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American Attitudes Toward Nuclear Energy

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Abstract
Despite the mature underlying technology behind nuclear energy production, public opinion on the topic has varied dramatically over the years. This paper seeks to analyze patterns in Americans' attitudes towards nuclear energy using aggregate polling data from previous national public surveys. Standard demographics such as age, education, and political affiliation are utilized in cross sectional comparisons against public opinion. For this, males and conservatives were found to have strong positive responses towards nuclear energy. Furthermore, time-series data has indicated nuclear energy fell out of favor in the early 1980s then later favored again in the early 2000s. The reason behind the change in the 1980s was likely due to the Three Mile Island accident. In the 2000s, this attitudinal shift was likely because of increasing concern over carbon emissions.

Keywords
Nuclear Energy— Attitude — Public Opinion — Survey

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Introduction

It is vital not to underestimate how important public opinion is to our country. Public opinion has a strong impact on the laws and policies that are put in place. Since public opinion is so central to our country's identity, interest in public opinion has only grown over time. By gathering survey data on individuals, such as age, gender, and party affiliation, studies can reveal the public's priorities and wants. As such, statistical analysis like this project are often very insightful to understanding voters and improving communications with voter bases. Nuclear energy is a well-established technology which has been used to meet energy needs since the 1950s. But its market share was always overshadowed by other energy sources, such as coal or natural gas. But the impending effects of climate change may change that dynamic. Using this technology to eliminate carbon emission is a policy many would be in favor with. For others, however, nuclear energy is too dangerous or uneconomical (Beck, 1999). Despite having a foothold in the energy sector for over 60 years, conventional nuclear energy has garnered a fair amount of controversy (Pahner, 1976). Even among environmentalists, they cannot agree upon whether nuclear energy is the best course of action for the future.

As society and human technology advances, its power requirements are ever increasing. With our current choice of energy sources, such as coal or natural gas, the effects of pollution become more evident as production increases. For this reason, many seek to pivot to a form of energy which can be reused, or has an infinite supply like solar or wind energy (Owusu & Asumadu-Sarkodie, 2016). Nuclear energy, while not technically a renewable form of energy per se, is a very clean form of energy which has a long lifespan and is oftentimes even discussed alongside renewable energies, furthering the mental correlation of the two. With increasing pressure to move away from fossil fuels to pursue renewable energies, is it possible the climate change crisis might change the public's perception in favor of nuclear energy? As mentioned previously, nuclear energy is not a renewable form of energy. Its fuel source has a limited lifespan in which it is useful to a power plant. Because of this limitation, many nuclear power plants were only designed and licensed to be in operation for forty years (Naus et al., 1995). Discussion about how to handle this used fuel has been a topic of much debate over many decades. The United States Department

of Defense attempted to resolve this issue by issuing Yucca Mountain in Nevada as the official landfill for all US based nuclear fuel sources. However even this faced backlash as the risks were deemed too "immense" by some (Slovic et al., 1991). Historical political background such as this make the current politics around nuclear energy different from other renewable forms of energy, and therefore worth exploring.

This paper will involve cross sectional data comparison across datasets, a time series comparison across datasets, and an analysis of the data [1]. Analysis of this data is important because by using multiple sources of data, one can then verify the integrity of the results. On the other hand, if there is a mismatch of results, then this can disprove patterns that are found in one dataset, but not in another. It can also even tell if a pattern only applies within certain times or circumstances.

0.1 Literature and background review

Both sides of the nuclear energy debate have been vocal in their cause, and have not yet been able to see eye-to-eye, even on the same issues of the topic (Beck, 1999). For instance, pro-nuclear advocates argue that based on shear energy potential, nuclear is more economical (Brook et al., 2014). Opponents then cite the large up-front cost and how more plants are scheduled to shutdown than are being built. Advocates would then counter that the decline in interest is due to a rise in misinformation and negative media coverage. (Herbst & Hopley, 2007). Both sides have their reasons to believe what they do, and each are often valid in their objections.

Nuclear energy opinion is worth researching not just because of its implications, but because of its rich history which defines the opinions of today. For instance, despite some research done to show that nuclear energy is safe when handled properly, historically the American public has been wary of its implementation within their country (Petrescu et al., 2016; Macilwain, 2011; Reilly, 1994). These concerns were and still are not completely unfounded, however. In its infantile stage, safety was not a priority when building and designing nuclear power plants (Beck, 1999). Even when safety protocols were reinforced with stricter precautions, lack of due diligence has been attributed to notable nuclear power plant disasters. Other reasons for the early aversion of nuclear energy was the perceived connection of nuclear energy to nuclear weapons. Despite US policy makers attempting to distinguish the two technologies, the correlation still remained in many people's minds (Baron & Herzog, 2020). When the demand for nuclear power was at its peak during the oil crisis of the 1970's, there grew a concern that there would not be enough uranium to meet the growing energy demand. However, as soon as the price of oil dropped, business went back to normal (Beck, 1999). Even governmental support waned when Jimmy Carter in the second half of his presidency deprioritized nuclear energy (Kasperson et al., 1980). After having a long history of conflict while trying to adopt this technology, it is understandable that the public may be cynical towards further endeavors to use nuclear power. This project will attempt to prove whether the public truly is jaded or not.

