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Triggers for policy change: the 3.11 Fukushima meltdowns and nuclear policy continuity

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ABSTRACT

The Fukushima meltdown in Tohoku, Japan, served as catalyst for some nations, including Germany, Belgium and Italy, to alter nuclear policies but had no impact on the approaches of a number of others such as Vietnam, China and Russia. Why, despite facing the same focusing event, did private- and state-owned utilities in some countries alter their nuclear energy policies while others kept the status quo. Adopting a mixed-methods approach to understand this variation in energy policy outcomes, quantitative analysis of 90 countries based on a new, *sui generis* dataset shows that strong voice/accountability is negatively correlated with changes in nuclear power programs while media openness and political stability are positively connected with atomic energy decisions. Using in-depth case studies of Germany and Japan, the role of domestic political institutions and country-specific norms is explored to show more precisely how actors interacted with ideas to influence energy decisions.

KEYWORDS Nuclear power; policy change; Fukushima; Japan; Germany; quantitative; qualitative

Introduction

The 3.11 compounded disasters in Tohoku, Japan, began with an offshore magnitude 9.0 earthquake on 11 March 2011 that set off a series of massive tsunamis. When these 20-m waves reached the coast 40 min later, they took more than 18,900 lives, destroyed thousands of homes and businesses and shut down the main and backup cooling systems at the Fukushima Dai-ichi nuclear power plant. With the diesel generators and battery systems offline, three reactors melted down within 48 h, releasing radioactive contamination into the air and water table in Ōkuma and Futaba. The Japanese government rated the accident as seven on the international nuclear event scale, the same category as the 1986 Chernobyl meltdowns in Ukraine. Several towns and villages in the area remain off limits to former residents

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and, while physical health impacts from radiation have yet to manifest among Fukushima residents, experts have documented extensive physical and mental health problems due to related anxiety and stress (Iwasaki *et al.* 2017).

The private- and state-owned power utilities in different countries have responded to the disaster in very different ways (Hayashi and Hughes 2013). Some, such as those in Israel and Venezuela, had considered adopting nuclear power before the disaster but then abandoned it soon afterwards. Operators in Vietnam, China, Turkey and Russia have 'stayed the course' with nuclear power, while those in other nations, including Germany, Belgium and Italy, used the event as a catalyst to exit the technology. Here, we investigate why the Fukushima nuclear meltdowns served as a focal point for policy change for some, but not most, energy utilities (Birkland 1997).

We use a mixed-methods approach to policy change, utilizing a new dataset of nuclear power decisions in 90 nations along with 2 extended case studies of energy policy in Japan and Germany. Our large-*N* analysis of 90 countries includes developed and developing countries along with nations with various levels of commitment to nuclear power. While it does not encompass all nation-states, it serves as a broadly representative sample of them (see below). Our small-*N* analysis focuses intensively on Japan and Germany because these countries serve as critical cases for the theories uncovered through large-*N* analysis. Japan, which hosted the reactors that melted down, has chosen to stay the course with nuclear power despite widespread public opposition to the policy (Samuels 2013). Germany, although physically distant from the event, used Fukushima as a critical decision point to discontinue its own well-developed nuclear fleet.

We contribute to the existing literature in several ways. First, while previous scholars have looked at energy decision-making either through large-*N* analyses (Fuhrmann 2012) or small-*N* case studies (Hindmarsh and Priestley 2016, Bernardi *et al.* 2018), we are among the first to use a mixed-methods approach to the issue of post-Fukushima energy policy (Lieberman 2005). Next, our research goes beyond previous quantitative investigations focused on energy decision-making by employing a new dataset that brings together a variety of measures of civil society strength, demographics, governance and energy market conditions for each country included. We take seriously not only the economic, market and demographic factors that can influence decision makers toward one energy source or another but also the governance structures and media environment in which those political elite operate. Finally, we build on the socially constructed nature of disasters and their interaction with political systems (Hughes 2016).

Fukushima, as a natural-technological disaster, produced geographically localized health, agricultural, livelihood and housing effects, yet it had global effects in terms of policy change. While the potential for disasters acting as trigger events for critical junctures in the country in which they occur has been well documented (Olson and Gawronski 2003), this is not the case for the international effects of a single crisis. Situations in which a single crisis produces important transformations in domestic public policy at home or abroad are quite rare (t'Hart and Boin 2001). Our comparative study attempts to shed light upon how and why a crisis can become a critical juncture in the political contexts of countries physically unaffected by it.

We first look at the theories that can help explain decision-making about energy sources then move to the data and results from our large-*N* analysis. We then process trace cases of decision-making over the nuclear power programs in Japan and Germany to show precisely how domestic coalitions responded to Fukushima in terms of national energy frameworks. We conclude with larger observations about any potential nuclear renaissance in the post-Fukushima twenty-first century.

Theories

We use past studies to identify core categories of causal mechanisms that may affect energy decisions, including energy market conditions, party politics, demographics, the strength of civil society and quality of governance.

