The Words, Policies, and Deeds of Global Climate Change Mitigation

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Abstract

This paper studies the disparities between a country's formal statements and their actions in the context of climate change mitigation. Countries all over the world have been cooperating on setting goals for themselves and creating treaties to lower energy consumption internationally, yet the high amount of consumption and greenhouse gas production takes away from what appears to be productive cooperation. Even with increases in renewable energy consumption, the consumption of fossil fuel energy is still gradually increasing for most countries. Given the discovered differences between what countries say versus what they do to combat climate change, it is important to speculate on which values drive their decision-making. With this insight, effective policies and robust transitions into renewable energy can be created to help mitigate the issue of climate change.

I. Introduction

Climate change is one of the most salient, pressing issues that has been at the forefront of discussion for policymakers worldwide. Effects from climate change can be felt directly by individuals, various species of animals, and the ecosystems that they all cohabitate in. Broad effects from climate change include droughts, heat waves, storms, melting glaciers, rising sea levels, increasing temperatures in the oceans, and increased frequency in dangerous weather patterns. The residual damages from these effects can also threaten existing infrastructure and limit agricultural opportunities.[1]

A cited reason for climate change occurring and subsequently causing damage to ecosystems is the volume of greenhouse gas (GHG) emissions blanketing the Earth.[2] This blanketing effect, in turn, traps heat in the Earth's atmosphere. GHG emissions primarily come from the consumption of fossil fuels like coal, natural gas, petroleum, and other oils used for energy.[3]

It's a fascinating phenomenon that policymakers still not been able to create global strategies to mitigate the growing concerns pertaining to climate change despite the many threats that the issue has presented to the world. Even if there is no individual incentive to pursue mitigation strategies, one would like to think that the potential harms of climate change, such as an uninhabitable planet, would deter the many interdependent parties involved from actively

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[1] "Climate Change Impacts." *National Oceanic and Atmospheric Administration*, 13 Aug. 2021, https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts.

[2] "Climate Action Fast Facts." *United Nations*, United Nations, https://www.un.org/en/climatechange/science/key-findings#physical-science.

[3] "Causes and Greenhouse Effect." *Geographical Survey Ireland*, Department of the Environment, Climate and Communications, https://www.gsi.ie/en-ie/geoscience-topics/climate-change/Pages/Causes-and-the-greenhouse-effect.aspx.

contributing to the problem. Unfortunately, it seems that this is not the reality of the situation, and it's important to figure out why.

Perhaps the context surrounding climate change is too complex with a vast number of possible strategies. With this complexity, achieving successful mitigation is impossible for countries and companies even if they wanted to.

A scenario with similar complications was seen in the real world on the gameshow *Survivor: Thailand.* In one episode, the two teams (tribes) on the show played the game of "21 flags" for one of the challenges that the tribes compete in each episode.[4] The losing tribe has to vote out a tribe member, so there was great incentive for each tribe to try and win. The rules of this game can seem simple: one tribe is randomly selected to take away either 1, 2, or 3 flags at a time from the original total of 21 flags. The tribes continue this process, switching between each other after every turn. The winning tribe is the one who takes the last remaining flag, whether that is done by taking 1, 2, or 3 flags.

At first glance, this game can seem slightly complicated. In fact, there are 223,317 possible ways that this game can unfold [See Fig. 1]. However, the winning strategy is simply to keep the opponent at a multiple of 4 flags. This ensures victory since the opponent will be forced to leave 1, 2, or 3 flags at the end. Once you know this strategy, the game should unfold in a simple manner. To contrast this ideal scenario, in the actual challenge played on the episode of *Survivor*, the two tribes were unable to follow the winning strategy until the 10th turn out of the 12 total turns.[5] Despite how simple the path to victory should be, the vast amount of different

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[4] "Survivor: 21 Flags." *YouTube,* uploaded by noblestatman, 7 Nov. 2015, https://www.youtube.com/watch?v=aonCsvi0LKc&list=LL&index=4&t=143s

[5] Dixit, Avinash K, and Barry J Nalebuff. *The Art of Strategy*, W. W. Norton & Company, Inc., New York, NY, 2010, p. 46.

possible strategies clouded the tribes' judgement, leaving both unable to properly prepare for the outcome.

Fig. 1-Calculation of Possible Moves in the 21 Flags Game on Python; David Lupea, NYU

```
def flags(n):
    if n == 1:
        return 1
    if n == 2:
        return 2
    if n == 3:
        return 4
    return flags(n - 1) + flags(n - 2) + flags(n - 3)

print(flags(21))
```

```
223317
```

Although this game of 21 flags is different from the "game" of climate change mitigation, there could be similarities drawn between the two. There is a lack of foresight available in both of the games. The "players", or decision makers of the game, weren't able to "anticipate where [their] initial decisions will ultimately lead and use [that] information to calculate [their] best choices" as writers of the book, *The Art of Strategy*, Avinash K. Dixit and Barry J. Nalebuff would put it.[6] Despite the tribes' incentives to strive for victory in the 21 flags game, they acted in ways that weren't optimal for winning. A strategy couldn't be properly reasoned even after

[6] Dixit, Avinash K, and Barry J Nalebuff. *The Art of Strategy*, W. W. Norton & Company, Inc., New York, NY, 2010, p. 35.

tribes were given time to strategize. In an arguably more complex game, like climate change mitigation, countries and companies also act contrary to the planet's best interests because of an inability to anticipate the end result of their decisions. Therefore, it's difficult to act accordingly in the present.