[1] Twitter sentiment analysis was not possible due to the technical internal problems at Twitter

1. Methods and data collection

Data was collected from a few main sources. The first was from Gupta et al. (2019), a researcher who did work tracking the nuclear "mood" in the United States three years ago. The data was sourced from the Roper iPoll database, using the terms *atomic energy*, *atomic power*, *nuclear energy*, and *nuclear power*, spanning the years 1945 to 2016. Latent opinion was aggregated using the Dyad Ratios Algorithm (DRA). The sample universe for this data was all Americans, and therefore should reflect the country's opinion. Another source was from Ann Bisconti, an expert on public opinion and communications research on nuclear energy. Surveys were done on respondents who live within a 10 mile radius of US nuclear power plants (Bisconti, 2022). Roughly one thousand respondents were chosen, with those who work at the plant excluded from the survey. Responses should also be telling of the US population, however one might assume the opinions the residents have will be stronger than those not near a plant. The third source was collected by Davis Smith. The data was aggregated through the 2010 General Social Survey and utilized a list-assisted sampling frame for 72 percent of the population (Smith & Marsden, 2019). The sample universe includes respondents across the country. Although the focus of this database archive is on religion, this dataset specifically holds responses from both religious and non-religious respondents.

2. Data analysis

2.1 General attitudes

As can be seen from both datasets, the average amount of support seems to lean slightly towards favor more than oppose. In figure 1, the dashed vertical line represents the mean of the opinions. Behind the scenes, these response categories are transformed into an integer scale and the mean of scale is calculated. This is then translated back into a relative position of where the mean should be plotted, and represents to the reader where the average lies. The dashed lines which make up a diamond shape is the standard deviation of the survey results. Both left and right sides of the box represent the lower and upper quartiles, and the lines outside of the box are called whiskers, which represent responses outside of the quartile ranges.

In the Smith survey, the mean was closest to neutral, as the the results were split. This could be for a few reasons. For one, those who do have an opinion, don't feel strongly one way or another, and therefore simply chose a response from out of the two options. This could also be because the year before, there were many international talks about securing nuclear weapon free zones (Pelindaba Treaty, and the Central Asian nuclear-weapon-free zone). Despite nuclear weapons and nuclear energy being two different topics, Baron has shown

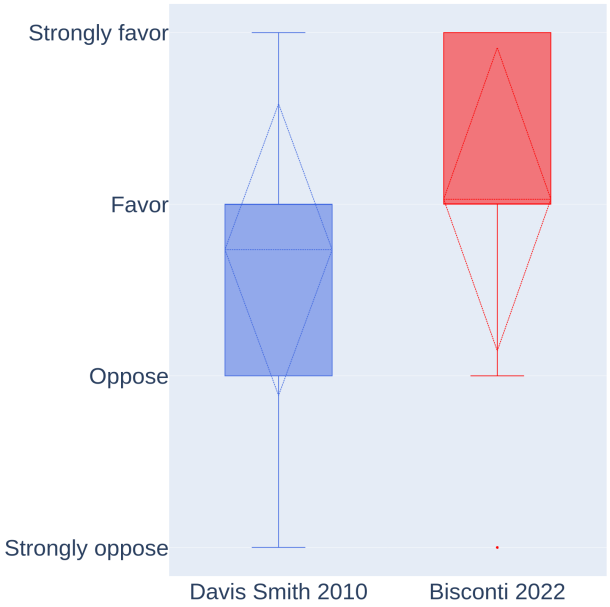

Figure 1. General nuclear energy attitudes

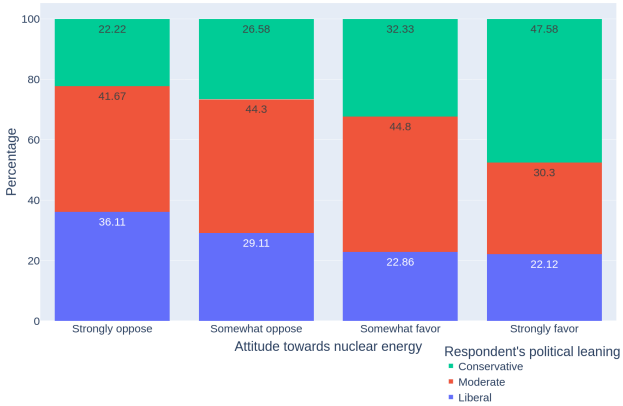

Figure 2. Smith political ideology

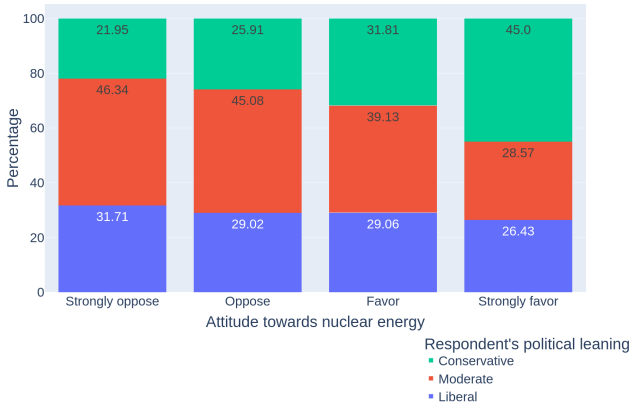

Figure 3. Smith political ideology

that these two are often interchangeable in the public's eye (Baron & Herzog, 2020).