Speaking broadly, the conditions in the *energy market* may have a profound impact on decision makers and energy firms in countries considering or already undertaking nuclear investment (Scalise 2013). Countries which already have a profound investment in atomic energy may envision such spending as sunk costs which must be recovered and therefore seek a return on investment even when public opinion no longer supports the technology. Thus, countries with larger existing fleets before a major nuclear accident may wish to continue using the technology while those with smaller (or nonexistent) investments have more policy space in which to maneuver postcrisis. In addition to this quantitative dimension, the time cycles related to nuclear power plants are an important factor.

Two important points in time are the amortization period and the assumed operating life of a reactor, which has been roughly 40 years for most nuclear nations. Not yet having reached the first or second of these two points can increase the economic incentive for continuing to support the technology. On the other hand, reaching one or both of these two points can diminish market resistance to discontinuing this means of energy production and make an exit easier. To measure the conditions of the energy market, we identified the number of reactors in the country in

December 2010 (3 months before Fukushima) and the percentage of energy generated from nuclear power (before Fukushima).

Beyond energy market conditions, domestic politics, especially *party politics*, may influence politicians and relevant private sector actors. From a macroeconomic perspective as well as seen from various policy fields, the question of whether parties matter in public policy trajectories has delivered mixed results (Persico *et al.* 2012). However, when applied to the field of environmental and energy policy, parties do seem to make a difference (Egle and Zohlnhöfer 2007, Heintz 2010). Studies of energy decision-making have regularly referenced environmental-themed parties, such as the Green Party, as important actors in the policy process (Kitschelt 1986, AQ4 Böcher and Töller 2012). This is because energy technologies are no longer only presented as a solution to the energy needs of a country but can also be subject to contestation in the public sphere, which can in turn influence policy decisions (Roose 2010). We measure the potential influence of single-issue parties focused on environmental issues such as nuclear power through Green Party vote share.

In addition to energy markets and politics, national *demographics* may push politicians and private actors toward certain configurations of energy choices (Park and Sovacool 2018 examine the geopolitics of this phenomenon). Larger nations may require consistent baseload supplies of energy for businesses, homes and manufacturing while smaller nations – such as New Zealand, Sweden and Denmark – may be able to rely on renewable energy sources such as wind and solar along with other nonnuclear sources such as liquefied natural gas (LNG) or oil. Further, the wealth of the nation may also indicate different energy needs: advanced, highly developed nations will already have diverse energy sources and may not need to add (or supplement) nuclear investments. In contrast, poorer, developing nations with rapidly growing populations may feel that they require nuclear energy to meet increasing power demand. To capture these trends, we include measures of population (in 1000s) and per capita GDP.

Some scholars have argued that the overall strength and activities of *civil society* strongly influence public and private sector policies (Aldrich AQ5 2008; see also Bernardi *et al.* 2018). We build qualitative and quantitative models on past findings about the interaction between the civil society and the media, a set of institutions that can set the agenda and frame issues for political elites. Societies that are more open to citizen input (e.g. free press coverage of disasters), and where citizens regularly participate in informal political processes such as protests, marches and demonstrations, may be less likely to pursue unpopular nuclear energy goals after disaster. In such societies, the media may more regularly seek out or at least include antinuclear statements from counter-experts in

civil society organizations and emphasize public sentiment on the technology rather than technocratic or bureaucratic perspectives.

Similarly, utilities and decision makers in a society where the international nongovernmental organization (NGO) Greenpeace is present, and a society with more NGOs per capita, may be less likely to pursue nuclear power because of the political pressure these groups can wield on decision makers directly and indirectly. To capture the underlying openness of the policy process, its population and the activity level of its civil society, we utilize a number of proxies, including democracy rating, media rating, Greenpeace absence/presence, protest absence/presence and NGOs per capita.

Finally, beyond party politics and civil society, the structures of government – its *governance* – may also affect decision-making on energy. Politically stable governments may also be more likely to push nuclear power than authoritarian ones, where leaders are less concerned about audience costs. Personalist regimes, governing monarchies and one-party states among the authoritarian countries tend to last longer than multiparty regimes (Geddes 2003) and are more stable and responsive. To capture such governance conditions in each country and their theoretically ambiguous outcomes on energy policy, we look to measures including voice/accountability, political stability and government effectiveness.

Large-*N* analysis

We linked proxies for each of the theories described above – energy market conditions, demographics, national party politics, civil society and governance – to measurable factors at the national level. Sources used to capture these characteristics are in Appendix 1 and the full list of countries included in our dataset in Appendix 2. Descriptive statistics for the variables in our large-*N* dataset on 90 countries can be found in Table 1. All the independent variables were captured in 2010 (or the nearest available year before the 2011 disaster) while our outcome variable was measured from mid-2011 onward when the meltdowns occurred (using the latest data since that point).

The 90 countries selected cover every region of the world and encompass democratic and authoritarian regimes, states with nuclear power reactors and those without, wealthy and poor. Overall, our sample encompasses nearly 85% of the world's population. Although some scholars (see, e.g. Hug 2003) contend that nonrandom samples in large-*N* studies can lead to selection bias, the countries included here were not 'self-selected' as a function of the outcome of interest. Rather, the countries selected provide variation on both the dependent and independent variables and reflect the state of the world in 2011. For example, 24% of countries in the world were

Table 1. Descriptive statistics.