Further thought into this idea led to some skepticism on the accuracy of this relationship drawn between the 21 flags game and the game of climate change mitigation. It would be perfectly reasonable to assume that the best interests of the planet as a whole doesn't align with the individual interests of countries and companies. Maybe the issue of climate change is persisting simply because individual countries and companies view the issue as a tragedy of the commons. In this case, the benefits experienced by the planet would only occur with total cooperation. Otherwise, no individual country benefits from investing in sustainable practices.

To get an idea on how value systems driving decision-making could be more nuanced than one might think, one can turn to multiple studies of the ultimatum game. This game involves one player having a sum of money to split between themself and their counterpart. The counterpart can then accept the proposed division of this sum or they can reject it and leave both players with no money. Interestingly, it has been observed that about half of the offers end up being rejected when the counterpart is given 20% of the total value or less.[7] It'd be theoretically rational for the counterpart to accept any deal where they get more than $0. They would be better off than they were before, at least financially. Contrastingly, this can be an indicator that individuals don't have to solely value money. Value is also placed into fairness, altruism, and revenge among many other things.

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[7] Dixit, Avinash K, and Barry J Nalebuff. *The Art of Strategy*, W. W. Norton & Company, Inc., New York, NY, 2010, pp. 50–51.

Although there can be other factors outside of financial value taken into account for decisions, this would be difficult to extend to the scale of a whole country. For countries or companies, it's a reasonable assumption that their values stem from their own financial status. It may seem irrational for countries and companies to not put in great amounts of work to mitigate climate change. Without a livable planet, there won't be a country nor a company to run. However, it's possible that these countries and companies don't currently view mitigating climate change as something that is a priority for themselves to act upon. There's a lack of individual financial incentive that they're most likely seeking.

This thought of countries, in particular, not valuing climate change mitigation efforts can seem peculiar when looking at how many countries are setting targets for emissions cuts and working together to set treaties. The Paris Climate Accords, for example, has allowed 196 parties to agree upon steps that all of the countries can take together to combat climate change.[8] With the resulting words and promises from these targets and treaties, it could appear as if countries do indeed place a high value on mitigating climate change.

Countries' words should ideally be an indicator of what their actions will look like. This idea has led to the main research question: Are the efforts of countries to mitigate climate change reflective of what they say they're going to do? Essentially, this question tests the idea of "talk is cheap". It's hypothesized that if a country has set ambitious goals and targets for itself to mitigate climate change, then this should be reflected in some sort of data. For instance, some countries set targets for when they want to be GHG neutral. Being GHG neutral means emitting

[8] "The Paris Agreement." *United Nations Framework Convention on Climate Change*, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

less GHG than what is naturally absorbed by the planet.[9] If one country sets this target's deadline earlier than other countries, then they should ideally have lower GHG production than its counterparts.

It's important to answer this question because it's vital to minimize the subsequent damages of climate change mentioned earlier in order for our future generations to live on a habitable Earth. It's crucial to identify if there's an ongoing issue of countries not acting in accordance with their mitigation targets and goals. If this is a persistent issue, it can spark further discussion in how to incent these countries to limit the effects of climate change. Likewise, two different countries with similar ambition can still yield a difference in success for mitigating climate change. Differences in success could highlight some of the more utile, effective strategies from around the world in lowering GHG emissions.

[9] "A Beginner's Guide to Climate Neutrality." *UNFCCC*, United Nations Climate Change, 26 Feb. 2021, https://unfccc.int/blog/a-beginner-s-guide-to-climate-neutrality.

II. Data Collection

To see a country's actions, or performance in mitigating climate change, the consumption of fossil fuel energy was used as a proxy. The data for this was obtained from the U.S. Energy Information Administration, an administration under the U.S. government that tracks various data and statistics of all things energy related.

The specific set of statistics that were pulled from their database examined international total energy consumption. Data was recorded for 230 countries and territories, and the data points were comprised of the total consumption of coal, natural gas, petroleum and other liquids, nuclear, and renewables in quadrillion British thermal units (quad Btu) from the years 1980 to 2019 [See Fig. 2]. British thermal units are "the quantity of heat required to raise the temperature of one pound of liquid water by 1 degree Fahrenheit at the temperature that water has its greatest density (approximately 39 degrees Fahrenheit)."[10] The Energy Information Administration has plenty of information on conversions and the practicality of the British thermal unit measure.

Fig. 2-Afghanistan Energy Consumption 2015-2019; Energy Information Administration website

PIN	API		2015	2016	2017	2018	2019
		Afghanistan					
		Consumption (quad Btu)	0.126	0.118	0.125	0.143	0.123
		Coal (quad Btu)	0.028	0.035	0.046	0.051	0.045
		Natural gas (quad Btu)	0.005	0.006	0.006	0.006	0.005
		Petroleum and other liquids (quad Btu)	0.07	0.052	0.047	0.061	0.049
		Nuclear, renewables, and other (quad Btu)	0.023	0.025	0.026	0.026	0.025
		Nuclear (quad Btu)	–	–	–	–	–
		Renewables and other (quad Btu)	0.023	0.025	0.026	0.026	0.025

[10] "Units and Calculators Explained: British Thermal Units (Btu)." *U.S. Energy Information Administration*, 13 May 2021, https://www.eia.gov/energyexplained/units-and-calculators/british-thermal-units.php.