From the Bisconti survey, a much more vocal response is observed. The public clearly favors nuclear energy, and perhaps this is due to the time in which the survey was taken, the year 2022. With green energy and green solutions becoming more accepted by the general public (Thomas et al., 2022), one would expect nuclear energy to be included under that favoritism . Another reason for the high amount of support could be because all respondents are located near a nuclear plant, and therefore fear of the unknown is not as strong a presence within the respondents. For those who do not know or understand the reasons for why the US would switch to nuclear, the idea of switching may seem alarming and unjustified.

2.2 Political ideology

Both plots, figure 3 and figure 2 represent a similar story, showing that conservatives tend to favor nuclear energy more than liberals. This difference has only been increased in recent years as shown in figure 2 as conservatives make up almost half of the survey results of the "Strongly favor" response. On the other hand, the amount of liberals who once chose to strongly oppose nuclear energy has decreased equally as drastically.

A possible rationale for why more conservatives are represented in the Bisconti dataset could be because all the respondents were chosen because of their proximity to a nuclear plant. Energy plants of any type typically are located far away from large populations of people because of NIMBY. If the people interviewed are from sparsely populated places, like in a suburb or the country, they are typically more likely to be conservative (Cleutjens, 2021).

NIMBY Not in my backyard

2.3 Political party

Intuitively, the next demographic feature to explore is political party affiliation. Figures 4 and 5 are interesting in that if one were to assume that Republican respondents were almost a 1:1 match with conservative respondents, one would expect to see plots which mirror the previous ones. However this is not the case. Conservatives' and Republicans' attitudes do not exactly align, however they do somewhat overlap as in the Bisconti data, 72% of Republicans are also conservatives, while only 50% of Democrats consider themselves liberals. The Smith survey data is less correlated, as 64% of Republicans consider themselves conservatives, and 47% of Democrats are liberals. In the Bisconti dataset, responses were surprisingly evenly split. Representation from every party was always within a 4% difference between each attitude category. One might expect Republicans to have a negative attitude towards nuclear energy due to nuclear energy often being viewed as an opponent to traditional coal plants; a technology Republicans had often backed in the past. Yet as can be told by both sur-