Variable	*N*	Mean	Std. dev.	Min	Max
Dependent variable					
Policy outcome	90	1.133333	0.6217048	0	2
Energy market					
Number of reactors	90	4.811111	14.26152	0	104
Percentage energy from nuclear	90	8.807778	16.197	0	74.1
Party politics					
Green Party vote share	88	0.016461	0.0431632	0	0.222222
Demographics					
Population (in 1000s)	90	65,894.42	191,675.1	318.041	1340,000
Per capita GDP	89	20,375.11	22,573.93	530	111,813
Civil society					
Democracy rating	90	1.344444	0.8095096	0	2
Media rating	89	1.123596	0.8369347	0	2
Greenpeace absence/presence	89	0.426966	0.4974398	0	1
Antinuclear protest presence	89	0.325843	0.4713443	0	1
NGOs per capita	82	1.27E-05	0.0000164	4.70E-08	8.28E-05
Governance					
Voice/Accountability	90	0.205778	1.004499	−1.73	1.6
Political stability	90	−0.029111	0.9734782	−2.7	1.4
Government effectiveness	90	0.413444	0.9426548	−1.34	2.2

authoritarian in 2011 compared to 21% in the dataset. The dataset is representative enough for us to make generalizable claims about the effect of the Fukushima disaster on policy change.

The outcome of interest is the change (or lack thereof) in nuclear energy policy carried out by private utilities and state-owned electricity producers in each nation after the Fukushima meltdown. Our analysis used a categorical outcome with three groupings: reducing or ending nuclear power, status quo and increasing use of nuclear power. Given the nature of our explanatory variable – an ordinal, categorical measure – we estimate our coefficients using a maximum likelihood estimate ordered probit (oprobit) model. For results for our two models, see Table 2.

Our ordered probit model revealed three variables to be statistically significant. One (related to voice/accountability) suggests that decision makers in countries where citizens found it easy to hold officials responsible for political choices were more likely to shift away from atomic energy. Countries with more authoritarian leaders were more likely to ignore any concerns in civil society and either move toward or continue with nuclear power.

The remaining two statistically significant findings (related to *political stability* and *media rating*) indicate that (potential or actual) nuclear operators in countries which are autocracies or under non-democratic governance and thereby more stable, i.e., have fewer or no changes in political party or administration (e.g. China) and were more likely to increase use of nuclear power. Indeed, 63% of the countries that ramped up their nuclear programs in the wake of the meltdowns were semi- or fully autocratic. This

Table 2. Estimated regression coefficients.

Variable	Estimated OLS coef w/SE	Estimated OLS coef w/SE and MI	Oprobit coef/ SE	Oprobit coef w/SE and MI
Number of reactors	−0.005	−0.001	−0.014	−0.007
	0.006	0.006	0.014	0.013
Percentage energy from nuclear	0.001	−0.003	0.002	−0.005
	0.005	0.005	0.011	0.010
Green Party vote share	−1.631	−2.168	−4.069	−5.255
	1.650	1.677	3.737	3.661
Population (in 1000s)	0.0000011*	0.000	0.000	0.000
	0.000	0.000	0.000	0.000
Per capita GDP	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000
Democracy rating	−0.095	−0.044	−0.248	−0.160
	0.208	0.206	0.470	0.443
Media rating	0.544***	0.388*	1.345***	0.977***
	0.208	0.202	0.491	0.446
Greenpeace absence/presence	−0.115	−0.119	−0.284	−0.279
	0.191	0.189	0.436	0.407
Antinuclear protest presence	0.158	0.072	0.379	0.167
	0.180	0.183	0.414	0.396
NGOs per capita	1969.413	858.805	4407.424	2285.619
	5010.206	5195.273	10,809.800	10,947.220
Voice/Accountability	−0.575**	−0.399	−1.423**	−1.02*
	0.292	0.279	0.697	0.621
Political stability	0.316***	0.285**	0.813***	0.717***
	0.116	0.109	0.286	0.251
Government effectiveness	−0.120	−0.164	−0.284	−0.327
	0.168	0.163	0.370	0.347
Constant	0.922	1.074		
	0.360	0.358		
Cut Point 1			−0.999	−1.241
Cut Point 2			1.349	0.976
Number of observations	77	86	77	86

In two models, multiple imputation (MI) was used to fill in missing variables for Green Party vote share and NGOs per capita. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

reinforces the pattern observed for *voice/accountability*: when decision makers benefit from political structures and institutional designs that shield them from shifts in public opinion that could challenge their positions in government, they are able to pursue more aggressive nuclear power programs.

The positive coefficient for the media rating variable is more challenging to interpret; as shown in our case studies, the media of certain nations may be biased toward or influenced by pronuclear ideas and therefore reinforce pronuclear sentiments from business interest groups and pronuclear politicians. Japan's media, for example, long supported the government's push for energy independence through an indigenous, commercial nuclear fleet. In authoritarian regimes such as China, authorities regularly seek to influence even social media through deliberate interventions meant to drown out citizen opposition (King *et al.* 2017).