In order to filter out irrelevant data points, the only energy sources that were examined include coal, natural gas, petroleum, and other liquid energy sources. These were used since they were the only energy sources that qualified as fossil fuels. As noted before, the consumption of fossil fuels is a great contributor to the GHG that blankets Earth and accelerates climate change. With this in mind, the consumption of these energy sources seems like an appropriate proxy for evaluating a country's performance against climate change.

To fulfill the second measure of interest, a proxy will be needed for the ambitiousness in each country's targets and goals for cutting emissions. Of course, this can be something that is difficult to quantify. In an attempt to resolve this issue, data was pulled from the Climate Change Performance Index (CCPI) of 2020. The year 2020 was used for the index since it followed the dates that were available in the energy consumption data. The CCPI ranks 61 salient countries on 4 main categories: energy use, renewable energy, GHG emissions, and climate policy. Although the climate policy section would seem as if it took into account the actions of the countries, much of the ranking in this section dealt with the ambitiousness of their targets to reduce waste and emissions. Since the rankings appeared to align with the second measure of interest, the CCPI rankings for climate policy were used as a proxy for the ambitiousness of statements.

To simplify our examination of each country's statements in relation to their actions, a subset of countries was selected based on two key criteria. The first qualifying criterion is that their consumption was 10 quad Btu or greater in the most recently recorded year (2019). The other of the criteria is that their average consumption minus 2019's consumption was greater than 1 quad Btu. The first yields the countries who are leaders in consumption levels while the second yields the countries who exhibit signs that they may be actively lowering their consumption. The main reason for picking these criteria was to create a simplified pool of

countries to examine the research question with. With the two main measurements taken care of and a subset of countries to examine, the actions of the countries can be compared to their respective targets and goals.

III. Data Analysis

Based on the criteria previously explained, there were a total of 12 countries of interest selected for examining the research question. There were 10 countries who consumed more than 10 quad Btu in the year 2019: Canada, China, Germany, India, Iran, Japan, Russia, Saudi Arabia, South Korea, and the United States. 3 countries had a difference greater than 1 quad Btu between their average consumption and their consumption in 2019: Germany, Ukraine, and the United Kingdom. Germany was counted in both groups, displaying high consumption yet a decline in consumption over the years.

Countries were mapped out onto a graph from 1992-2019 [See Fig. 3]. 1992 was the chosen starting point since many countries' data begins as this point due to the end of the Cold War. A quick look at the graph will make it clear that the United States and China have been consuming energy at higher volumes than any other country. As of 2019, the United States consumed 81.8970 quad Btu of fossil fuels, and China consumed 130.5845 quad Btu. For more perspective, Russia is the next closest country in consumption, but their quantity consumed is only 29.5255 quad Btu. The United States does appear decently constant from 1992 to 2019, but China has been on a steep rise. To get a better idea of this, the difference in average consumption and 2019 consumption for the United States is -4.5356 quad Btu while it's -69.9539 quad Btu for China [See Table 1].

Fig. 3- Countries of Interest Fossil Fuel Consumption (1992-2019)