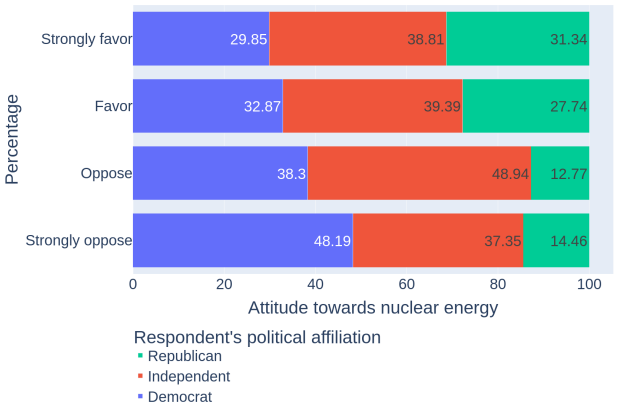

Figure 4. Smith political party affiliation

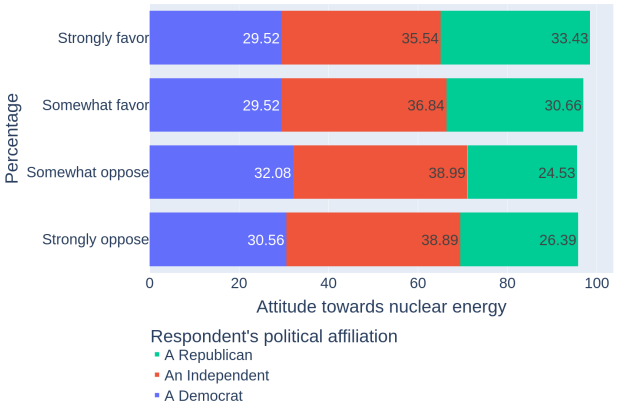

Figure 5. Bisconti political party affiliation

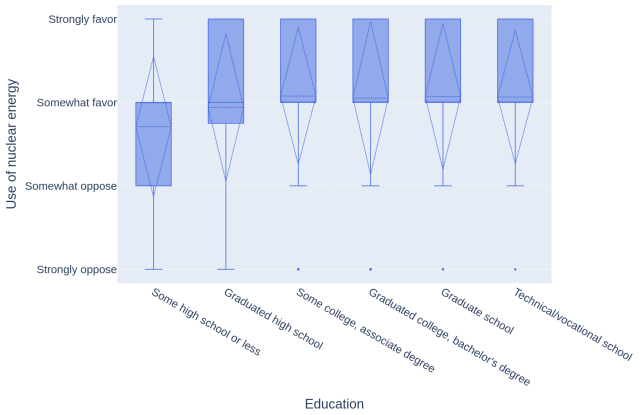

Figure 6. Respondent's education from the Bisconti dataset

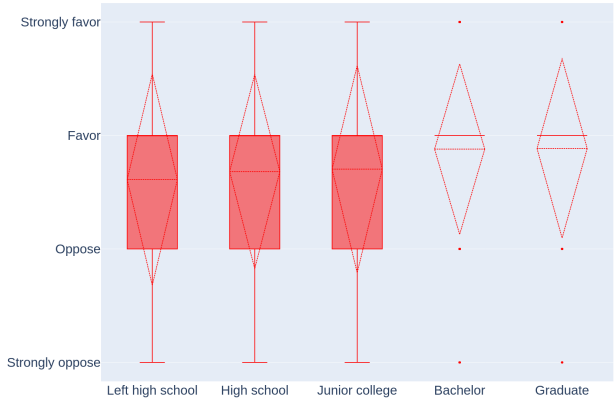

Figure 7. Respondent's education from the Smith dataset

veys, this is not the case. This is likely because the GOP has stated that they support all development of energy which are marketable, which includes nuclear energy (Priebus, 2016). Republican voters would be in agreement with their party because most voters seem very concerned about the economic considerations behind energy production (Gustafson et al., 2020). Furthermore, while green energy is often a talking point for Democrats, but it was not until 2020 that nuclear power was fully endorsed. (Bryce, 2020).

2.4 Education

All the data points in figures 6 and 7 show that education has no effect on people's opinion of nuclear energy. Despite long standing arguments about education leading to higher support for environmental causes, this data seems to mostly disprove it. The only exception to this rule is respondents with less than a high school degree. As seen in the Bisconti data, those with less than a high school degree are less likely to support nuclear energy. However, this could be because this group had the lowest sample size of any group, standing at only 24 respondents. Therefore the conclusions of this group might yield results of low resolution or results which are slightly skewed. Nevertheless, this group still is shown as the demographic group which is least likely to favor nuclear energy.

2.5 Sex

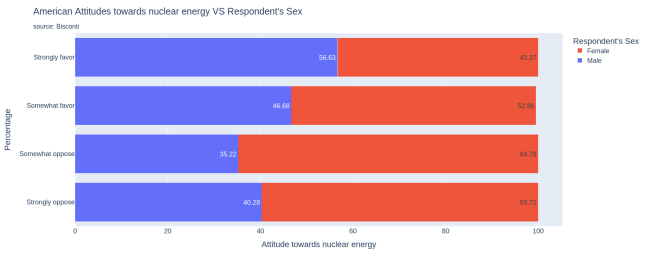

Figure 8. Respondent's sex from the Bisconti dataset

The mean is very consistent between both datasets, as can be seen in figure 10. The quartile range overlap also helps readers in determining that male's opinion of nuclear energy generally range from 'strongly favor' to 'favor', while female's generally range from oppose to favor. In the Smith and Bisconti surveys, females make up 55% and 52% of the

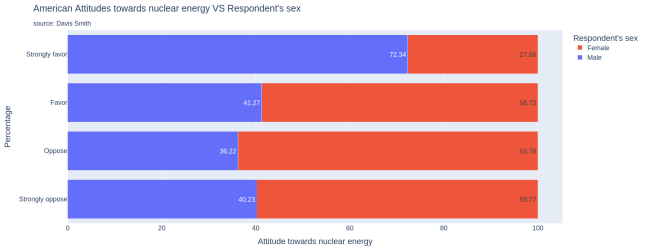

Figure 9. Respondent's sex from the Smith dataset

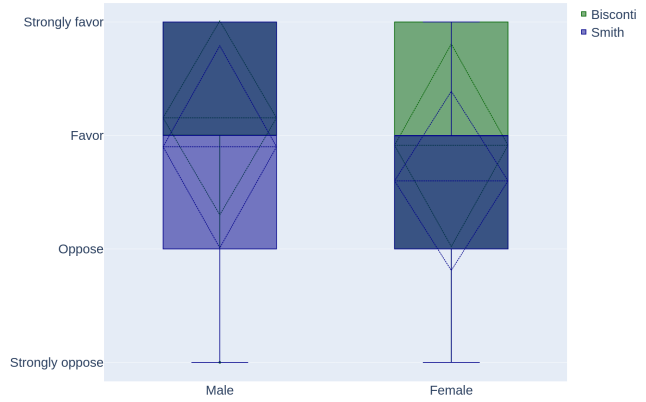

Figure 10. Respondent's sex in box plot format

population, respectively. If there were to be no correlation between sex and attitudes, one would expect to see a split in each attitude category of roughly 50%. Nevertheless, males in both datasets make up a larger representation of those who strongly favor nuclear energy. This is especially evident in figure 9, where men make up more than 72% of those who strongly favor nuclear energy. In the Bisconti data, males largely fall into the "favor" or "strongly favor" category, females largely oppose or strongly oppose. A possibility for this could be because men outnumber females in STEM fields. The enthusiasm for the fields in general could be higher and could correlate to higher support for nuclear energy. But as seen before with figures 6 and 7, high levels of education does not equate to favoritism. It's not the education or degree, but possibly the field which influences attitude.