To better evaluate these coefficients, we use graphics that capture our predictions about the relationships between our variables of interest, namely political stability and voice and accountability with nuclear policy change. The software program Clarify provides both extrapolations and information about the uncertainty of those predictions (Tomz *et al.* 2001). Figure 1 shows that as accountability for the regime increases – holding all other variables at their means – the regime would move toward *decreasing* the use of nuclear power (or maintaining the status quo). Figure 2 shows that as political stability increases, countries are more likely to *increase* their use of nuclear power.

These findings suggest that decisions on the expansion or suppression of nuclear energy policy reflect governmental arrangements, the degree to which constituents' voices are amplified or silenced, and freedom of the press. Notably, many of our measures of civil society (including the presence of antinuclear protests, the siting of Greenpeace offices and the number of NGOs per capita) did not reach statistical significance despite past qualitative findings about the links between civil society and nuclear power decisions (see, e.g. Aldrich 2008, Dusinberre and Aldrich 2011). Instead, it seems that the ability of constituents to hold elites accountable

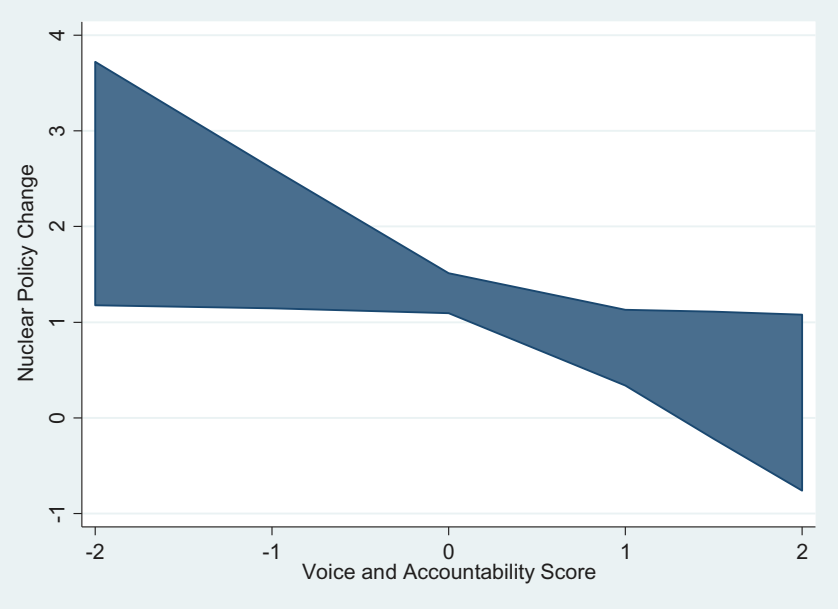

Figure 1. Relationship between voice/accountability and nuclear policy change.

Notes: N = 90, number of simulations = 1000, regression model. All variables (number of reactors, percentage energy from nuclear, Green Party vote share, population, per capita GDP, democracy rating, media rating, Greenpeace absence/presence, antinuclear protest presence, NGOs per capita, political stability, government effectiveness) held at their means except for voice and accountability and score, which varied between −2 and 2. The shaded area indicates the 95% confidence interval around the predicted value.

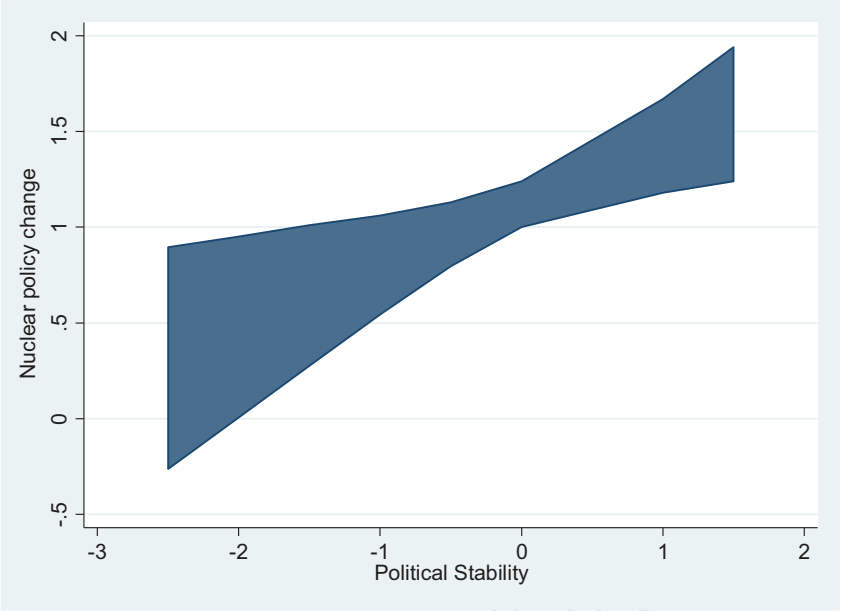

Figure 2. Political stability and nuclear policy change.

N = 90, number of simulations = 1000, regression model. All variables (number of reactors, percentage energy from nuclear, Green Party vote share, population, per capita GDP, democracy rating, media rating, Greenpeace absence/presence, antinuclear protest presence, NGOs per capita and government effectiveness) held at their means except for voice and political stability, which varied between −3 and 2. The shaded area indicates the 95% confidence interval around the predicted value.

for their political decisions is more salient for policy change than, for example, protests against nuclear power. This does not negate the rich qualitative work linking civil society to nuclear power decisions but, instead, highlights how, *in general*, standard measures of civil society strength are not correlated with changes in nuclear power policy.

