help minimize problems with sphericity violation and family-wise errors. Before running ANOVA, we conducted normality tests on all seven variables. Results indicated they were normally

distributed. None of the variables had their skewness and kurtosis values higher/lower than  $\pm 1$ . We also assessed whether frame use varied in the five selected years. To do that, one-way ANOVA with Bonferroni's corrections was performed.

To answer RQ2, which asked about the influence of the seven national macro factors on the use of the frames, linear regression was used. To avoid multicollinearity, we performed a series of regression tests to identify variance inflation factors (VIF) by selecting each of the predictors as the dependent variable. Test results showed that *Government Effectiveness* and *GDP per capita* had unusually high VIF values of 3.49 and 3.77. Results of a Pearson's correlation test confirmed the two variables were highly correlated ( $r = 0.805$ ,  $p < 0.01$ ). We transformed *Government Effectiveness* using  $\log_{10}$ . The transformation reduced the VIF values to below 3.0, indicating a success ([Hair et al.](#), 2010).

## 5. Findings

RQ1 asked about the most used frames overall. Descriptive data showed that of the seven, *International Relations* was the most popular frame ( $M = 0.254$ ;  $SD = 0.112$ ). The second was the *Economic Impact* frame ( $M = 0.192$ ;  $SD = 0.112$ ). *Social Progress*, however, was the least popular frame ( $M = 0.037$ ;  $SD = 0.055$ ). Results from our repeated measures ANOVA with Greenhouse-Geisser corrections confirmed the patterns, demonstrating that the means of frame use in the news media in the 45 countries and territories differed significantly ( $F(4.103, 886.245) = 119.283$ ,  $p < 0.001$ ,  $\eta^2 = 0.356$ ). Post hoc tests using Bonferroni corrections showed that the mean of the use of the *International Relations* frame was significantly higher than that of all six other frames. Specifically, the mean difference between *International Relations* ( $M = 0.254$ ) and *Economic Impact* ( $M = 0.192$ ) was 0.062,  $p < 0.001$ ; *Energy* ( $M = 0.071$ ) was 0.183,  $p < 0.001$ ; *Domestic Politics/Regulatory Process* ( $M = 0.151$ ) was 0.103,  $p < 0.001$ ; *Scientific Evidence* ( $M = 0.059$ ) was 0.195,  $p < 0.001$ ; *Natural Impact* ( $M = 0.183$ ) was 0.071,  $p < 0.001$ , and; *Social Progress* ( $M = 0.037$ ) was 0.217,  $p < 0.001$ .

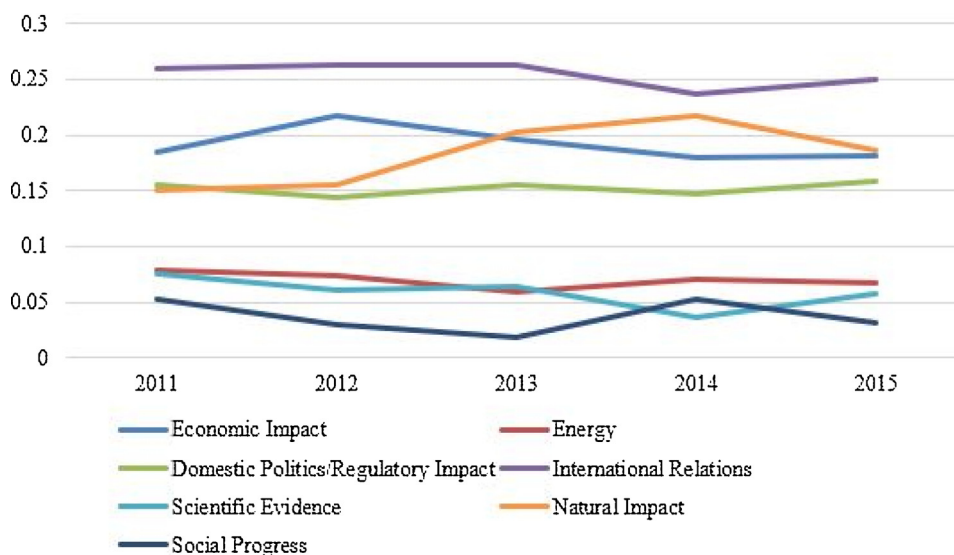


Fig. 2. Means of media's climate change frame use by year.

In assessing whether the use of the seven frames varied across the time, one-way ANOVA test results using Bonferroni correction measures demonstrated that two frames *Natural Impact* ( $F(4, 214) = 2.909, p < 0.05$ ) and *Social Progress* ( $F(4, 214) = 2.979, p < 0.05$ ) saw statistically significant difference between the five years. However, post hoc tests using Bonferroni corrections showed no statistically significant difference across all 28 pairwise comparisons. This means time is not a factor in how the news media from these countries frame climate change (Fig. 2).