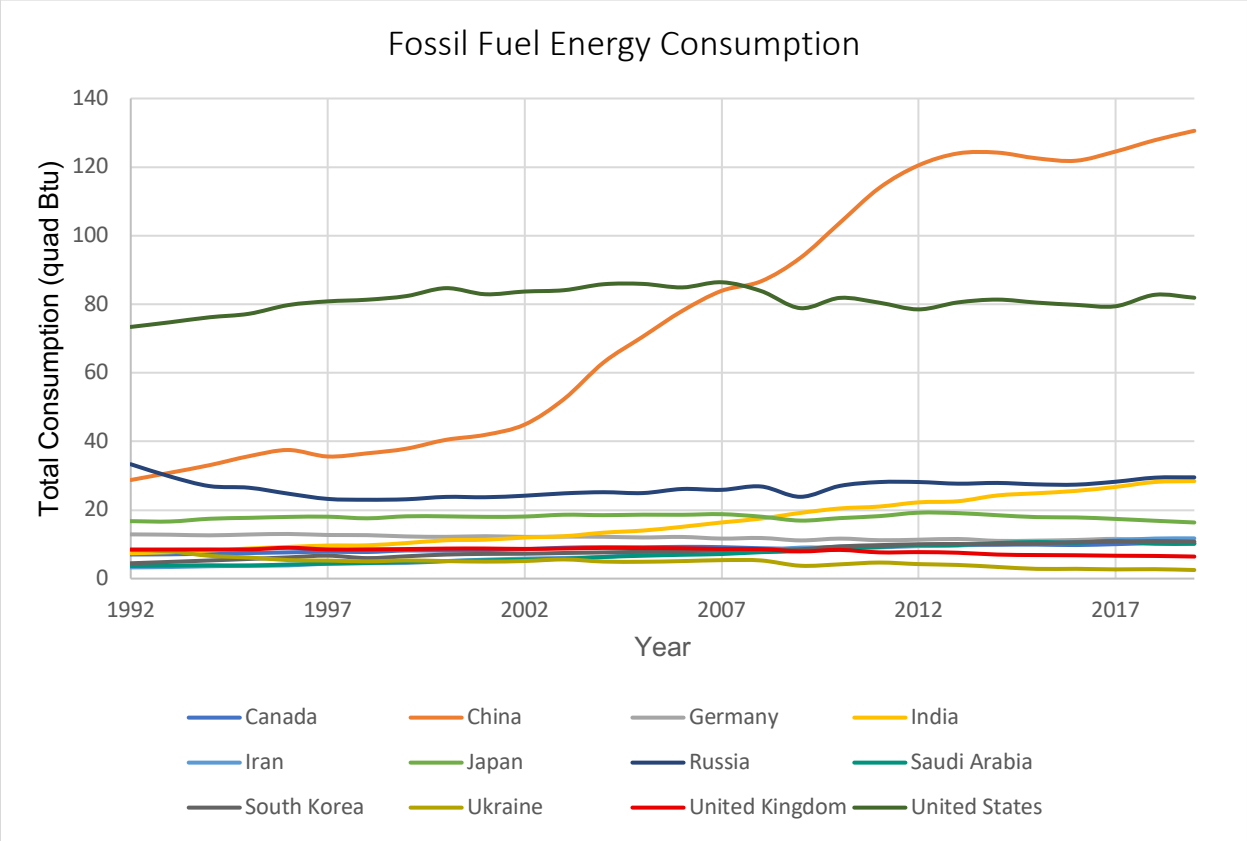


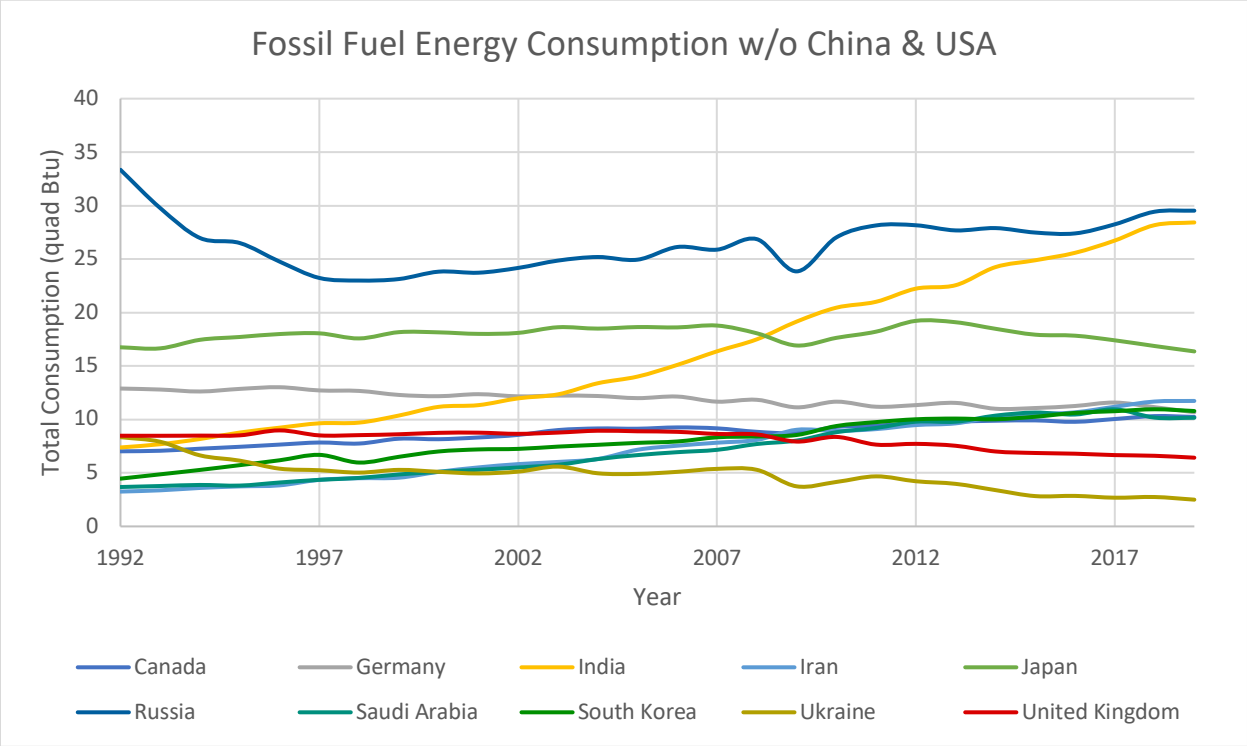
Table 1- Measures of the Consumption Over Time for the Countries of Interest

Country	AVERAGE*	AverageDIFF**	BeginningDIFF***
Canada	8.09015377	-2.148599544	-3.642029988
China	60.6305867	-69.95389782	-112.0695564
Germany	11.9849032	1.315181444	2.655085479
India	12.9416696	-15.48299364	-25.18900543
Iran	5.76108518	-5.971561149	-10.18815076
Japan	16.8521073	0.48771691	-2.265335866
Russia	26.4682728	-3.057242259	3.822949918
Saudi Arabia	5.75069648	-4.40642009	-8.503289295
South Korea	6.41165949	-4.377317722	-8.960392802
Ukraine	4.79406002	2.293256142	5.84605939
United Kingdom	8.14421826	1.719382301	2.149693228
United States	77.3613348	-4.535652799	-12.07975383

*AVERAGE=Average consumption from oldest year recorded to most recent year recorded (all in quad Btu)
**AverageDIFF=Difference between the average consumption and consumption of the most recently recorded year
***BeginningDIFF=Difference between the oldest year recorded minus the most recent year recorded

To get a better idea of what has been going on for countries outside of China and the United States, the other countries were also graphed separately [See Fig. 4]. Here, there's a noticeable rise in consumption from India and Saudi Arabia. There's also an interesting ramp-like shape from Russia where they decreased consumption from around 1992-1998 and then increased beyond 1999. Germany, Ukraine, and the United Kingdom have been decreasing in consumption. The rest of the countries appear to be decently constant in their consumption.