To make sense of the complex relationships among the actors and institutions in the quantitative models, we need a fine-grained analysis of the policymaking process within some of these cases. Cases of Japan and Germany can help us better understand how constellations of political actors influence energy decision-making and to see what factors may have been overlooked in our quantitative approach (Lieberman 2005).

Small-*N* analysis

Germany and Japan are extreme test cases for our theories of political change (Brady and Collier 2010). Before the meltdown, Germany had 17 atomic reactors and generated some 20% of its electricity from nuclear

energy; yet, within 2.5 months of the accident, the government announced its intention to shut all plants by 2022 along with the immediate closing of 8 of its online reactors. In contrast, Japan, the actual site of the accident and also the only nation ever to experience the impacts of nuclear weapons, has sought to restart its nuclear power plants. Prime Minister Shinzō Abe of the Liberal Democratic Party (LDP) reversed his party's campaign pledge and announced his intention to restart nuclear power plants soon after his successful 2012 campaign. The government continues to pursue this goal despite widespread public opposition to nuclear power. Due to a stricter regulator and court challenges, a handful of nuclear power plants have come online since the accident and the government continues to predict that nuclear power will produce one-fifth of Japan's energy by 2030.

Japan

While many observers expected nuclear plant operators in Japan to exit the field after the Fukushima disaster, they have not (Samuels 2013). Rather, the Abe administration has emphasized the need for Japan to maintain its nuclear power program. The government, electric utilities and business supporters justify the continuation of atomic energy in terms of environmental impact (low carbon dioxide emissions), economic costs (due to imported LNG and oil),and energy security (freeing Japanese from dependence on unstable markets and countries). By summer 2018, Japan's new nuclear regulator had allowed the restart of several reactors, with the newest government energy plan calling for 29 reactors to be back online by 2030 (Aldrich *et al.* 2015).

Several factors have contributed to Japan's continued involvement with nuclear power despite the Fukushima meltdowns and resulting widespread opposition. The government itself has, since the earliest days of government-sponsored research in the 1950s and the start of commercial nuclear power in the mid-1960s, promoted nuclear power through a variety of public policy instruments designed to sway 'hearts and minds'. Even before the first nuclear power plants were constructed and managed by private utilities, the central government assisted in their siting by providing maps of technically feasible areas more favorable to siting and less prone to resistance. Once the regional monopolies began building plants, the central government provided large financial incentives for host communities, public awards ceremonies for local government officials who supported the technology, and along with 'Atomic Energy Day,' a variety of pronuclear science curricula on atomic energy for children (Aldrich 2008). The government has held and furthered its own consistent pronuclear position.

As a result, Japan's energy framework rests on a coalition of 'reciprocal consent' between private energy utilities, regulators in the central

government and political parties (Samuels 1987). Much like the Iron Triangle described in the US policy arena where Congressional committees, interest groups and civil servants insulate issues such as defense spending, this constellation of nuclear actors, also known as the *genshiroku mura* (nuclear village), has been remarkably stable over the post-World War II era (Hymans 2011). As a result of regular pronuclear public relations campaigns, incentives, and soft social control tools, until the Fukushima disaster national surveys showed that some two-thirds of the country wanted to increase the number of nuclear power plants.

Public support for nuclear power flipped into widespread opposition following the Fukushima disasters. Opposition has not translated into political outcomes. Civil society's ability to influence Japanese nuclear policy has been extremely limited not only because of a lack of access points to policy decisions about the technology (Cohen *et al.*1995) and relatively few national-level antinuclear groups (Aldrich 2008) but also because laws made it challenging for nonprofits to effectively organize and mobilize against the state (Pekkanen 2000). While there have been a handful of recall elections against pronuclear mayors and some local assemblies, such as Maki-machi, have passed citizens' referenda against nuclear plants, most pronuclear politicians at local, regional and national levels have suffered few electoral consequences. After the disaster, large-scale *datsu genpatsu* (antinuclear) demonstrations with more than 120,000 participants across Japan plus many citizen referenda had no noticeable impact on the Abe administration.

While the average Japanese resident opposes nuclear power, and various antinuclear groups such as the Citizens' Nuclear Information Center have organized antinuclear movements, the media have not amplified citizen interests or pushed for strong governmental oversight of the industry. Japan's reporters hold close ties to bureaucrats and politicians through a *kisha kurabu* (press club) system, which discourages reporters from reporting information damaging to their sources in the government (Freeman 2000) and creates restrictive 'cartels of the mind' (Hall 1997). Independent reporters, foreign news journalists and others outside the mainstream press are regularly excluded and find it hard to gather relevant information. Politicians punish reporters who investigate potentially harmful stories by denying them access and have even used collective punishment against entire kisha clubs when members have violated these unspoken agreements on 'civility'.

