Climate Change and the Authoritarian Alternative: Quantifying the effects of Beijing's 2008 Space Rationing Policy on Air Quality

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ABSTRACT

A growing body of literature has indicated a propensity for authoritarian policy responses to public health obstacles caused by climate change among governments of emerging countries located in Latin America and Southeast Asia. Though previous research has provided sufficient explanations for this trend, citing lack of economic resources and disproportionate geographic vulnerability, there is a significant deficiency in research examining the impacts of such authoritarian policy regimes on air quality. This case study examines Beijing, China's 2008 Summer Olympics Space Rationing Policy, in which license-plate numbers determined whether a vehicle was allowed to drive within city limits during peak traffic hours, and its impact on particulate matter concentrations over a 10-year period from 2008 to 2017 using secondary data collected by the U.S. Embassy in Beijing to determine the effectiveness of authoritarian environmental policy. I calculated summary statistics for each period of policy implementation and compared it to the equivalent pre-treatment day period to measure the absolute and percent change in PM2.5 concentrations with respect to the U.S. Environmental Protection Agency's Air Quality Index. The initial policy implementation from July 20th to August 24th, 2008 was the only period which exhibited a negative absolute and percent change in mean, median, and standard deviation concentrations of PM2.5, dropping from an average of 95.54286 to 70.59722 micrograms per cubic meter for a percent change of -26.10937. The PM2.5 concentrations over the 10-year study period exhibited an absolute improvement in AQI, peaking at an average of 104.0457 to the lowest record average of 70.07739 micrograms per cubic meter in 2017, consistent with the application of additional and more restrictive measures to combat smog which has historically persisted within the city of Beijing.

KEYWORDS

Particulate Matter (PM 2.5), Beijing 2008 Summer Olympics, end license plate number, U.S. Embassy, environmental authoritarianism

INTRODUCTION

There exists a narrowing window to stop the most negative outcomes of climate change and avoid a widespread climate catastrophe (IPCC 2016). In a 2018 assessment the IPCC stated that "Limiting global warming to 1.5°C would require rapid, far-reaching and unprecedented changes in all aspects of society", indicating an urgency to discard more moderate solutions in favor of drastic measures. Environmental Authoritarianism policy is a potential interpretation of this sentiment, one that is justified by science denialism and a lack of public consensus on the reality of climate change (Leiserowitz et al. 2009, Funk 2020) and one that is becoming increasingly relevant internationally as many governments have begun to favor the authoritarian alternative (Beeson 2010). For these developing countries which lack the economic and legislative resources, as well as the infrastructure necessary to insulate themselves from natural disasters, market based solutions and scientific investment remain unviable and out of reach (Fritsche et al. 2012). Rather than continue to discard the possibility of authoritarianism as a mechanism in combating climate change, we should begin to study the impact that such policies have on the environment around us, a truth that for some has already been realized and for others is fast approaching(SHAHAR 2015).

Environmental Authoritarianism (henceforth EA) is a top down, non-participatory environmental policy approach which gives governments complete control over all environmental policy decisions(Dean 2002). There are many examples of AE policy which combat the sources of climate as well as policy which focuses on lessening the impact of climate change. But these two principles are not mutually exclusive, an example of an AE policy which aims to immediately combat both is China's Road Space Rationing policy. In order to measure the effectiveness of Environmental Authoritarianism, a good case study would look at a large-scale policy implementation of Road Space Rationing that took place over a long term period to measure PM 2.5, and would be applicable to macro level discussions about Environmental Authoritarianism (Fann and Risley 2013).