2.6 Age

In figure 11, one may first notice that there is a large group of respondents in the Smith survey around the age of 53, which strongly favor nuclear energy. In fact, the general age of respondents in both surveys seem to be around 51 years of age. Responses generally are from those around the age of 48 to 53, and are distributed fairly evenly between all attitudes. There is a noticeable lack of responses from those under the age of 30. The reason for this could be older possible participants are most accustomed to random surveys, and therefore may be more comfortable participating.

In the Bisconti dataset, the results are as one might expect. Those who within the age range of 38 to 23 fall in favor of nuclear energy. In the strongly oppose category, one observes many respondents in their upper 50's. In the oppose category, we notice a lesser, but still large amount of responses around the age of 53. In fact, looking at each violin plot around the 53 year mark, starting from strongly oppose to strongly favor, we notice a decrease in responses. On the other hand, the exact inverse can be observed around people in their mid to early 30's, with an increase in responses when looking from strongly oppose to strongly favor.

Equally important of note is the possible reasons behind the shift in attitudes from generation to generation. The generations which would expect to see the results of climate change in their lifetime are more willing to move from traditional fossil fuels, while those who will not see the impacts are more likely to be against nuclear energy. Those who old enough to not see the majority of effects could even be part of or financially tied to the fossil fuel industry. Voting for another industry would be against their own best interests, as doing so would harm their own fiscal earnings.

2.7 Race

The largest group within each survey in figures 12 and 13 is the White population, with Black respondents and a grouped collection of other races making up the rest of the percentage. In these graphs, we notice a conflicting result between the two surveys. In figure 12, White respondents are the largest group which 'strongly oppose' and 'oppose' nuclear energy. The "strongly oppose" category is the most noticeable, as there is almost a 7% difference between that and the White participants which oppose nuclear energy. Yet in figure 13 from the Smith dataset, it depicts an even broader gap in opinions in this racial group. Whites make up 84% of the respondents in the "strongly favor" category, while they only account for 64% in "strongly oppose".

This difference in conclusions could be attributed due to a few reasons. The first could be because of location. As mentioned previously, the Bisconti survey are made up of respondents who were located near a nuclear plant. Perhaps White respondents align more closely to the effects of NIMBY, whereas Black respondents and respondents of other races align closer to the effects of YIMBY. The reason for YIMBY is often a sign of support for local development and affordable housing (Brown & Glanz, 2018).

YIMBY Yes in my backyard

2.8 Climate Change

Figures 14 and 15 present a large difference in opinions not only between attitudinal categories within each survey, but across both surveys as well. Opposite to what one might believe, those who are concerned about climate change are not necessarily in favor of nuclear energy. A logical thought process would be to assume that if one favors nuclear energy, they likely favor it because the respondent cares about environmental impacts and how lack of change in energy production