As a result, Japan's media have not served as a counterbalance to government policy, whether of civil servants or politicians (Okumura 2009). Rather, prominent media outlets have followed the government lead in supporting nuclear power. Matsutaro Shoriki, editor of the *Yomiuri Shinbun*, one of Japan's three largest newspapers, for example,

began promoting the peaceful use of nuclear energy as early as the mid 1950s when then Diet member Yasuhiro Nakasone pushed for government funds to research atomic energy. Matsutaro's paper ran a series of Op-eds and articles that sought to persuade the public of the importance of supporting 'Atoms for Peace'. Later, following the Chernobyl accident, all Japan's major newspapers continued to support domestic nuclear power, emphasizing the inherent safety of Japan's engineering in contrast to that of Ukraine (Abe 2013). More recently, Japanese television coverage of the Fukushima accident regularly relied on pronuclear Japanese government sources for information about the event rather than seeking out neutral nuclear experts or antinuclear activists (Imtihani and Mariko 2013). Japan's acquiescent media have missed a series of opportunities, including past disasters and Fukushima, to push the government for energy alternatives and policy change.

One additional political factor has reduced the potential pressure on decision makers: Japan has no Green Party to speak of. Whereas a number of mainstream political parties in Europe partner with Green Parties, the long dominant LDP and the underdog Democratic Party of Japan have not. These national-level characteristics differ drastically from those in Germany.

Germany

Immediately after 11 March 2011, the nuclear disaster in Japan dominated the German media and the national political agenda. Despite the lack of any physical risk to the European population, the disaster resulted in a major change in Germany's energy policies. In the context of repeated attempts at energy sector reform for over 10 years, the most striking change was that the pronuclear government suddenly proclaimed an exit from nuclear energy. Several factors in the German context made Fukushima a window of opportunity that mobilized not only large protests against nuclear energy but also convinced long-term nuclear policy advocates of the necessity to promote alternative energy sources instead. These include the nature of the German media coverage of nuclear energy, the electoral landscape marked by antinuclear activism and the path dependency of energy reform.

When compared with the general trend apparent through our large-*N* analysis, Germany presents a special case of media influence. Instead of being biased toward pronuclear ideas, many important media outlets had inherently antinuclear positions in their reporting based on historically embedded framing of nuclear energy, which contrasted starkly with reporting in other European countries and Japan. Since the early 1970s, media

reporting on nuclear energy in German has been highly politicized (Kepplinger 1988) and focused on potential risks (Kepplinger and Lemke 2014).

Three days after the Fukushima accident, German chancellor Merkel shut down all German nuclear reactors (Merkel 2011). This decision ensured intense coverage of the domestic debate in parallel with reporting on the situation in Japan. German media coverage of nuclear energy after Fukushima became a debate about the need to exit from the technology, which was rapidly decoupled from events in Fukushima, with 80% of media reports including statements for or against a German nuclear exit (Arlt and Wolling 2014, Weiß *et al.* 2014). Approximately three-quarters of those statements supported a nuclear exit. Opinion polls show that positive and negative attitudes toward nuclear energy were more or less on par in the years leading up to 2011, while after Fukushima, a majority of the German public supported a rapid nuclear exit.

In parallel with the media's central role in presenting a nuclear exit as the default position after Fukushima, the political actors themselves rapidly and pro-actively attempted reform. The pronuclear parties in power had previously faced opposition on an institutional level from antinuclear parties and civil society. After Fukushima, antinuclear movements took on a new force as they swept the country based on a broad base of domestic. The government's radical shift in energy policy can therefore be attributed to an electoral strategy aimed at neutralizing this issue in view of upcoming elections. Fukushima occurred at a time when nuclear energy had become a point of contention that could mobilize electorates and reconfigure ruling coalitions.

Historically, the importance of the nuclear question in the partisan landscape can be attributed to the rise of the Green Party. Protests against the construction of reactors in the 1970s formed into a national social movement that entered the political discourse as awareness of nuclear risks grew (Roose 2010). As in Japan, the German federal government initially took a proactive role in promoting and funding research and development on nuclear energy technology during the 1950s and 1960s. This situation had fundamentally changed by the 1980s, when nuclear energy became a symbol for the all-encompassing risks of modern technology (Bargheer 2018). The creation of the Green Party in 1980 institutionalized the environmental movement. Increasingly, federal policymakers from leftwing parties saw nuclear energy not as an economic necessity but as an environmental problem. Thus, alternative approaches to energy policy were reflected in the institutional landscape, the energy portfolio being shared by different ministries and governmental agencies, pursuing differing priorities of environmental protection or economic and industrial goals (Huenteler *et al.* 2012). In the partisan and electoral landscape, by 2011, supportive and

antagonistic attitudes toward nuclear energy formed a deeply entrenched divide, separating Social Democrats and Greens from Christian-Democrats and Liberals.

In elections after Fukushima, the Green party was the only party that did not lose votes but gained comparatively to their previous positions (by an average of 8.9%). For the first time in 58 years, the Christian-Democrats lost one of their strongholds (Baden-Württemberg) to the Green party. By performing a rapid U-turn on her party's previous position, Merkel imposed a top-down policy change on her party between the disaster and the elections. As a result, the Christian-Democrats minimized their losses and performed, on average, better than the Liberals and Socialists. These results underline what a central force the Green party had become for German nuclear policy. With Fukushima and subsequent media coverage ensuring that nuclear energy was central in the upcoming elections (Steltemeier 2012), the threat of the antinuclear Green party and Socialists profiting from this issue made a nuclear exit the only feasible way forward for the ruling coalition.

