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RESEARCH NOTE

The rationale for supporting nuclear power: analysis of Taiwanese public opinion survey

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Abstract

The future of nuclear energy use has become increasingly contentious across the world. This is especially the case in Taiwan, which simultaneously suffers from the instabilities associated with fossil fuel imports and widespread public doubts about the government's ability to handle a Fukushima-scale disaster, while also being increasingly dependent on nuclear energy. This study employs the 2013 Taiwan Election and Democratization Study (TEDS) survey on the Lungmen Nuclear Power Plant to gauge public opinion on the nuclear issue. The results demonstrate that while the public tends to be pro-nuclear when they are informed about the financial consequences of abandoning nuclear power and reassured about safety concerns, opponents of nuclear power, though numerically fewer, tend to be more vocal. Further research is needed to determine the exact logic of the public's decision making, based on a more precise set of preconditions.

1 Introduction

For many years, the inherent dangers of utilizing nuclear power for energy generation have been well-known to the general public across the world, and public doubts regarding the safety of nuclear energy have gradually intensified. A series of disasters, from the partial meltdown at Three Mile Island in the United States in 1979, to the 1986 Chernobyl disaster in the Soviet Union, and the 2011 accident at Fukushima, Japan, have strengthened the global anti-nuclear movement.

Yet at the same time, the usefulness of nuclear power as an alternative energy source, providing cheap, relatively sustainable mass power generation, has only become more significant. The volatility of global energy prices, highly dependent as they are on the security of shipping routes for commodities such as oil, natural gas, and coal, has led to a two decade-long rush to develop alternatives to traditional fossil fuel imports (Jacobsson and Johnson, 2000; Solomon and Banerjee, 2006; Lund, 2007; Regnier, 2007). What began as a policy reaction in the aftermath of the 1973 oil shock has evolved into a matter of national security for countries that fear the economic impact of the disruption of fossil fuel imports (Margolis and Kammen, 1999; Li, 2005; Sawin, 2006).

The issue of the need for renewable energy is particularly acute and sensitive for Taiwan. As a small island with negligible domestic reserves of fossil fuel, Taiwan is and always has been heavily dependent on imports of oil, gas, and coal to supply an energy-intensive economy increasingly centered on high-value technological manufacturing. Yet, as a small open economy with relatively few energy investments abroad, it has little clout in the global energy market. To stabilize and reduce overall end-user energy prices, Taiwan has to utilize alternative means of procuring energy that are fundamentally less dependent on foreign conditions and can produce enough power to offset any losses in fossil fuel-based electricity.

As a source that fits both the import stability and mass generation criteria, nuclear energy has been at the center of Taiwan's alternative energy policy for decades (Tzeng, 1989; Tsai and Chou, 2005; Chen *et al.*, 2009; Huang and Wu, 2009). Another reason for the proliferation of nuclear plants is the relatively small amount of fuel they require, and the comparative stability of such fuel supplies which remain less subject to disruption than supplies of oil and gas from the Middle East and Africa.

In the aftermath of the Fukushima disaster, however, global opinion turned sour on nuclear power amid fears of a repeat of the damage done in Japan, given similar shortcomings in corporate governance combined with government cover-ups (Chang, 2011; Hall, 2011; Jorant, 2011; Aoki and Rothwell, 2013). This is particularly the case in Taiwan, where the ongoing construction of the Lungmen Nuclear Power Plant has attracted the attention of an increasingly vocal public and become the focus of NIMBY concerns. The geographic proximity of the Fukushima site to Taiwan and the widespread belief that utility firms in both countries suffer from similar weaknesses in corporate governance have given the public almost endless ammunition and a renewed determination to pursue the goal of scrapping Lungmen altogether.

Yet the halting of the Lungmen project would have real economic implications for Taiwan. As mentioned above, Taiwan is highly dependent on nuclear power, so scrapping the plant would mean higher energy prices and more restricted energy supplies for both businesses and households. As such, it is still difficult to judge whether safety concerns outweigh the costs of reducing supplies of nuclear power.

This study will focus on current public opinion in Taiwan regarding nuclear energy – in particular, the construction of the Lungmen Nuclear Power Plant – in the context of the everyday economic importance of nuclear energy generation. Utilizing responses to the relevant questions in the 2013 Taiwan Election and Democratization Study (TEDS), we seek to clarify the public's position on nuclear energy.

In the survey, respondents are reminded of the possible economic impact of the loss of nuclear energy, the possibility that the public's safety concerns may be overstated, and how they can use democratic means to legally compel politicians to give the Lungmen plant the green or red light. The resulting responses represent the balance of anxieties among the general public concerning the economic and safety implications of the continued use of nuclear power on the island.

The public's mixed feelings on nuclear power have strong implications for Taiwan's domestic politics. Beyond the straightforward consideration by politicians of which position on the issue can garner the most public support, the nuclear energy issue also tests the institutional influence of Taiwan's various grassroot movements. If protestors are able to halt the construction of an economically important infrastructure project they will set a strong precedent for populist participation in Taiwanese politics,

paving the way for public opinion to be transformed into policy objectives on many other issues in the future.

Furthermore, Taiwanese public opinion on nuclear energy can more broadly and loosely reflect international opinion on the same issue. After all, the as-yet-unknown extent of the Fukushima incident has triggered negative reactions among the public, scholars, and politicians as far away as Europe (Jorant, 2011; Huenteler *et al.*, 2012). The views of the Taiwanese public on the issue and their impact on the formation of energy policy may indicate how the same issue will be treated in other countries with a similar economic and political profile.

In this study, before we examine the TEDS results and their implications in detail, we will first review the relevant literature on the subject to establish the background of the development of nuclear power and the accompanying changes in public opinion. Then we will explain the methodology of the TEDS surveys, focusing on how the questions regarding nuclear energy are posed to respondents. Finally, after summarizing the TEDS results, we draw conclusions concerning how the opinions expressed in them may affect energy policies in Taiwan and abroad.