China's positionality as a developing country which has gone through recent demographic and economic change make it an ideal case study for the implementation of contemporary Environmental Authoritarianism, as it allows for relevant conclusions to be drawn that contribute to macro level discussions (Zhao 2003, Middeldorp and Le Billon 2019). Beijing is the capital of the People's Republic of China with a population of over 21 million people. The municipality has the second highest urban population of any Chinese city, with over 5 million vehicles according to a 2014 estimate. In order to combat road congestion and local air pollution in preparation for the 2008 summer Olympics that took place from August 8th to 24th, Beijing implemented Road Space Rationing under the National Climate Change Programme. Road Space Rationing was a policy regime comprising the odd-even license plate, end-license plate number, yellow car, and pollution red alert policies (Beijing 2020). In order to understand the impact of Environmental Authoritarianism policy, I will analyze the effectiveness of the 2008 Beijing Olympics Road Space Rationing Policy on PM 2.5. To draw conclusions about the robustness of air quality improvement, I will be analyzing the short and long term effects of the policy over a 10-year period, starting from before its implementation in July 2006 and ending in July 2016. Using R, I will engage in quantitative analysis comparing the various air quality metrics during the implementation of RSR using datasets collected from the U.S. Embassy in Beijing.

Environmental authoritarianism

Due to the conflict between climate change, public health, socioeconomic and political factors, more and more developing and developed countries alike are considering the authoritarian alternative. Authoritarian Environmentalism (AE) presents a model of top-down, non-participatory environmental policy-making (McCarthy, 2019). The centralized approach of AE grants it unique advantages, primarily reconciling the conflicts between environmental concerns and individual liberties through government mandates (McCarthy, 2019). Mandates often result in the compromise of individual rights and raise concerns about government overreach (Eaton & Kostka, 2014). AE policy does not necessitate an authoritarian state, although it is often practiced by authoritarian governments. Although not widely implemented in many countries, those facing consequences of climate change exacerbated by economic, political, public health, demographic, and social conditions are looking towards AE as a potential solution (Shultz et al., 1994).

China demographic changes, urbanization, and air pollution

The demographic changes that have taken place in China over the last decades have exacerbated poor air quality conditions in urban areas. The family planning policies implemented in China throughout the latter half of the 20th century have accelerated the declining birthrate while their low death rate stabilized. As the Country's GDP has grown, the rate of urbanization has also increased. Current projections estimate an urbanization rate of 80% by the year 2050 (Gu et al., 2017). The growing working age population, aging population, rates of urbanization, and floating population all have positively contributed to carbon emissions, with Urbanization considered to be the main factor driving this growth in pollution. The majority of the rural to urban transition has occurred within the last 2 decades, with the rate increasing year over year, exacerbating the public health conditions within major cities (Yang et al., 2015). Nowhere is this trend more pronounced than in the Beijing Municipality.

The policy of space rationing

The Beijing Municipality is a special administrative region, where the central government has direct control over the city within the Beijing province, granting them more access and ability to enforce laws. This is in contrast with the majority of cities in China, which are governed by local and provincial level authorities. Beijing is the capital of the People's Republic of China with a population of over 21 million people. The municipality has the second highest urban population of any Chinese city, with over 5 million vehicles according to a 2014 estimate (Lee at al., 2008). In order to combat road congestion and local air pollution in preparation for the 2008 summer Olympics that took place from August 8th to 24th, Beijing implemented Road Space Rationing under the National Climate Change Programme. Road Space Rationing was a policy regime comprising the odd-even license plate, end-license plate number, yellow car, and pollution red alert policies (Beijing 2020).

The first implementation of the road space rationing for the 2008 Beijing Olympics solely consisted of the odd-even license plate number policy. Beginning on July 20th, just 19 days before the start of the Olympics on August 4th, the restriction would only allow cars with an odd number on the end of their license plate to drive within the city of Beijing on one day and even end number license plate cars the next. Those who did not comply with this restriction would face a fine of 100 yuan, equivalent to $15USD, enforced by road cameras as part of a larger surveillance network

(BBC 2008). This alternation aimed to reduce the number of cars on the road by half, and prevent outdoor Olympic events lasting more than 1 hour from being postponed or potentially canceled.