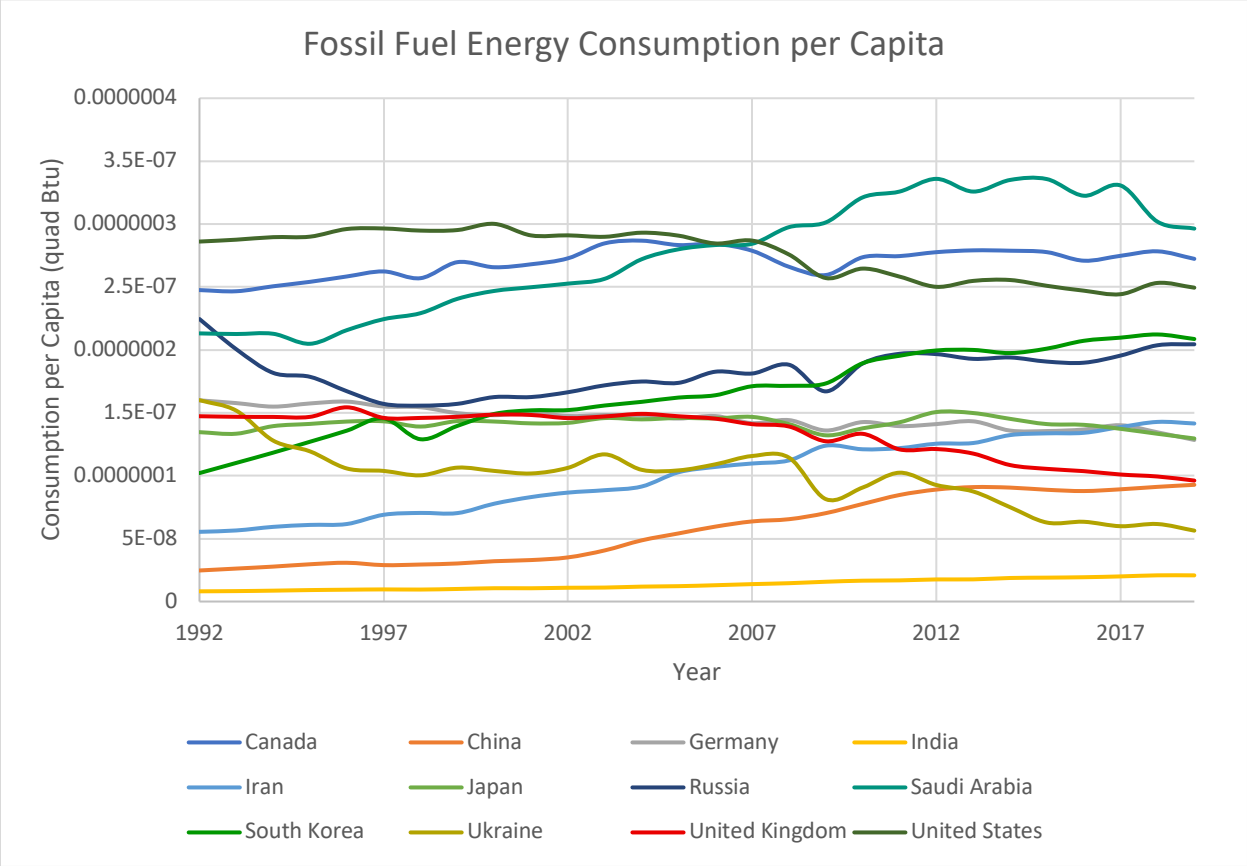
Fig. 4-Countries of Interest Fossil Fuel Consumption (1992-2019) without China & U.S.



Getting a general idea of the total consumption is a vital piece of the analysis. However, to potentially obtain new insights, the countries' consumption per capita was also graphed out [See Fig. 5]. These data were derived from the existing consumption data along with the World Bank's data on each country's population. Saudi Arabia and Canada are at the top of

consumption per capita, while India, Ukraine, and China are at the bottom of consumption per capita. Another interesting note is that the United States is the only country with an increase in total consumption yet a decrease in consumption per capita. It would be a fair argument for some to say that the per capita consumption isn't too important if the country as a whole is still consuming at such large quantities, but it is interesting to see this slight difference between total consumption and per capita consumption. Per capita consumption could also be an indicator of countries with better policy.

Fig. 5-Countries of Interest Fossil Fuel Consumption per Capita (1992-2019)



With the policy of each country in mind, one could turn to the CCPI rankings of climate policy for the measure of ambitiousness in statements, targets, and goals of the various countries. Filtering in for only the countries of interest, the rankings were stacked up against one another [See Table 2].