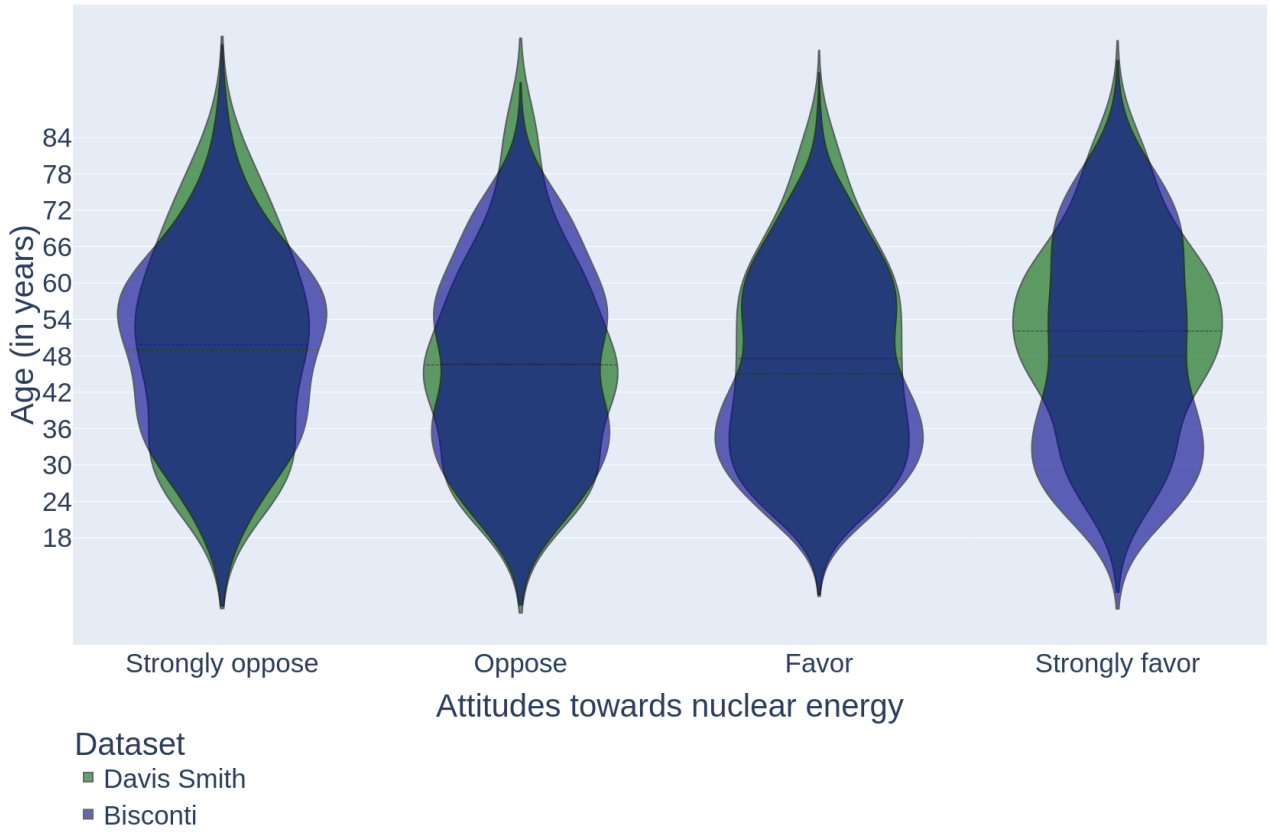

Figure 11. Respondent's age

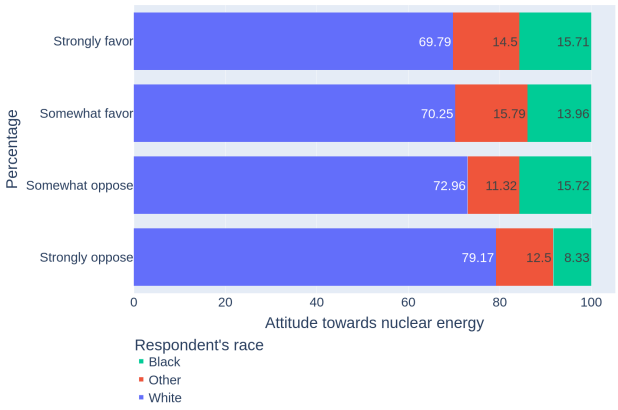

Figure 12. Respondent's race from the Bisconti dataset

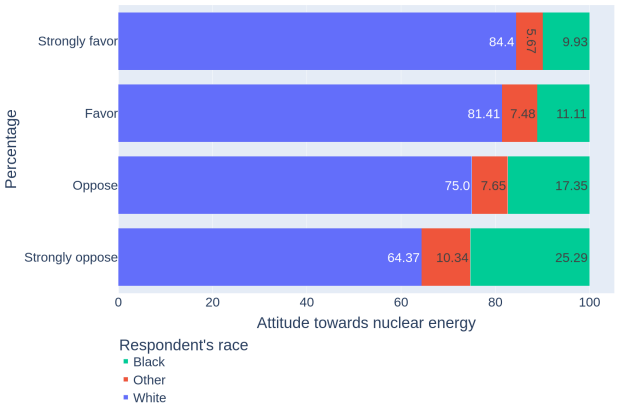

Figure 13. Respondent's race from the Smith dataset

landscape that will affect climate change. However, one can observe that the two largest groups ("Strongly favor" and "favor") are those who deeply care about climate change, and those who may not even believe in climate change.

One compelling conclusion would be that those which are in the "strongly oppose" category are conservatives, whereas most of respondents in the "strongly favor" are liberals or independents. This would explain why there is a large demographic of those who don't consider climate change to be important, and yet support nuclear energy. The presence of a group of respondents who believe climate change is "Not dangerous at all for the environment", yet favor nuclear energy in the Smith survey would seem to agree with this notion.