RQ2 asked about the influence of the six socioecological variables on climate change frame use. Results from our linear regression tests indicated that *GDP per capita* was a strong predictor of the use of four out of seven frames (See Table 1). Specifically, *GDP per capita* had significant and positive relationships with two frame variables including *Scientific Evidence* ( $\beta = 0.306, p < .01$ ) and *Domestic Politics/Regulatory Process* ( $\beta = 0.757, p < .001$ ). This means that the higher GDP per capita a country has the more likely its news media would frame climate change as issues of science and domestic politics. Two other frame variables that saw significant relationships with *GDP per capita* including *International Relations* ( $\beta = -0.732, p < .001$ ) and *Natural Impact* ( $\beta = -0.335, p < .01$ ). This means the press from richer countries are less likely to discuss climate change from the natural impact and international relations angles.

*CO2 Emission* was associated with two frames including *Energy* ( $\beta = 0.246, p < .01$ ) and *Domestic Politics/Regulatory Process* ( $\beta = -0.179, p < .05$ ). This means that the news media from countries that are larger carbon emitters are more likely to discuss the issue of climate change in relations to energy but less likely to portray it as a domestic politics issue. *Climate Severity* was a statistically significant predictor of

the use of *Natural Impact* frame ( $\beta = 0.153, p < .05$ ). This indicates that the news media from countries that suffer more from natural disasters (e.g., The Philippines, India, Gambia, etc.) tend to frame climate change through the lens of natural impact. *Government Effectiveness* also had a statistically significant relationship with the *Natural Impact* frame ( $\beta = -0.208, p < .05$ ). This demonstrates that in countries with an effective government, climate change is less likely to be framed in the light of natural disasters.

## 6. Discussion

This study investigated the use of frames in 45 countries and territories' media portrayal of climate change/global warming, an environmental phenomenon that influences every country in the world. It used a big data approach to analyze 37,670 articles in four different languages to identify seven broad frames that the news media had frequently used in covering climate change. Findings showed that overall, the press from the countries in the sample favors the *International Relations* frame the most. This reflects the fact that climate change is a global issue that needs to be dealt with at the global level.

*Economic Impact* was the second most popular frame in the corpus. The economic aspect has always been an important factor, driving debates on climate change, as acknowledging, committing to fighting climate change will have significant impacts on every economy in the world (Burke et al., 2018). In addition, even when natural disasters and climate change would be brought into the discussion, the loss caused by these events would eventually be materialized in the economic sense. These are possible reasons why the news media tend to prefer the *Economic Impact* frame.

Table 1

Linear regression results on frame use in the news.

Predictor	Econ Impact	Energy	Domestic Politics/Reg	Intr'n'l Relations	Natural Impact	Scientific Evidence	Social Progress
Climate Severity	0.128	0.007	0.002	-0.049	<b>0.153<sup>†</sup></b>	0.027	0.073
CO2 Emission	-0.050	<b>0.246<sup>**</sup></b>	-0.179 <sup>*</sup>	-0.029	0.016	0.109	-0.038
GDP Growth	0.026	-0.066	0.059	-0.025	0.012	0.016	0.040
GDP per capita	-0.050	0.145	<b>0.693<sup>***</sup></b>	<b>-0.732<sup>***</sup></b>	<b>-0.333<sup>***</sup></b>	<b>0.267<sup>**</sup></b>	-0.192
Press Freedom	0.086	-0.078	-0.083	-0.055	-0.070	-0.110	0.092
Gov'n't Eff'ness	-0.161	0.037	0.094	0.083	<b>0.208<sup>†</sup></b>	0.001	0.065
R <sup>2</sup>	<b>0.078</b>	<b>0.204</b>	<b>0.497</b>	<b>0.575</b>	<b>0.102</b>	<b>0.125</b>	<b>0.071</b>

<sup>\*</sup>  $p < 0.05$ .

<sup>\*\*</sup>  $p < 0.01$ .

<sup>\*\*\*</sup>  $p < 0.001$ .



*Social Progress*, however, was the least used frame in the corpus, with only nearly 4% of the content was devoted to covering new lifestyles or social development related to climate change.

The major focus of this study is to investigate the influence of six economic, environmental, political and media system variables on how the press frames climate change. Previous research found that these explanatory factors are important contextual variables, contributing to setting national priorities (Bentley et al., 2015), influencing societal values (Graaf and Evans, 1996), shaping public concerns (Fairbrother, 2012), as well as driving the media agenda (Schäfer et al., 2013). Findings of this study show that they are influential in shaping the news discourse on climate change, making salient climate change aspects that are relevant to their countries' economic, political, and environmental situations, while obscuring others that are not.