Table 2- Countries of Interest Climate Policy Rankings; CCPI 2020

Country	CCPI 2020 Climate Policy Rank
Canada	21
China	10
Germany	17
India	15
Iran	25
Japan	56
Russia	48
Saudi Arabia	34
South Korea	29
Ukraine	49
United Kingdom	12
United States	60

Overall, there aren't any strong, detectable relationships between a country's climate policy ranking and their performance on consumption. One example of this from the countries of interest can be seen between China and Ukraine. China was ranked 10th for their climate policy while Ukraine was ranked at 49th. This is interesting due to the fact that Ukraine has consistently been decreasing their total consumption over the years spanned by the data. In fact, Ukraine has the highest measure of average consumption minus 2019 consumption out of the whole dataset. These are indications of Ukraine's efficacy in lowering their consumption and therefore lowering their contributions to climate change. Additionally, Ukraine has been the 2nd lowest in consumption per capita since about 2013 among the countries of interest.

Looking at China, on the other hand, their total consumption has been far beyond that of any other country in the whole dataset. Some positives can be taken away from China. After all, they have the 3rd lowest per capita consumption out of the countries of interest. Unfortunately, this number has been on a steady incline since the early 2000's. Subjectively, it can be argued that these statistics may not warrant China being ranked so much higher than Ukraine. Out of all of the countries ranked by the CCPI, China wound up in the 84th percentile while Ukraine was in the 20th percentile. Ukraine's better performance in energy consumption does not seem to match with these rankings.

Additional variation in the CCPI between Ukraine and China came in their respective analyses for climate policy. Ukraine was viewed negatively by national experts because of their "lack of a coal phase-out plan and the government's unambitious targets. Hence the country's 2030 GHG emission reduction and renewable energy targets are rated *low*…"[11] To contrast this, China received more praise by these national experts as they "acknowledge that China put a lot of effort to over achieve its 2020 goals in the run up to national GHG emissions 2030 targets."[12] Despite this disparity in praise, an in-depth look at the energy consumption data would make one believe that Ukraine is out-performing China on the ambitiousness of their targets.

A proposed idea from the CCPI as to why Ukraine is successful at keeping their energy consumption so low is that they have been experiencing conflict and turmoil in areas rich in coal and other key energy sources. To verify if this phenomenon was exclusive to Ukraine and China, a simple linear regression was run using the CCPI climate policy ranking as the predictor

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[11] Burck, Jan, et al. "Results 2020 - Climate Change Performance Index." *NewClimate*, Dec. 2019, p.19, https://newclimate.org/wp-content/uploads/2019/12/CCPI-2020-Results_Web_Version.pdf.

[12] Burck, Jan, et al. "Results 2020 - Climate Change Performance Index." *NewClimate*, Dec. 2019, p.20, https://newclimate.org/wp-content/uploads/2019/12/CCPI-2020-Results_Web_Version.pdf.

variable. The variable being predicted was the average consumption per capita minus the 2019 consumption per capita for each country of interest [See Table 3]. Here there's a p-value of about 0.4206 for the variable of the CCPI climate policy rank. There is no statistical significance between the proxies of mitigation performance and mitigation ambition.

Table 3-Regression Between Climate Policy Ranking & Average Fossil Fuel Consumption per Capita Minus 2019 Fossil Fuel Consumption per Capita (in quad Btu)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.256709747
R Square	0.065899894
Adjusted R Square	-0.027510117
Standard	3.97007E-08
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.11196E-15	1.11196E-15	0.705490703	0.420572474
Residual	10	1.57615E-14	1.57615E-15		
Total	11	1.68734E-14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.82755E-08	2.39984E-08	-1.178226111	0.265983502	-8.17473E-08	2.51962E-08	-8.17473E-08	2.51962E-08
CCPI 2020 Climate Policy Rank	5.65214E-10	6.72926E-10	0.83993494	0.420572474	-9.34158E-10	2.06459E-09	-9.34158E-10	2.06459E-09

Being that there was no detectable correlation, the regression was run one more time with the overall CCPI ranking as the predictor variable instead [See Tables 4 & 5]. Interestingly, there would be a statistically significant correlation with an alpha of 10% since the p-value comes out to about 0.0764. However, it can be difficult to deduce anything from this analysis since renewable energy production is weighed into the CCPI ranking and not the fossil fuel consumption. Also, an alpha of 10% can be relatively high compared to the typical 5%. In the case of using an alpha of 5%, there wouldn't be a statistically significant correlation. Overall,

there isn't much here besides an interesting observation that expresses slight correlation between the CCPI ranking and energy consumption of the countries.

Table 4-Countries of Interest Overall Ranking; CCPI 2020

Country	CCPI 2020 Overall Ranking
Canada	55
China	30
Germany	23
India	9
Iran	57
Japan	51
Russia	52
Saudi Arabia	60
South Korea	58
Ukraine	17
United Kingdom	7
United States	61

Table 5-Regression Between Overall CCPI Ranking & Average Fossil Fuel Consumption per Capita Minus 2019 Fossil Fuel Consumption per Capita (in quad Btu)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.529846203
R Square	0.280736999
Adjusted R Square	0.208810699
Standard	3.48374E-08
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.737E-15	4.737E-15	3.903120253	0.076425773
Residual	10	1.21364E-14	1.21364E-15		
Total	11	1.68734E-14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.87155E-08	2.22814E-08	1.288764738	0.226495618	-2.09306E-08	7.83615E-08	-2.09306E-08	7.83615E-08
CCPI 2020 Overall Rank	-9.82025E-10	4.97069E-10	-1.975631609	0.076425773	-2.08956E-09	1.25513E-10	-2.08956E-09	1.25513E-10