As for the difference in magnitude in attitudes between

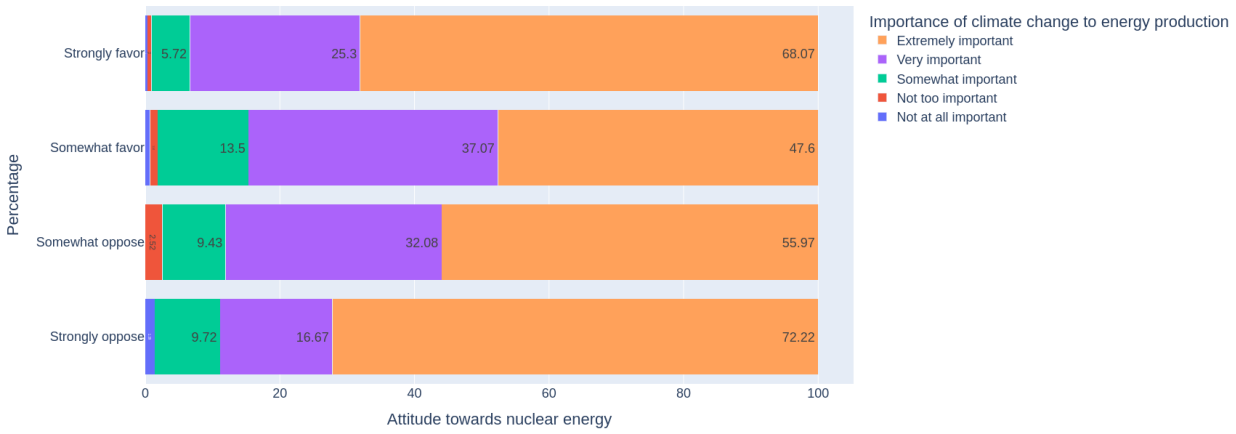

Figure 14. Respondent's race from the Bisconti dataset

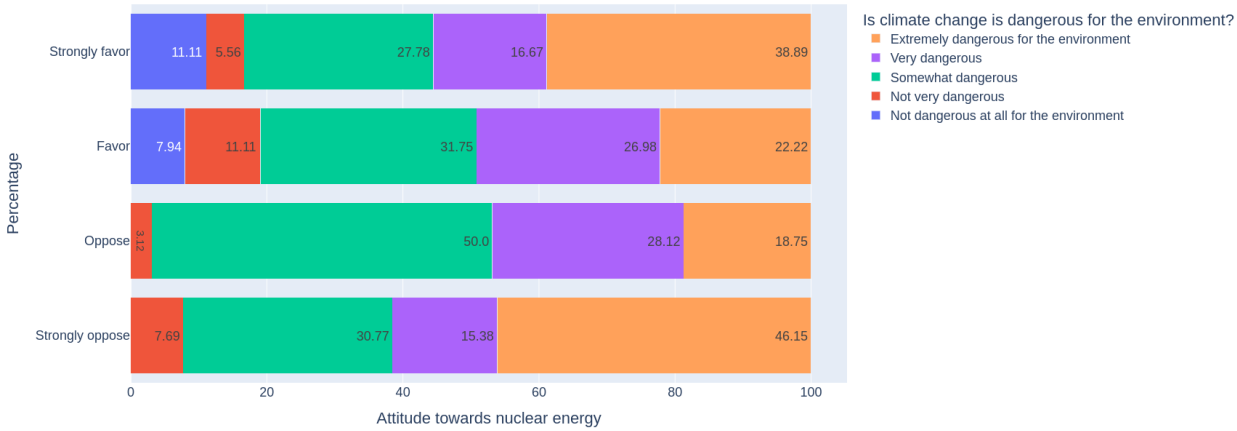

Figure 15. Respondent's race from the Smith dataset

the two surveys, it is clear that opinions of climate change are heightened in the Bisconti survey. One cause for this could simply be the difference in time frame in which each survey was taken. Data from figure 14 was taken in the year 2022, twelve years after the data from figure 15 was taken. Perhaps during these years opinions and awareness of climate change changed, resulting in the data presented here today.

2.9 Attitudes over time

When comparing the data between the Gupta and Bisconti datasets in figure 16, immediately one will notice that the values match very closely. The Gupta data does have more spikes in opinions than the Bisconti, which somewhat more smooth. This is quite interesting, as it suggests the Bisconti data is a fairly representative sample of America's opinions as a whole when it comes to the general question of if Americans support the use of nuclear energy in this country.

The Gutpa and Bisconti data (figure 17) shows that support was always high in the past few decades, and was never outnumbered by those who opposed it until around 2016. Support ranges from 58% to almost 70% from the Gupta data alone, but it resides in a smaller range than the Bisconti survey. Again, this could be due to both location and time period. The Bisconti data was always higher overall, but this is especially true when comparing data from the past with respondents who do not necessarily live near a nuclear plant.

In the years prior to 2008 as shown in figure 17, the two surveys conflict each other, as the Bisconti survey trends in the opposite direction of the Smith dataset. Its not the years from 2008 to 2009 that the trends do seem to reflect one another, and support appears to grow. Furthermore, the line graph, shows a steady decline in the late 1970s, and a slow uptick in support until the years 2010.

In the 70's, the most amount of plants were created, and with oil prices dropping, people saw the end of the tunnel for the oil crisis. Therefore, the creation of new nuclear plants was unnecessary. This can be seen by the data point in 1993, where support for building new plants was at roughly 31% while support for nuclear energy was over 60%. And during the rise in opposition in the early 1980's, Reaganomics became a hot topic for the country, as the idea of conserving energy fell to the wayside as oil prices dropped. This is one possible explanation for the lack of support during this time frame.