2 Literature review and theoretical framework

When it is developing a unique ideological platform, a political party must gradually assemble a list of key issues and take a firm stand on each of them in order to form a core supporting constituency. Choosing the issues themselves, however, is not straightforward, nor can it be done quickly. With changing conditions and different topics in the spotlight of public discussion, a political party must constantly stay in touch with the most relevant issues and what views on these issues are attracting the most support, keeping its political strategists updated concerning the opinions of voters so that electoral support can be maximized without the party's ideological position being undermined.

The need for a party to continually update its platform is particularly urgent in the case of mature democracies, in which political parties constantly seek to open up battlegrounds around new issues in order to gain new voters, while at the same time avoiding any revolutionary ideological changes so as not to lose their traditional constituencies. This is apparent in the changing nature of American politics. For instance, the issue of racial segregation did not emerge as a key ideological differentiator

between the Democrats and Republicans until the emergence of a national civil rights movement in the mid-1960s (Sundquist, 1968; Pomper, 1971, 1972; Kirby, 1980). This is in spite of the fact that racial tension had been an obvious social phenomenon in the United States practically since independence.

In dealing with emerging issues, a party will usually attempt to sort them out into what we can call 'easy' and 'hard' issues. Easy issues can be defined as those that require little consideration before a decision is made. The public can understand an easy issue in a straightforward way based on easily available information, and sections of the public quickly reach their own consensuses on those issues, allowing the party to rapidly estimate how much of the voting constituency can be captured or lost by choosing one position over another. Indeed, as Carmines and Stimson (1989, p. 11) state, the fundamental difference between an easy issue and a hard one is 'how much cognitive processing is required to deal meaningfully with an issue'.

On the other hand, 'hard' issues can be defined as those that 'require contextual knowledge, appreciation of often subtle differences in policy options, a coherent structure of beliefs about politics, systematic reasoning to connect means to ends, and interest in and attentiveness to political life to justify the cost of expensive fact gathering and decision making' (Carmines and Stimson, 1989, pp. 11–12). These are issues that require the electorate to gather and analyze a large amount of information in order to make a rational choice. Due to the complex nature of these issues, involving different potential consequences in different environments, their long-term impact on party support may be unpredictable and remain uncertain for a long period of time, contributing to relatively long and unstable national party realignments.

The changing influence of these hard issues on party support and alignment can be defined as 'issue evolution'. The issues involved always 'have a long life cycle; they develop, evolve, and sometimes are resolved over a number of years'; and 'the crucial importance of this issue type stems from the fact that its members can lead to fundamental and permanent changes in the party system' (Carmines and Stimson, 1989, p. 11). The information-intensive nature of these issues means that the public will not always be in a position to make consistent rational judgments about them, and can thus be more easily manipulated and swayed by politicians and the media.

The result of this manipulation is new political divisions within formerly united constituencies with few ideological cleavages. Previously harmonious balances and political equilibriums are disturbed by such splits, owing much to what Riker (1982, pp. 197–212) calls 'internal contradictions.' These previously unseen divisions only come to public attention when there is 'growing consciousness of policy problems in need of solution' (Carmines and Stimson, 1989, p. 9). In the context of American politics, this idea of internal contradiction not only pertains to racial tensions since the mid-1960s, but also to economic ideologies in the 1980s after the advent of Reaganomics (Cavanagh and Sundquist, 1985, p. 37).

To explain how these hard issues evolve over time, scholars of political science have borrowed the concepts of evolution and natural selection from Darwinian biology (Nelson and Winter, 1982; Axelrod, 1984; Kingdon, 1984; Boyd and Richardson, 1985; Radnitzky and Bartley, 1987). These scholars have come to see natural selection not as a way of justifying the existence of a certain social status quo, but as an organic metaphor to rationalize any gradual realignment of electoral loyalties over a period of time, in which a party will weed out any 'weak' political stances that are not attractive to large numbers of potential voters (Burnham, 1970; Gould, 1981). This explains how a party's position on any hard issue is developed from a present-day perspective.

3 Nuclear energy policy as a 'hard' issue

Whether or not to utilize nuclear energy as a primary source of power generation should be considered a 'hard issue', according to the definition above. The possibility of increased energy prices due to political instability in the Middle East and fear of a nuclear accident in the aftermath of Fukushima have polarized public opinion on the issue. Having only imperfect information on the risks of nuclear radiation and the potential economic costs of reducing reliance on nuclear power, the public has no easy way of reaching a consensus on how the issue should be dealt with politically.

The dual-sidedness of the issue has been felt particularly in Taiwan, which has always been heavily dependent on energy imports. Previous studies have focused on the issue of energy efficiency on the island and shown that there has been an absolute increase in energy generation and demand in recent decades despite continued technological improvements leading to improved energy efficiency (Huang and Odum, 1991; Cheng and Tin, 1997; Lee and

Chang, 2005; Yeh *et al.*, 2010). The prominence of economic concerns about energy security pits the collective Taiwanese public consciousness against the global grassroots anti-nuclear movement as the risks associated with nuclear power have grown clearer over the years.

Hence, it is likely that public opinion on nuclear energy will depend on how the imperfect information on both sides of the argument is presented in the decision-making process. Depending on whether they focus on the financial costs of limiting nuclear power, or the lack of safety procedures in nuclear power plants, surveys of public opinion may produce dramatically different results supporting entirely contradictory points of view. The shifting balance of pros and cons on the issue due to major events resonates with the theory of issue evolution as described by Carmines and Stimson (1989).

Governments or politicians in general tend to use what Snyder (1991) calls 'myths' to justify their actions. For example, Snyder claims that the myths of empire arose out of coalitions of interests that logrolled various policy choices that were justified by expansionist ideology. In this way, narrow interests gain power by joining coalitions and trading favors. Each group gets what it wants, and expansionism becomes a choice that all members of the coalition support, even if it is not their first preference. In another remarkable piece of research, Kaufmann (2004, p. 64) demonstrated the Bush administration's success in shifting the main focus of the Iraq debate from containment of regional aggression to deterrence of direct attacks on America. Furthermore, these beliefs had a major influence on the American public's support for a preventive war.