IV. Implications

With no detectable relationship between a country's ambitious statements and their actions in climate change mitigation, it's important to speculate as to why this may be occurring. Starting by looking at China, it has been noted that on 3 occasions in the past 4 years, the country decided to heavily ramp up production of coal in times of economic slowdown and energy shortages.[13] Here, there appears to be a misalignment in what China prioritizes over what is best for the longevity of the planet. China values having energy from fossil fuels to easily quell these energy shortages and economic downturn. Whether this is just or not is up for debate. If lives are on the line and fossil fuel consumption is necessary, maybe people would decide that it's worth saving the lives today at the cost of Earth's long-run sustainability.

One would hope that an increase in alternative energy sources would subdue the need to rely on fossil fuel consumption for potential life-saving scenarios. To assist in pondering this point, the consumption of renewable and nuclear energy from the same countries of interest was graphed out [See Fig. 6]. It can be noted that every country is increasing in renewable and nuclear energy, with the exception of Japan. Japan's decrease can be linked to their 2011 earthquakes and nuclear disaster devastating parts of the country.[14] China, on the other hand, has been rapidly increasing their renewable and nuclear energy consumption even beyond the United States.

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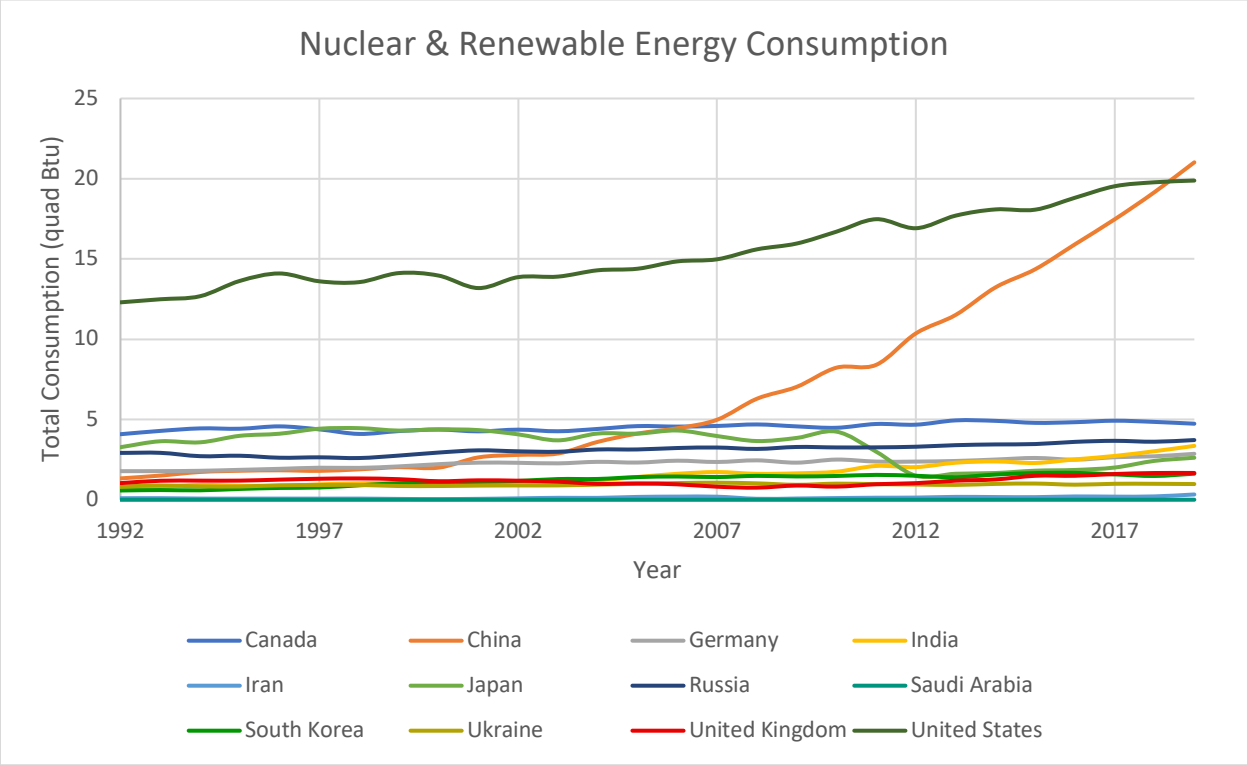
[13] Stalley, Phillip. "China's Climate Change Record: Beijing Tends to Meet Its Targets, but Sets the Bar Too Low." *The Conversation*, 4 Feb. 2022, https://theconversation.com/chinas-climate-change-record-beijing-tends-to-meet-its-targets-but-sets-the-bar-too-low-172138.

[14] "Fukushima Daiichi Accident." *World Nuclear Association*, Apr. 2021, https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.aspx.