Of all the factors, GDP per capita, which has been typically proxied for how affluent a country is, is the strongest predictor. The media from richer countries are more likely to frame climate change as an issue of domestic politics. This, perhaps, is because the voice of climate skeptics in richer countries gained stronger prominence in the media (Boykoff and Rajan, 2007). In these countries, climate change is a highly contested issue with multiple groups, in their efforts of politicizing climate change, trying to influence the media agenda and policymaking. Additionally, the balanced reporting norm in the media in some democratic countries may have compelled journalists to include various views on climate change, thus affecting the public's and decision makers' perception of climate change. Such reporting practices also give a possible explanation as to why the media in countries with higher GDP are more likely to frame climate change as a domestic politics issue (Boykoff and Boykoff, 2004; 2007). The news media from richer countries tend to frame climate change as a scientific issue. This finding makes sense as wealthier countries have more financial resources devoted to scientific research on climate change. News content from poorer countries, however, is more likely to emphasize the international relations and natural impact aspects of climate change. These are developing countries, where resources to mitigate the effects of climate change are sparse. Thus, they need international support in dealing with this transnational environmental phenomenon. The media portrayal of climate change has, therefore, reflected this reality.

This study also discovered that the media from countries with more severe weather tend to frame climate change with an emphasis on its natural impact. It is possible that in reporting on the issue, journalists tend to look for the cause of natural disasters. Thus, climate change-related issues emerged in the media coverage of countries with more severe weather (i.e., The Philippines, Gambia, etc.) more frequently.

Theoretically, this research found that the media from different countries frame the same transnational issue differently. It unveiled the influence of national traits on how the media portray a global issue. In comparing how the media in 45 countries cover climate change, this research has identified the connection between contextual factors and media frame use, an area that has often been overlooked by previous framing research. This study confirmed that development levels and the political and social environment of individual countries have a strong impact on media framing, contributing to the construction of the nationalized version of a global phenomenon in the media content.

## 7. Conclusion

Overall, this study found that there are significant differences in how the press from the 45 countries and territories frame climate change, a transnational environmental phenomenon that will affect every country in the world through increasing temperatures, more frequent natural disasters, and rising sea levels amongst other effects. This research speaks to the need of a scholarly examination of climate communication in a global context that includes a large variety of countries, an area that has seen insufficient interests from news media framing researchers (Schafer & O'Neil, 2017). With a rapid growth of

internet penetration, news media researchers have seen an increasing trend of journalism transcending national boundaries to align with the global news media agenda, especially regarding emerging global issues. But as findings of this study show contemporary journalism practices remain "particularized in specific local context" (Reese, 2008, p. 241).

Findings of this study reinforce such a hypothetical assumption that while journalistic norms are universally similar (Boykoff and Boykoff, 2004), differences in journalism practices (i.e., framing) may remain as dependent variables of broader social and political systems. Specifically, socioeconomic, environmental, and political aspects of a nation can influence how the media cover an issue. It contributes to the framing literature by identifying factors that shape frame use in the news, an area that has often been neglected in framing media research. Results of this study show that although such influences at meso (e.g., organization) and micro levels (e.g., individual journalists) are often more apparent and have been empirically proven, framing process needs to be assessed in a wider political, social, economic and social context in which media messages are constructed. Scholars have acknowledged the important role of the media in interpreting and spreading information on scientific, social, and political issues. How the media frame climate change has presumably affected the public knowledge of climate change. Finding out what factors influence the framing process of this natural phenomenon is therefore important in understanding the cultural politics of it.

This study is not without limitations. It could have investigated the media from more countries in the world to see whether suppositions of the influence of national traits on media coverage of climate change still hold. It could have included more national socioeconomic and environmental factors as independent variables to find out about their predictability on how the press frames climate change. Future studies should examine such an issue with more types of news media from countries. The use of broad issue-specific frames did not provide nuanced understanding of sub-national differences in media framing. Subsequent investigations should consider using a different way to operationalize frames to take into account these differences.

The theoretical implications of this study are significant. Framing theorists have, for long, argued that framing happens or media messages are constructed within a specific social, cultural, political and economic context (Carragee & Roefs, 2006; Entman, 1993; Scheufele, 1999). Such a context is also helpful for frames to be understood by the message receivers and thus to have effects. However, previous framing research, especially comparative quantitative ones, has failed to empirically assess the relationships between macro factors of a nation and the use of media frames in the country. This presents a theoretical and methodological gap in the literature of this widely used theoretical framework. This study, however, contributes to filling in that gap by investigating the influence of factors representing the wider political, economic and cultural environment of a nation and the media framing process. Results of this research demonstrate that macro factors (e.g., level of development) should be taken into account to better fathom how the media frame an issue. The incorporation of these factors would allow for better explanation of framing, putting this journalistic practice in a context where various types of influence could affect the construction of media messages. Methodologically, through its use of national structural variables, this study suggests a unique approach to operationalizing the long-time assumption in framing literature that the macro political and economic factors affect how media messages are formed. In terms of climate change, investigating the influence of these structural variables on the media coverage of the issue helps discern the dynamic of powers in addressing this global environmental phenomenon.

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