According to the literature, public opinion is frequently subject to the framing effect in that it is influenced by the language, ideas, history, and images presented in the speeches/statements of politicians or members of the political elite. The framing effect suggests that people do not form their preferences and make decisions in accordance with rational expectations based on utility theory (Quattrone and Tversky, 1998, p. 719, 734). In particular, the concept of framing effect goes against the utilitarian expectation of the invariance property of the public. This property requires preferences without assertive change so that the rational choice model is dispensed with. Similarly, studies show the general public often has very little information about policies, and as a result, their policy preferences seem to be affected by information supplied by the party elite (Bullock, 2011, p. 496). Slothuus and Vreese (2010) have explored an experimental

design to analyze how public opinion is affected by the framing issue and partisanship. Their conclusions are different from those of previous studies in that the partisan bias in citizens' responses to party frames seems to be more significant on issues at the center of party conflict than it is on consensus issues.

In conducting this study, we do not take sides on the issue of nuclear power, neither do we attempt or hope to persuade anyone that the public, and in turn politicians, should come to a particular policy decision on the issue. Indeed, we do not have any more information on the economic and technical advantages and disadvantages of nuclear power generation than is available to the political establishment or sufficiently curious members of the general public, and thus we are in no position to influence decision making.

Instead, we present the latest iteration in the process of issue evolution regarding nuclear power in Taiwan. By examining different questions in the survey with biases covertly coded into their wording so that respondents are guided toward answering in one particular fashion, we demonstrate that the issue is still far from being an 'easy' one that can be comprehended and acted upon in a straightforward way by the vast majority of the public. As such, it will be some time before a process of political natural selection will allow the opposing political camps in Taiwan, the pan-Green and the pan-Blue, to formulate their respective platforms with regard to the nuclear energy issue.

In the following sections, we go into greater detail on how different questions in the TEDS survey are biased in a way that can manipulate the reactions of respondents. After reviewing the collected results, we speculate how such biased questioning can lead to instability in public opinion in a way that will affect the issue evolution of nuclear power. Finally, we examine the implications for democratic politics of such instability, both in Taiwan and beyond.

4 Methodology

To examine the trends in public opinion on nuclear energy in Taiwan, we will review the most recent survey results available to the general public. The raw data being analyzed originate from TEDS 2013 which obtained its results through face-to-face interviews with a randomized sample of respondents located nationwide, including the islands of Taiwan, the

Pescadores, Kinmen, and Matsu. The data gathered were finalized for publication on 20 February 2014.

To gauge the Taiwanese public's attitudes toward nuclear power, we specifically look at the social issues section of the survey. After disregarding those respondents who chose not to answer these questions, the effective sample size of the social issues section of TEDS 2013 was 2,292 individuals. Below, we list the questions and clarify how the wording of each presents a certain manipulative bias, guiding respondents to answer in a particular manner.

This section contains three questions that ask only about the respondent's level of support for continuing the construction and utilization of the Lungmen Nuclear Power Plant, currently slated for completion in 2015. Each of the three questions has a certain bias inserted into the wording prior to the actual posing of the question. We label the three questions 'Original,' 'Condition 1,' and 'Condition 2′ with respect to their respective contextual manipulative power.

The Original question asks directly for the respondent's opinion of the Lungmen plant without any addition of extra information:

> There are debates on whether the construction of Lungmen Nuclear Power Plant should be continued or not. Are you for or against continuing the construction of Lungmen Nuclear Power Plant? (目前有關核四應該停建或續建引起社會上的討論, 請問您支不支持續建核四?)

The question basically tells the respondent that the issue of whether to construct the Lungmen plant is currently under debate by the public and implies that 'for' and 'against' are both equally valid and justifiable responses. No attempt is made to imply that one response is more desirable than the other.

The Condition 1 question, however, introduces an initial twist that appeals to anxiety among members of the public that abandoning nuclear power will have an economic impact on them

> If discontinuing the construction of Lungmen Nuclear Power Plant were to cause electricity prices to rise by 15 percent, would you be for or against discontinuing the construction of Lungmen Nuclear Power Plant? (如果停建核四, 電價會上漲一成五以上, 這樣的話您支不支持停建核四?)

The wording gives a very clear and strong hint that halting the construction of the Lungmen plant will indeed cause electricity prices to rise by a significant amount, affecting the livelihood of the average citizen. Given the economic anxieties prevalent among the general public, such a partial presentation of the financial impact of reducing dependence on nuclear power, without equivalent information on other potential effects, will undoubtedly guide the respondent to support the continued construction of the plant.

The Condition 2 question manipulates the respondent toward supporting continued construction in a totally different way. Instead of appealing to economic fears, Condition 2 attempts to allay the concerns of the average citizen about the potential dangers of nuclear power thus

> If Lungmen Nuclear Power Plant's safety and security could be approved by overseas nuclear experts, would you be for or against the continued construction of Lungmen Nuclear Power Plant? (如果核四經過國外專家鑑定，認為符合安全標準，這樣的話您支不支持續建核四?)

This question tries to increase the level of support for Lungmen by allaying respondents' fears of a possible Fukushima-like disaster. This is done by suggesting that the plant could be approved by overseas experts. Like Condition 1, the hypothetical precondition guides the respondent toward answering in a particular way (in this case in favor of nuclear power) through the presentation of partial positive information.

Comparison of the percentages of responses in support of the continued construction of the Lungmen plant to the three questions noted above should give us a good idea of the relative weight respondents give to financial and safety fears when formulating their opinions on nuclear power. Also, how much the levels of support yielded by Condition 1 and Condition 2 differ from that yielded by the Original will reflect the depth of the public's concern about both the economic and safety implications of nuclear power. And further comparison of the levels of support yielded by the two conditional questions themselves can help us deduce which of the two concerns looms larger in the public's consciousness.