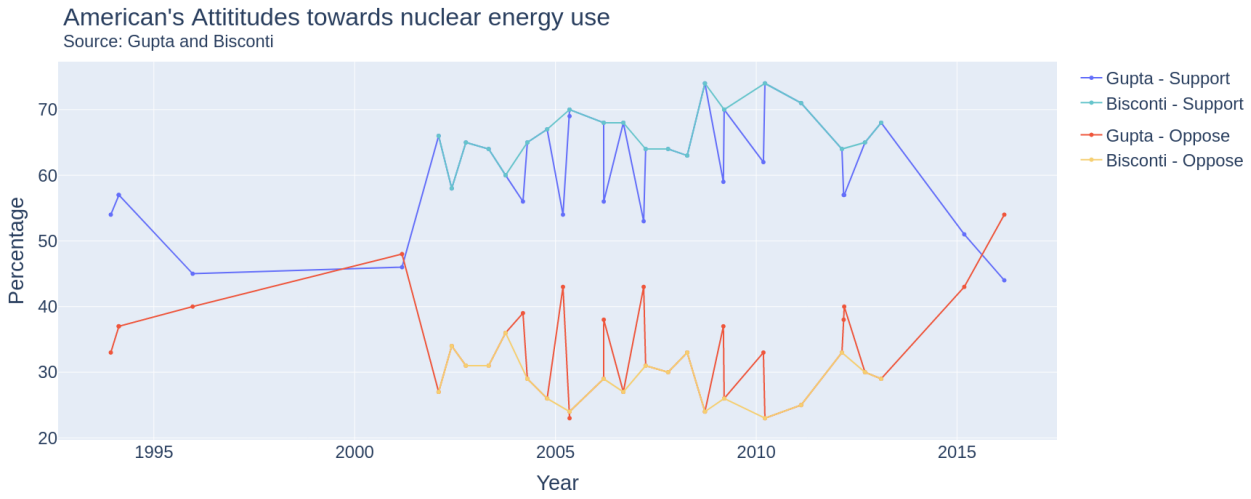

Figure 16. Respondent's responses over the years

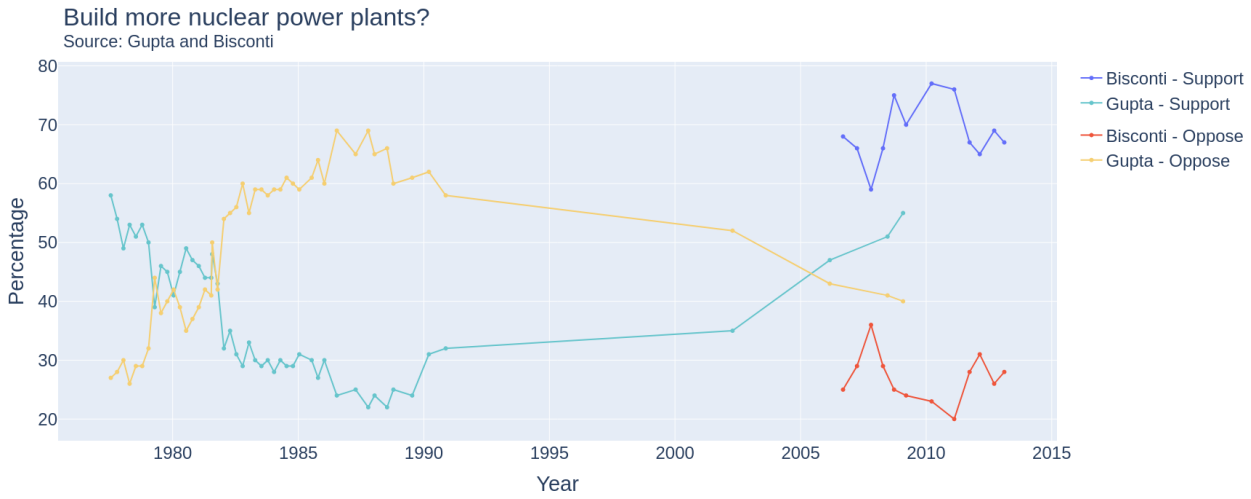

Figure 17. Respondent's responses over the years

3. Results and conclusion

In conclusion, the use of nuclear power plants as a energy production is a divisive topic for the country. Throughout most of the 1980s and 90s, Americans were mostly in opposition of nuclear energy. In the decade prior, the oil crisis was a catastrophe which affected all Americans back at home. Many had concerns about the days of cheap oil being gone. Moreover, the recent disaster, later named the "Three Mile Island accident", lead many to change their minds about the new technology.

It wasn't until the early 2000s that attitudes began to change. The reason for this change was likely due to rising concerns over climate change, then often called global warming. Many events were started around this time, with a focus on the impacts that carbon dioxide had on the environment and on the world. Conferences like the Millennium Summit, and Conference of Parties (COP) 6 were formal global discussions about how each country might together solve a common problem. These conferences were well talked about not only within political and scientific circles, but among the general populations as well. Mounting concerns like these are likely to sway public opinion.

Attitudes typically range wildly from as low as 30% to as high as 70% in support, and the mean of support was 57%.As of recently, most are in favor of nuclear energy, as can be seen by the Bisconti and Smith survey data. There was a brief period of time from around the year 2000 to 2006 in which Americans supported nuclear energy, but many did not want any new plants to be built. Since that time, public opinion has favored both nuclear energy and more plants to be built.

Furthermore, there are few factors within standard demographics records which can predict support for nuclear energy. Political ideology (political leaning) one such out-liar. Conservatives tend to favor nuclear energy more. However political party affiliation is not. Republicans, for instance, do not favor nuclear energy significantly more than independents

or Democrats. Whether or not one is concerned with climate change somewhat unrelated. Those who have strong opinions on climate change are slightly more likely to either strongly support or strongly oppose nuclear energy. The last indicator can be seen taken from the respondent's sex where males tend to strongly favor nuclear energy much more than females.

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