Finally, there is a very strong form of path dependency in Germany's nuclear policy reform since the turn of the century. Unlike the continued model of corporate energy governance in Japan, Germany was on a path that moved energy policy away from 'reciprocal consent' between lawmakers and corporations toward a reassertion of political hierarchy. The back and forth between anti- and pronuclear reforms slowly led away from drawn-out consensual decision-making procedures with the energy corporations toward stronger political leadership from the top down.

In 2002, the Social Democratic–Green government negotiated a phased-out nuclear exit to be completed earliest by 2022. This was overturned in 2010, when the remaining power plant runtimes were again prolonged in a contract signed with the operators. In this decision, nuclear energy was presented as a necessary evil bridging the way toward renewable energy. It proved to be a highly unpopular move, criticized as giving in to corporate pressure even by members of the ruling party. It seemed as if the government was being pushed around by energy companies who refused to compromise on issues such as the taxation of nuclear fuel. Fukushima thus provided an opportunity to marginalize corporate actors in energy policy reform. The nuclear exit finally voted on 30 June 2011 reverted to run-times similar to those in the 2002 exit plan and was put in the context of a long-term global energy transition toward sustainable energy.

In Germany, intense media coverage, the partisan and social movement landscape and the path-dependency in energy reform all made Fukushima an opportunity for strategically accelerated policy reform. Media reporting after Fukushima sustained the antinuclear atmosphere in the public

discourse and contributed to a national narrative of the exceptional character of the disaster. This allowed the government to renege on its most recent policy decision without losing credibility and to develop a solution first proposed by the political opposition.

Discussion

Two of the factors tested in our large-*N* analysis played an important role in Japan's post-Fukushima energy framework, especially its relatively open but pro-government, pro-Fukushima media and its (lack of) a Green Party. Our Japan case study also illuminates a third, critical factor not captured in our large-*N* analysis, namely the Japanese government's long-term support for the technology. Tokyo's extended running battle to capture the hearts and minds of the population has created a network of quasi-governmental institutions dedicated to promoting nuclear power which has continued even as the population itself has grown increasingly hostile to the technology. Pressure from national business associations has been reinforced by these existing norms and by Abe's goals of a stronger, more energy-independent nation. As a result, broader post-Fukushima opposition has not had political traction in Japan.

As with the Japan case, two factors investigated by our large-*N* analysis also surfaced in our German case: the role of the media (as a watchdog) and the antinuclear Green Party. History in the form of path dependency also influenced Germany's decision to exit nuclear power, as Fukushima crystalized strands of antinuclear policies and previous attempts at a phase-out. Germany's case shows how history's role in policy change may not be linear or incremental; exogenous events can open policy windows for change resulting from interactions between strategic actors and long-term institutional pathways.

We see our study as building on past research on nuclear decision-making which has often strongly focused on the role of formal political institutions, whether in terms of social movement tactics in the field of environmental politics (Schreurs 2002), the openness of state–society relations (Boyle 1998) or state capacity and access (Kitschelt 1986). Moving beyond these earlier approaches, we see interests, ideas and institutions interacting with policy entrepreneurs and doing so in path-dependent ways. The German case shows how policy entrepreneurs can use policy windows in order to justify and promote change in political preferences and values.

In Germany, the policy entrepreneurs who made use of Fukushima as a window of opportunity were already in power. They found in the Fukushima tragedy an opportunity not to push forward their ideas but rather to change course through the justification offered by the new rationality that nuclear energy presented an untenable risk even for technologically advanced societies. What to outside observers seemed like a highly

unpredictable and irrational decision to suddenly exit a long-upheld technology was, inside Germany, widely understood as a rational and inevitable policy change. Moreover, Chancellor Merkl and her advisors could fall back on solutions for a phase-out and energy alternatives elaborated by previous governments.

In post-Fukushima Japan, the lack of a serious pathway toward energy alternatives (Samuels 1987) and of a strong Green party, as well as the pronuclear stance in national media, contributed to the catastrophe being interpreted as a one-off event with a clearly identifiable culprit (Tokyo Electric Power Company). Fighting not for a new policy or solution, but rather against pre-existing vested interests and energy infrastructure, there were no policy entrepreneurs advocating for change who were in a position with access to power to seize upon this window for change. The dominant pronuclear rationality was therefore not put in question by Fukushima, and the window closed again with minimal impact on nuclear policy.

Conclusions

We have sought to uncover if there is a 'Fukushima effect' on nations where countries altered their nuclear power policies because of a major accident (Hindmarsh and Priestley 2016). As is typical in nuanced studies of national decision-making, the answer is: it depends. Our qualitative and quantitative analyses support arguments about the importance of regime type in energy decision-making. Some have argued that major accidents deter countries from engaging in nuclear power construction but that their degree of change depends on regime type. We find that nations with longer lasting, more stable regimes – such as those in Russia and China – saw Fukushima as a black swan event rather than a precautionary warning about their own nuclear programs. The same is true in democracies with no strong NGO role in energy policy formation and elements of stability similar to authoritarian regimes.