At the same time, the section also includes a question that probes respondents' willingness to participate in a referendum on the nuclear power plant issue. Unlike the first three questions, which gauge the public's attitude toward nuclear power in general, this question attempts to assess

whether respondents are generally in favor of expressing their opinions in a democratic fashion, if given the opportunity to do so. Essentially, by looking at whether the respondent would vote in a public forum to decide the fate of nuclear power in Taiwan, we can assess just how much interest the public has in this issue, and whether they are willing to spend time and incur the opportunity costs of actually voting in order to express their views. Indirectly, the public's level of enthusiasm also has implications for politicians as they deal with the nuclear power issue. Faced with a public that cares about nuclear power and would overwhelmingly vote in a forum to express their opinion, politicians must give higher priority to the issue and come out on one side or the other in order to remain electorally competitive. If the public's views are not so strong, the politicians can choose to remain ambivalent on the issue and will not have to worry too much about the likelihood of facing intense public scrutiny.

To evaluate the importance of the nuclear power issue according to this logic, the question asks directly

> Then, if there was a referendum on the construction of the Lungmen Nuclear Power Plant, would you vote in it? (那麼, 如果要舉行核四公投的話, 您會不會去投票?)

Those who answer 'yes' to the question are deemed to be those who care enough about the nuclear power issue for it to be a part of their overall political ideology when selecting political representatives. Anyone who answers 'no', on the other hand, may be assumed not to see nuclear power as an important part of their personal political platform, and it may be assumed that their views on nuclear power expressed in their responses to the first three questions, no matter whether they are for or against it, would not be important from a politician's perspective.

Together, responses to these four questions summarize overall public opinion on the nuclear power issue in Taiwan and the importance of the issue in domestic politics. Significant differences in the results yielded from question to question would confirm that the issue is a 'hard' one that can be manipulated by the provision of incomplete, biased information, leading to confusion and easy flip-flopping of the voting majority.

Lastly, to reconfirm the differences in public opinion concerning nuclear energy as expressed in responses to the Original and Condition questions, we decided to run side-by-side regression analyses of the three questions against a series of variables. Based on changes in the respective rates of

support for and opposition to nuclear energy as seen in the three questions, we simultaneously expect statistical correlations originating from the three to show significant deviations from one another. The specifics of such deviations should illustrate just what factors are prompting shifts in levels of support when preconditions are inserted into the conditional questions.

To properly understand how the general public views the nuclear issue in the context of the construction of the Lungmen plant, this study uses two separate regressions. The first is an ordered logit model that detects the public's support for nuclear power in the context of the Original and Condition questions. In particular, to increase the salience of the three questions' explanatory powers, we have chosen to run three separate models with different combinations of these three questions incorporated as variables. In the first one, we only use the Original, the second also includes Condition 1, while the third contains all three questions as variables. By seeing how the parameters and significance of the variables change with their inclusion or absence, we are trying to determine how these factors together affect the dependent variables, each to a differing degree. Specifically, we can deduce how the concerns of economic cost and nuclear safety affect the general public's attitude toward the construction of the Lungmen plant.

The second regression is a multinomial logit model that uses the same three questions to gauge the level of activism the pro- and anti-nuclear camps are likely to display in the case of a referendum on the Lungmen issue. It is our hypothesis that numerical superiority may not be directly correlated to voting power when it comes to the nuclear issue. In other words, smaller contingents of pro- or anti-nuclear activists may very well be able to defeat the 'silent majority' at the ballot box in the event of an actual referendum on the issue.

For the dependent variables, we incorporated some specific survey questions to test the level of political involvement of the respondents. The first of these is the previously mentioned question concerning willingness to participate in a referendum on the issue of the Lungmen Nuclear Power Plant. This question uses respondents' willingness to participate in opportunities for direct expression of opinions and decision-making procedures as a proxy.

The second question asks respondents which they care more about, environmental protection or economic development, supposing that there is a conflict between the two. This question is particularly relevant to the issue of nuclear energy, where concern for the environment is pitted

against economic concerns. Willingness to sacrifice a certain amount of economic well-being to protect the environment, we believe, should be positively correlated with opposition to the construction of the Lungmen plant and the use of nuclear energy in general.

The third question asks about respondents' level of trust in government officials. It asks how much they believe statements issued by top government officials, such as the president and cabinet ministers, through media outlets such as TV stations and newspapers. It may be assumed that the more one disbelieves official statements, the more likely one is to form independent opinions on nuclear energy.

The last two questions cover the respondents' views of the economy. The first, which we call 'retrospective evaluation of the economy', asks how respondents evaluate the condition of the domestic economy over the past year. The second, entitled 'prospective evaluation of the economy', asks respondents how they think the economy will perform in the upcoming year. These questions are included to further strengthen the power of the regression models, with emphasis on more clearly demonstrating the correlation between stance on the nuclear issue and the economic factor that influences the respondents' stances.

For control variables, the standard classifications for demographics and political ideologies are used. The demographic classifications include gender, age, educational attainment, ethnicity, and self-perceived social status.[1] We refer to previous research which indicates that ethnicity (Wu, 2002; Wu and Lee, 2005), ethnic consciousness (Wang, 1998; Wu, 1999, 2002), unification/independence preference (Chen, 2000; Sheng, 2002), and party identification (Wu and Huang, 2007) all have a significant impact on the public's electoral choices and on personal political attitudes. With respect to issue evolution, the open expression of stances on different issues by political elites, as reflected by differences between nominated candidates and their parties, can influence the responses and electoral behavior of the electorate (Carmines and Stimson, 1989).

1 This variable of social status is added to the regression for two reasons. First, studies have consistently confirmed that a person's subjective class is directly related to their political attitudes (Campbell *et al.*, 1960; Stone and Schaffner, 1988). There is a possibility that in Taiwan, social class corresponds, at least to some degree, to party affiliation as well as ethnic consciousness, given that many pan-Blue supporters with pro-China views tend to become wealthy through China-based investments and businesses. Second, in relation to the variable of preference for economic concerns over the environment, it would be logical for class status to be related to political attitude.