Fig. 6-Countries of Interest Nuclear & Renewable Energy Consumption (1992-2019)



Unfortunately, the rise in alternative energy sources hasn't seemed to curb most of the countries' fossil fuel consumption. A regression was conducted using the average renewable and nuclear energy consumption of a country minus its respective 2019 consumption as the predictor. The variable being predicted was the average fossil fuel consumption of a country minus the respective 2019 consumption [See Table 6]. This regression found a statistically significant positive correlation with a p-value of 8.5323E-06. Countries who were successful at increasing their renewable and nuclear energy consumption were also countries with large fossil fuel energy consumption. Hopefully the absence of decreasing fossil fuel consumption is due to a transition period needed to fully switch from fossil fuels to renewables. Otherwise, the rise in renewable energy does not hold much value in combatting climate change.

Table 6- Regression Between Average Alternative Energy Consumption Minus 2019 Alternative Energy Consumption & Average Fossil Fuel Consumption Minus 2019 Fossil Fuel Consumption (in quad Btu)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.934449924
R Square	0.873196661
Adjusted R Square	0.860516327
Standard Error	7.425953842
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3797.395825	3797.395825	68.86227682	8.53235E-06
Residual	10	551.4479046	55.14479046		
Total	11	4348.84373			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.237396381	2.397762326	0.09900747	0.92308893	-5.105151017	5.579943778	-5.105151017	5.579943778
AverageDIFF	4.024384349	0.484963175	8.298329761	8.53E-06	2.943819056	5.104949641	2.943819056	5.104949641

Research in the future should continue to seek efficient strategies in decreasing fossil fuel consumption since increasing the nuclear and renewable energy sources has not been enough. Looking at Germany, they have recently updated a policy they've had in place known as the Climate Action Law. This update, taking place in 2021, set targets for emissions cuts for each economic sector, created annual budgets for all of these cuts, and made the targets legally binding.[15] When first hearing about this policy, it could sound very promising in terms of climate change mitigation. The effectiveness of such policies should be closely researched and examined through the next few years. Countries struggling in the fight against climate change should begin implementing strategies and policies deemed to be most effective.

[15] Appunn, Kerstine, and Julian Wettengel. "Germany's Climate Action Law." *Clean Energy Wire*, 12 July 2021, https://www.cleanenergywire.org/factsheets/germanys-climate-action-law-begins-take-shape.

When considering future research, it is also important to keep in mind some of the struggles with this paper. With the broadness of the consumption data from the Energy Information Administration, there are many different directions that the data analysis could have gone. There's a good chance there's a measure more optimal than average consumption minus the most recent year's consumption.

Another restriction that comes up is the difficulty to find a proxy for the quantitative weight of ambitions and targets that countries make in formal statements. These are qualitative by nature, and it can be tough to attempt a quantitative analysis using them. Using the CCPI rankings removes a portion of objectivity. Any ranking system is at least marginally subjective. Even if the rankings are purely backed by data, the weight put on each data point is entirely chosen by the creators of the rankings.

The data was also restricted since the most recently recorded year of data from the Energy Information Administration was 2019. There have been many developments since 2019 in terms of climate change, which is a rapidly evolving issue. Using data from the past to inform our future decisions could be a slight extrapolation. One would like to believe that the best predictor of future behavior is past behavior, but this issue is changing so constantly that this belief may not carry over. Looking at 30-month-old data may hinder some utility of the analysis. It can also be difficult to use data from the past to judge a country's current performance in climate change mitigation.

Once a viable strategy is detected from future research, it would be insightful to conduct experiments to see how certain incentive systems would work from a behavioral standpoint.

Using game theory to examine climate change mitigation has been a growing idea.[16] The teachings that will come from a game theory laboratory could assist in detecting the optimal strategies and implementation of said strategies; the world desperately needs strategy to alleviate climate change and its side effects.

[16] Woodhouse, Phil, and Admos Chimhowu. "Development Studies, Nature and Natural Resources: Changing Narratives and Discursive Practices." *A Radical History of Development Studies*, 2nd ed., Zed Books, 2019, pp. 193.

V. Conclusion

This paper ultimately assisted in clarifying the existing gap of country targets versus how these targets come to fruition. Focus must be shifted on what countries are doing beyond the surface. Politicians should be pressured to offer more than just idle targets. Instead, in-depth policy to incent eco-friendly behavior should be publicized.

Policy will be the most important contributor to mitigating climate change at the end of the day. It must also be cheap enough for countries to comfortably shift away from fossil fuels into alternative energy sources. With this, it would be more accessible for less-wealthy countries, and it would also be feasible to maintain wealth for the richer countries.

The rapid increase in renewables and nuclear energy is seemingly a great start for creating feasible alternatives to fossil fuels. However, there still needs to be a successful transition from the vast amount of fossil fuel energy used today into these energy sources said to be less harmful to the planet. As of 2019, there was no detectable decrease in non-renewable energy use with an increase in renewable energy use, which is the desired relationship between the two.

Combining a feasible alternative energy source and a strategic policy implementation should be a great help in allowing the world to manage the risk of climate change. There is yet to be a universal strategy deemed optimal enough for all countries to put in legislation. Fortunately, with countries like Germany experimenting with policy, there is hope that an answer is just around the corner. There is great opportunity for behavioral economics researchers to really examine if such policies could satisfy the needs of the many interdependent parties at play here. After, the only objective that would remain is implementing these strategic policies into widespread law. With the salience and the rise in cooperation to tackle climate change, there is a

future to behold in mitigating the issue. There's work to be done, but with enough effort and pressure on politicians, it is very possible to halt the adverse effects caused by climate change.