Domestic political actors, especially the media, played a large role in the decision-making process. Germany's media set the agenda for politicians, emphasizing the dangers of the technology and arguing that Japan's experiences should be seen as a warning to Germany. In contrast, Japan's media, serving not as a watchdog but often as a mouthpiece for official government position, have consistently avoided such confrontation with politicians and the *genshiryoku mura* (nuclear village).

In an era when many still speak of the possibility of a nuclear renaissance, we offer several empirically testable caveats along with a clear research agenda. First, our research suggests that ideas and institutions interact with history to create very different energy policy trajectories.

Future scholarship should create larger datasets about nuclear power decision-making involving not just this most recent disaster but a time series framework with the Three Mile Island, Chernobyl and Fukushima events embedded. A longitudinal study involving more than just 90 countries along with variables that can capture norms would better illuminate patterns of policy responses to crises over time and space.

Next, actors in democratic nations with watchdog-role playing media can push issues to center stage. The German media helped localize the threat of a 'fire across the water' and instill a sense of urgency among residents and politicians. Many US-based environmental activists continue to emphasize studies finding radioactive particles in ocean water and in air as a reason for the United States to move away from the technology. News of confirmed physical health impacts continue to surface – rates of thyroid cancer and leukemia among first responders and children, for example – will likely be utilized in antinuclear political activities. Experts should qualitatively and quantitatively track how media organizations around the world have helped drive discussions on the topic of energy choices.

Finally, we showed how a country with an active Green Party in combination with historically powerful antinuclear movements and accompanying policy entrepreneurs moved drastically away from nuclear power. Germany's constellation of norms and interests is unique, however, and we predict that few other nations with such a commitment to nuclear energy will follow in its footsteps. Given the standard mix of media openness, Green Party vote share, and regime type across the world, many more countries will instead 'muddle through' disasters like Fukushima, neither curtailing nor increasing existing nuclear energy programs. In many democracies, Fukushima increased the will of policymakers to aim toward a nuclear phase-out in the long run. However, in the short term, Fukushima did not deter many countries from reinvestments in the nuclear sector.

While opinion polls across the world have shown that residents in nations with nuclear power see the technology in a more negative light, it is unlikely other countries will move so quickly and drastically. Rather, due to rising availability of LNG, increasing interest in solar and wind power along with energy efficiency and heightened sensitivity to atomic energy, decision makers may find it most politically feasible to look to nonnuclear sources.

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Appendices

Appendix 1. Data sources for large N analysis

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Variable	Sources
Energy policy outcome (dependent variable)	http://www.worldnuclearreport.org/IMG/pdf/2011MSC-WorldNuclearReport-V3.pdf; worldenergy.org; http://fukushima.com/international-response/; http://www.iaea.org/technicalcooperation/Home/Highlights-Archive/Archive-2012/16112012_CPF_Moldova.html; http://keia.org/sites/default/files/publications/april_2011.pdf; world-nuclear.org; http://www-pub.iaea.org/MTCD/Meetings/39798_presentations.asp; http://www.ener2i.eu/page/34/attach/0_Armenia_Country_Report.pdf; https://miningawareness.wordpress.com/2013.11/04/happy-austria-nuclear-free-beacon-of-hope-for-the-world/
Number of reactors	https://www.iaea.org
Percentage energy from nuclear	https://www.cia.gov/library/publications/the-world-factbook/fields/2239.html#al
Number of NGOs	http://www.wango.org/resources.aspx?section=ngodir#Table1 (from 2013)
Green Party vote share	http://www.electionguide.org/ http://www.parlgov.org/stable/index.html
Per capita GDP	World Bank
Democracy and media scores	Freedom House
% Population that demonstrated	World Values Survey Afrobarometer
Protest/Absence of protest	LexisNexis Academic
Greenpeace Office presence/absence	http://www.greenpeace.org/international/Global/international/publications/greenpeace/2011/GPI_Annual_Report_2010.pdf
Voice/Accountability, government stability	Kaufmann, Kray, and Mastruzzi 2010 (Governance Indicators).

Appendix 2. Countries in the dataset

Albania
Algeria
Argentina
Armenia
Australia
Austria
Azerbaijan
Bangladesh
Bahrain
Belarus
Belgium
Botswana
Bosnia & Herzegovina
Brazil
Bulgaria
Canada
Chile
China
Colombia
Croatia
Cuba
Cyprus
Czech Repub
Denmark
Dominican Repub
Egypt
Estonia
Finland
France
Georgia
Germany
Greece
Hungary
Iceland
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Ivory Coast
Japan
Jordan
Kazakhstan
Kenya
Korea RO (South)
Kuwait
Latvia
Lithuania
Luxembourg
Macedonia
Malaysia
Malta
Mexico
Moldova
Morocco
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Peru
Poland
Portugal
Romania
Russia
Rwanda
Saudi Arabia
Serbia
Slovak Republic
Slovenia
South Africa
Spain
Sri Lanka
Sudan
Sweden
Switzerland
Taiwan
Tanzania
Thailand
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Venezuela
Vietnam