To identify political ideology, we extracted responses to survey questions on party affiliation, ethnic consciousness, and stance on Taiwan independence. For the wording of the questions on these variables as well as how they are coded for use in our analyses, please see the appendix. In the next section, we present the results of the surveys and examine whether they support or refute our hypotheses.

5 Discussion of findings

To gauge the opinions of the Taiwanese public on nuclear energy, we first of all look at the results for the Original question and the two conditional questions that pertain to the level of support for continued construction of the Lungmen Nuclear Power Plant. Rather than conducting a split-sample experiment that divides the sample into three equal groups, all respondents were asked all three questions. Sequential questioning of this kind can help us find out how attitudes toward nuclear energy can be transformed by external influences. The results of the three questions are presented in Table 1.

All invalid answers to the questions have been removed from the data in Table 1, including 'others', 'refuse to answer', 'don't know', and 'hard to say'. This gives different sample sizes and reveals an interesting phenomenon: when conditions for approving the Lungmen plant are stated in conditional questions, some respondents become more firm in either their support for or opposition to nuclear energy. The increase in the sample sizes for the conditional questions seems to imply that a certain portion of the Taiwanese public is uncertain about nuclear energy when it is not given any explicit information about its potential consequences.

In addition, the results clearly show that the Original question, without any additions that might persuade respondents to support the nuclear

Table 1 Support for Lungmen Nuclear Power Plant

	Original	%	Condition 1	%	Condition 2	%
Strongly support	113	5.66	275	13.67	187	9.13
Support	542	27.14	893	44.38	904	44.12
Oppose	841	42.11	713	35.44	685	33.43
Strongly oppose	501	25.09	131	6.51	273	13.32
Total	1,997	100.00	2,012	100.00	2,049	100.00

plant, produces the lowest number in favor of nuclear energy. Adding conditions pushes pro-nuclear responses into the majority, showing that public opinion is very volatile on this issue. Furthermore, the Condition 1 question, the one that mentions that abandoning nuclear energy might result in a rise in electricity prices, yields a higher level of support for nuclear energy than the Condition 2 question that offers the option of the plant being tested to international standards. Correspondingly, the overall figure for those opposed to nuclear energy is lower in the first conditional question, helped by a large difference in the strongly opposed.

The differences in the results yielded by the two conditional questions underline the fact that the public's concerns about nuclear energy are primarily economic. Even among people who are ambivalent about or opposed to nuclear energy, many will switch to a supportive position as soon as they are informed that abandoning the nuclear plant will lead to a hike in electricity prices. The large shift of nearly 20% in those in favor of the nuclear power plant signifies the highly destabilizing role economics plays in public opinion on nuclear energy. A significant minority, at least, clearly sees financial concerns as more important than nuclear safety.

The higher level of support for nuclear energy yielded by Condition 1 compared to Condition 2 may conversely indicate an inherent lack of trust among the general public in 'expert advice' when it comes to an issue such as nuclear energy. Perhaps as a result of suspected government cover-ups in the aftermath of the Fukushima disaster, many people feel that even nuclear scientists could be somewhat biased. Their doubts about the objectivity of scientists, who, they believe, may have ties to the government and the nuclear industry, make them unwilling to take the opinions of experts at face value.

More interestingly, to understand the real impact of the conditions in the conditional questions, we must find out how many of the respondents are prepared to express their opinions in a referendum. Hence, we cross-tabulated the answers to the three questions above with willingness to vote in a referendum on the Lungmen plant. The results are presented in Table 2.

What is obvious from the cross-tabulation, which again excludes all invalid answers, is how the percentage of respondents willing to vote in a referendum remains steady across effective samples from the initial three questions pertaining to the level of public support for nuclear energy. Among both those who are willing and those who are unwilling to vote in a referendum, the proportions of those who support and those who oppose the

Table 2 Support for Lungmen Plant by willingness to vote

	Strongly support	%	Support	%	Oppose	%	Strongly oppose	%	Total	%
Original										
No	21	1.11	141	7.43	251	13.22	70	3.69	483	25.45
Yes	86	4.53	369	19.44	542	28.56	418	22.02	1415	74.55
Total	107	5.64	510	26.87	793	41.78	488	25.71	1,898	100.00
Condition 1										
No	36	1.88	215	11.23	230	12.01	25	1.31	506	26.42
Yes	234	12.22	638	33.32	440	22.98	97	5.07	1,409	73.58
Total	270	14.10	853	44.54	670	34.99	122	6.37	1,915	100.00
Condition 2										
No	32	1.65	281	14.49	159	8.20	32	1.65	504	25.99
Yes	150	7.74	555	28.62	498	25.68	232	11.96	1,435	74.01
Total	182	9.39	836	43.12	657	33.88	264	13.62	1,939	100.00

Lungmen plant remain almost the same as the proportions expressed in the three questions themselves. There is no sign that people endorsing one position on this issue are less likely to vote than people endorsing the other.

Furthermore, in the regression analysis of the Original, Condition 1, and Condition 2 questions, consistent results are found for all three. The compiled parameters for the three questions are listed side by side in Table 3.

Initially, it is clear that for many of the statistically significant parameters, the correlations for the Condition 1 are the exact opposite of those for the Original and Condition 2. This is particularly the case for the 'preference for economics over the environment', 'trust in government', and party identification variables. This is because Condition 1 asks whether the respondent supports the *discontinuation* of the Lungmen plant while the other two questions ask about support for *continuing* its construction. Once this is taken into account, we can see that the correlations run in the same direction, in terms of support for *continuing* construction, for all statistically significant variables under each of the three questions. Below, we review these consistent correlations and set out their implications for nuclear energy in Taiwan.

First, looking at the 'preference for economics over the environment' variable, there is a clear positive relationship between those supporting economic development over environmental protection and those who support continued construction of the Lungmen plant. The relatively steady parameter values across the three questions show that the economic concerns of nuclear energy supporters are largely unaffected by any preconditions.

The same economic concerns can even be further interpreted as coloring the political ideology of respondents. In the regression analysis, we see a clear positive correlation between those who support eventual unification with China, vote for pan-Blue parties, and have a higher level of trust in government officials, on the one hand, and support for nuclear energy on the other. There is also a negative correlation between those who identify themselves as 'Taiwanese only' (i.e. not 'Chinese') and support for nuclear energy. While indirect, these correlations can be attributed, at least partially, to affiliation to the ruling Kuomintang (KMT). This group, who usually has strong family and business ties in China as well as loyalty to the KMT, can be considered to be an economic elite minority. As the business class, they have much more to lose financially from abandoning nuclear power than other sociopolitical groups in Taiwan.

Table 3 Ordered logit model for nuclear energy support

	Original		Condition 1		Condition 2	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Intercept 1	0.564	1.369	−3.427**	1.292	2.127	1.483
Intercept 2	2.834*	1.370	−0.269*	1.291	6.014***	1.495
Intercept 3	5.412***	1.377	3.024*	1.291	10.079***	1.509
Condition 1: Higher electricity price (very much against as reference group)						
Against			−1.111***	0.267	−0.349	0.297
For			−3.470***	0.286	−2.181***	0.317
Very much for			−6.173***	0.351	−4.042***	0.395
Condition 2: Approval by overseas experts (very much against as reference group)						
Against					3.093***	0.354
For					4.939***	0.368
Very much for					7.278***	0.425
Gender (male)	−0.241*	0.098	−0.237*	0.109	−0.222#	0.119
Age (60 years or above as reference group)						
20–29 years	−0.569**	0.190	−0.715**	0.210	−0.989***	0.228
30–39 years	−0.401*	0.170	−0.529**	0.189	−0.513*	0.205
40–49 years	−0.342*	0.165	−0.371*	0.182	−0.283	0.198
50–59 years	−0.219	0.158	−0.173	0.176	−0.095	0.193
Education (college or above as reference group)						
Elementary school or less	−0.504*	0.212	−0.758**	0.238	−0.765**	0.261
Middle school	−0.281	0.175	−0.748***	0.199	−0.761***	0.217
High school	−0.148	0.122	−0.324*	0.133	−0.296*	0.146
Ethnicity (Mainlander as reference group)						
Taiwanese Hakka	0.120	0.202	0.054	0.221	0.255	0.241
Taiwanese Minnan	0.109	0.165	0.115	0.178	0.242	0.194
Preference for economics over environment	0.149***	0.019	0.068**	0.021	0.034	0.023
Trust in government	0.605***	0.077	0.417***	0.085	0.361***	0.092
Social status (upper class as reference group)						
Lower class	0.739	1.369	1.138	1.258	2.161	1.434
Lower-middle class	0.681	1.363	1.138	1.249	2.190	1.425
Middle class	0.833	1.361	1.134	1.247	2.111	1.422
Upper-middle class	0.998	1.369	1.105	1.258	1.915	1.433

Party identification (independent as reference group)						
Pan-Blue	0.611***	0.126	0.465**	0.138	0.249#	0.150
Pan-Green	−0.603***	0.125	−0.540***	0.142	−0.525**	0.155
Unification/independence preference (maintain the status quo as reference group)						
Taiwan independence	0.258#	0.134	0.097**	0.145	0.092	0.158
China unification	−0.325**	0.125	−0.212*	0.142	−0.054	0.155
Ethnic consciousness (both as reference group)						
Taiwanese	−0.269*	0.108	−0.193	0.124	−0.112	0.135
Chinese	0.654**	0.240	0.690*	0.270	0.784**	0.300
Retrospective evaluation of the economy (stayed about the same as reference group)						
Gotten better	−0.290	0.206	−0.403#	0.224	−0.459#	0.244
Gotten worse	−0.284*	0.120	−0.313*	0.134	−0.292*	0.147
Prospective evaluation of the economy (stay about the same as reference group)						
Get better	0.490**	0.152	0.396*	0.167	0.442*	0.180
Get worse	−0.225#	0.134	−0.049	0.151	0.069	0.166
Log likelihood	3,552.3794		2,732.809		2,217.421	
LR χ^2	564.10		1,274.07		1,744.41	
DF	26		29		32	
Nagelkerke R^2	0.1370		0.3180		0.4403	
N	1,670		1,622		1,601	

Note. Cell entries are unstandardized regression coefficients and standard errors.
#$P < 0.10$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

The data in Table 4 show that the public is uncertain about nuclear energy policy when it has no explicit information. Compared to those who are unwilling to vote in a referendum, respondents who are more strongly against its continued construction are willing to vote for the discontinuation of the Lungmen plant. If respondents are informed that electricity prices will rise by 15% if the plant is abandoned, then those who are willing to vote in a referendum tend to be those in favor of its construction.

What is more, according to the data in Table 4, when presented with the possibility of construction being overseen by foreign experts, respondents who are willing to vote in a referendum are more against the continued construction of the plant. In other words, the Taiwanese public are clearly ambivalent about nuclear energy, and many will switch from opposition to

Table 4 Multinomial logit model of stance of referendum

	Yes/do not vote		No/do not vote	
	Coefficient	SE	Coefficient	SE
Intercept	14.538*	427.916	12.099*	427.915
Original: Continuing construction (very much against as reference group)				
Against	−0.721**	0.246	−0.223	0.405
For	−1.686***	0.349	1.407**	0.438
Very much for	−1.740**	0.666	1.238*	0.546
Condition 1: Higher electricity price (very much against as reference group)				
Against	0.088	0.489	−0.504	0.398
For	1.220*	0.480	−0.931*	0.431
Very much for	1.308**	0.498	−0.839	0.543
Condition 2: Approval by overseas experts (very much against as reference group)				
Against	−0.398	0.351	−0.612	0.557
For	−1.336***	0.363	−0.378	0.555
Very much for	−0.684	0.521	0.290	0.602
Gender (male)	−0.185	0.162	0.095	0.184
Age (60 years or above as reference group)				
20–29 years	−0.612#	0.327	−1.122**	0.345
30–39 years	−0.598*	0.298	−1.117***	0.315
40–49 years	−0.348	0.293	−0.894**	0.302
50–59 years	−0.361	0.290	−0.398	0.290
Education (college or above as reference group)				
Elementary school or less	−0.822*	0.359	−0.813*	0.390
Middle school	−0.624*	0.304	−0.300	0.323
High school	0.662**	0.199	−0.508*	0.216
Ethnicity (Mainlander as reference group)				
Taiwanese Hakka	0.193	0.356	0.313	0.353
Taiwanese Minnan	−0.153	0.279	0.032	0.269
Preference for economics over environment	−0.063*	0.300	0.038	0.034
Trust in government	0.298*	0.132	0.210	0.137
Social status (upper class as reference group)				
Lower class	−13.127	427.916	−12.790	427.915
Lower-middle class	−13.225	427.916	−12.458	427.915
Middle class	−12.890	427.916	−12.231	427.915
Upper-middle class	−12.576	427.916	−12.184	427.915

Party identification (independent as reference group)				
Pan-Blue	0.074	0.203	0.302	0.214
Pan-Green	1.071***	0.201	0.809**	0.268
Unification/independence preference (maintain the status quo as reference group)				
Pro-independence	0.042	0.236	0.432#	0.221
Pro-reunification	−0.085	0.198	0.184	0.255
Ethnic consciousness (both as reference group)				
Taiwanese	0.224	0.184	−0.180	0.197
Chinese	−0.215	0.517	0.466	0.418
Retrospective evaluation of the economy (stayed about the same as reference group)				
Gotten better	0.592#	0.360	0.202	0.375
Gotten worse	0.049	0.196	0.274	0.229
Prospective evaluation of the economy (stay about the same as reference group)				
Get better	−0.260	0.257	0.254	0.250
Get worse	0.074	0.219	0.169	0.263
Log likelihood	−995.1367			
LR χ^2	1,107.23***			
DF	70			
Pseudo R^2	0.3575			
N	1,489			

Note. Cell entries are unstandardized regression coefficients and standard errors.
$^{\#}P < 0.10$; $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

support as soon as they are informed that abandoning the nuclear plant may lead to a hike in electricity prices.

The implications of this study for policymakers are simple and straightforward. One is that, given the continued volatility of public opinion on this issue, policymakers can, by informing the public about the potential financial consequences of rejecting nuclear energy and making reassuring statements about nuclear safety, easily and quickly convince a significant segment of those who are opposed to nuclear power and those who are ambivalent about it to switch to a supportive position.

However, on the public relations front, it will not be easy to increase support for nuclear energy. Even if policymakers could persuade a large portion of the general public to support nuclear power, these supporters are not as vocal as the opponents. The vehemence of the opponents of nuclear energy can easily translate into a larger public presence,

neutralizing the numerically superior pro-nuclear section of the public. Either way, policymakers will have to face opposition from an energetic minority if they decide to continue construction of the Lungmen plant.

6 Conclusion

From the oil crisis of the 1970s through the most recent turbulence in the major oil-producing region of the Middle East, the fossil fuel-based economies have been plagued by unpredictability in their energy imports which has been detrimental to continued economic growth. This is the reason for the emergence of nuclear power as a significant alternative source of energy. The lack of other economical and sustainable substitutes for fossil fuels has also strengthened the political leverage of energy exporters at the expense of the major importers.

This is especially true in a small open economy like Taiwan, which is almost completely reliant on fossil fuel imports and dependent for its prosperity on exports of high-tech products produced with these inputs. The lack of an independent capacity to protect the logistics networks for fossil fuel imports, as well as the lack of a significant diplomatic presence in the energy-producing countries, makes Taiwan extremely vulnerable to sudden conflicts that threaten to disrupt energy supplies. From this perspective, government efforts to introduce nuclear power, a mass-producible, inexpensive alternative to foreign oil, gas, and coal, are highly sensible and logical.

However, public anxieties about nuclear energy have grown in recent years due to a series of safety concerns. This is particularly the case since the Fukushima disaster of 2011. Mistrust of government responses, including the covering up of information on the lethal consequences of nuclear radiation leaks, has turned public opinion sharply against the continued use of nuclear power in Taiwan. The ongoing construction of the Lungmen Nuclear Power Plant, especially, has triggered a powerful backlash from anti-nuclear campaigners who are attempting to utilize widespread doubts about nuclear safety in Taiwan.

In this study, we have presented the results of the survey questions in TEDS 2013 pertaining to public opinion on the Lungmen Nuclear Power Plant. We use the responses to these questions as the best available proxies for measuring public attitudes toward nuclear power in Taiwan. The first three questions gauge public support for the plant, with the second and third questions offering certain preconditions, while the last two attempt

to predict the level of voter turnout and the result of a referendum on the issue.

The survey results allow us to draw a few clear conclusions on public behavior regarding nuclear energy. One is that, as soon as they are informed about the economic importance of nuclear power and reassured as to safety, a significant number of people are likely to switch to supporting nuclear energy, pushing the pro-nuclear group into the demographic majority. Respondents are more likely to change their views when it is argued that abandoning nuclear power will result in electricity price hikes. Together, these results demonstrate the volatility of public opinion on the nuclear energy generation issue, as well as the relative importance to the public of economic factors compared to safety concerns.

But despite the fact that a majority of the respondents said they were in favor of the Lungmen plant, nearly two-thirds of those who stated that they would participate in a referendum on the issue said they would vote against its continued construction. The comparative enthusiasm of opponents of nuclear energy generation, or conversely, the relative diffidence of supporters, may affect any attempts by policymakers to pass legislation to expand the use of nuclear power in Taiwan. In other words, the absolute numbers of supporters and opponents may not ultimately decide the fate of nuclear power in Taiwan in the foreseeable future.

The results of the regression analysis, on the contrary, demonstrate the preeminence of economic concerns on the issue of support for nuclear power. Male respondents of higher social status, who are members of a mainlander economic elite and who support the ruling KMT, tend to be much more in favor of the continued construction of the Lungmen Nuclear Power Plant. As high-earning professionals and business owners, these individuals would be much more affected by the adverse financial impact of halting nuclear power use in Taiwan. Such economic considerations alone stand out as the deciding factor in the formation of opinion on nuclear energy among a large segment of the general public.

However, we do realize that using support or opposition to the Lungmen plant as a proxy for general support for nuclear power in Taiwan poses some particular problems. The nuclear energy issue, when presented in the form of something as concrete as the building of a nuclear power plant, risks enhancing certain judgmental biases among respondents. The emotional, not strictly rational aspect of decision making on the issue, dominated by NIMBYism, may very much outweigh long-term economic

interests. Such short-term concerns would not be as influential if respondents were asked for their stances on nuclear energy without reference to the Lungmen plant or any other concrete issue.

As for possible future directions of research in this field, aside from conducting more surveys into general support for nuclear energy outside the context of a particular nuclear power plant, future studies should also look into improved methodologies that would more specifically determine what triggers changes in levels of support on the issue. While we noted, in rather vague terms, the remarkable volatility of public opinion based on the provision of incomplete information on the financial and safety implications of the nuclear power plant, the preconditions given are limited at best.

Additionally, we note that this study uses data from only one year. Unfortunately, the absence of similar questions in TEDS for previous years has prevented us from forming panel data that can directly gauge how public opinion has changed over time. More surveys of the public's views on nuclear energy are essential if we are to establish correlations between the different factors touched upon in this study. We hope that future research, with more precise questioning of respondents over longer time periods, may provide greater insights into how the Taiwanese public makes up its mind on the nuclear power issue.

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Appendix

Survey questions and coding of variables

Original. 'There are debates on whether the construction of Lungmen Nuclear Power Plant should be continued or not. Are you for or against continuing the construction of Lungmen Nuclear Power Plant?' (1 = *very much against*; 2 = *against*; 3 = *for*; 4 = *very much for*).

Condition 1. 'If discontinuing the construction of Lungmen Nuclear Power Plant were to cause electricity prices to rise by 15 percent, would you be for or against discontinuing the construction of Lungmen Nuclear Power Plant?' (1 = *very much against*; 2 = *against*; 3 = *for*; 4 = *very much for*).

Condition 2. 'If Lungmen Nuclear Power Plant's safety and security could be approved by overseas nuclear experts, would you be for or against the continued construction of Lungmen Nuclear Power Plant?' (1 = *very much against*; 2 = *against*; 3 = *for*; 4 = *very much for*).

Willingness to Vote in a Referendum. 'Then, if there was a referendum on the construction of the Lungmen Nuclear Power Plant, would you vote in it?' (1 = *yes*; 2 = *no*).

Attitude in Referendum. 'Would you vote 'For' or 'Against' discontinuing the construction of Lungmen Nuclear Power Plant?' (1 = *for*; 2 = *against*).

Gender. Respondent's gender. (1 = *male*; 2 = *female*).

Age. Respondent's age measured in years. (The continuous variable is divided into five categories: *20–29 years*, *30–39 years*, *40–49 years*, *50–59 years*, *over 60 years*).

Education. Respondent's level of educational attainment measured on a four-tier scale. (1 = *elementary school or less* [through 6th grade]; 2 = *middle school* (grades 7–9); 3 = *high school*; 4 = *college or above*).

Ethnicity. Ethnic background of respondent's father. (1 = *mainlander*; 2 = *Taiwanese Hakka*; 3 = *Taiwanese Minnan*).

Preference for economics over environment. 'If economic development and environmental protection cannot be simultaneously emphasized, some people would stress protecting the environment, while others would focus on developing the economy. Where do you stand?' (0–10 gradient serving

as a continuous variable with 0 as completely focused on environment, and 10 as completely focused on the economy).

Trust in government. 'Do you believe the words of governmental officials (such as the president and cabinet ministers) expressed in newspapers and on TV?' (1 = *strongly disbelieve*; 2 = *disbelieve*; 3 = *believe*; 4 = *strongly believe*).

Social status. Respondent's self-perceived social class identification on five-tier scale. (1 = *lower class*; 2 = *lower-middle class*; 3 = *middle class*; 4 = *upper-middle class*; 5 = *upper class*).

Party identification. 'Generally speaking, do you think of yourself as close to any particular political party?' Those who classify themselves as independents are asked the following question: 'Do you think of yourself as being a little closer to one of the political parties than the others? [If yes] "Which party do you feel closest to?" (1 = *pan-Blue* [Kuomintang, People First Party, New Party, and leaning toward pan-Blue]; 2 = *pan-Green* [Democratic Progressive Party, Green Party, Taiwan Solidarity Union, and leaning toward pan-Green]; 3 = *independent* [those who skipped the question]).

Unification/independence preference. 'Concerning the relationship between Taiwan and mainland China, which of these six positions do you agree with: (1) immediate unification; (2) immediate independence; (3) maintain the status quo, but in the future move toward unification; (4) maintain the status quo, but in the future move toward independence; (5) maintain the status quo, but in the future decide to move toward either unification or independence; and (6) maintain the status quo forever?' (1 = *China unification* [immediate unification and maintain the status quo, but in the future move toward unification]; 2 = *Taiwan independence* [immediate independence and maintain the status quo, but in the future move toward independence]; 3 = *maintain the status quo* [maintain the status quo, but in the future decide to move toward either unification or independence, and maintain the status quo forever]).

Ethnic consciousness. 'In our society, some people say they are Taiwanese, some people say they are Chinese, and some people say they are both Taiwanese and Chinese. Do you think you are Taiwanese, Chinese, or both?' (1 = *Taiwanese*; 2 = *Chinese*; 3 = *both*).

Retrospective evaluation of the economy. 'Would you say that over the past twelve months, the state of the economy in Taiwan has gotten better,

stayed about the same, or gotten worse?' (1 = *gotten better*; 2 = *stayed about the same*; 3 = *gotten worse*).

Prospective evaluation of the economy. 'Would you say that in the forthcoming year, the state of the economy in Taiwan will get better, stay about the same, or get worse?' (1 = *get better*; 2 = *stay about the same*; 3 = *get worse*).