After the policy was deemed a success by Beijing Traffic Management Bureau and the Beijing Municipal Bureau of Environmental Protection, they created the end-license plate number, yellow car, and pollution red alert policies. The end-license plate number policy was first implemented on September 28, 2008 and ended on January 10th, 2009. This policy prohibited vehicles with an end license plate number of 1 or 6 from driving on public roads on Monday, 2 or 7 on Tuesday, 3 or 8 on Wednesday, etc. The penalty for not abiding by this policy was 200 yuan, equivalent to $30USD (bjjtgl 2012). The Yellow Car policy began January 1st of 2009 and prohibited emission inefficient cars, denoted by a yellow-sticker required to be displayed on their windshield, from driving within the expressway 10 km from the city known as the 5th road ring of Beijing. It is important to note that this is the only policy within Beijing's road space rationing regime which has not ceased implementation since its initial debut. The Pollution Red Alert policy is enacted when the AQI rises above 200 for over 72 hours, at which point the odd-even license number policy restrictions begin until the AQI level falls to a sustained moderate level. It is important to understand Air Quality Indexes in order to determine the success of the Road Space Rationing policy on Air pollution.

Research framework, methodology, air quality indexes, and particulate matter 2.5

In order to analyze the effectiveness of this policy, I performed a secondary analysis of datasets collected from the U.S. embassy in Beijing from 2008 to 2018 which include measurements of PM 2.5 concentration hour-by-hour overtime. I used R to analyze these datasets and answer my research questions, calculating daily, weekly, monthly, and yearly averages as well as linear regressions to determine overall trends. In addition to linear regressions, I calculated 20, 50, 100, 200, and 500 moving averages. In economics, moving averages are used to isolate the overall trend of stocks over time, while diminishing the effects of short term fluctuations, this allows economists to accurately make predictions and draw conclusions about trends in the economy. Likewise, I will be using moving averages to isolate the true trend of air quality, while diminishing the effects of seasonal variation or weather patterns. I visualized these datasets and In order to be able to make macro level contributions to discussion about public health, I converted the concentrations of PM 2.5 to their respective level using the EPA's AQI index. An Air Quality Index is an indicator of pollution levels for various pollutants. Government and Public Health Agents use Air Quality Indexes in order to assess the relative risk of air pollutants on the public. In Public Health, PM 2.5 is the most widely monitored air pollutant because these particles are small enough to travel deep within the respiratory tract, reaching the lungs and even making it into the bloodstream. Particulate matter less than 2.5 micrometers pose the greatest risk to human health as a result, causing acute short-term coughing, lung inflammation, and shortness of breath when exposed. Long term exposure of PM 2.5 has shown the most severe negative health effects, exacerbating existing medical conditions such as asthma and heart disease, as well as causing chronic bronchitis, reduced lung capacity, and increasing rates of mortality among heart disease and lung cancer patients. In this study, I used the U.S. Environmental Protection Agencies AQI index in order to assess Beijing Air Quality. The EPA's air quality index consists of 5 distinct categories for air pollution severity: Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, Hazardous. I used these categories in order to qualitatively award success to each implementation period of the SR policy. The categories "Good" and "moderate" were deemed as target ranges for air quality, and if the implementation of the AQI policy directly leads the recorded AQI to transition from the "Unhealthy", "Very Unhealthy", or "Hazardous" categories to "good" or "moderate" then the implementation of the policy was considered a success. For this general metric of success, I did not distinguish between the "good" and "moderate" categories, although I quantified the percentage and absolute change after the implementation of the policy.

METHODS

Study site

Beijing is the Capital City of China, located in the Northeast region of the country. According to the Beijing Municipal Bureau of Statistics, the Municipality has a population of 21,333,332 as of 2022 making it the 2nd Largest Chinese Megacity by Population. In 2014 there was an estimated 5.4 Million vehicles within the city, but the rate of vehicle growth has slowed with a recent 2018 estimate putting the amount of locally registered vehicles within the city at 5.97 Million.

Data collection

I used secondary data downloaded from the U.S. Department of State Air Quality Monitoring website, www.stateair.net, which includes historical air quality datasets from 2008-2017. The U.S. Embassy Located in Beijing China's Chaoyang district, (Latitude 39° 57' 0", Longitude 116° 28' 11.9994"), completed in 2008. Air quality monitoring at the site began after its completion, recording its first observation of PM2.5 on April 8th, 3:00pm.

In order to analyze the short term effects of space rationing on PM 2.5, I isolated the 5 instances from 2008-2016 in which the end-license plate number policy was enforced within each dataset, then calculating mean, median, standard deviation and variance for each period using functions within R Studio. I then isolated the corresponding period prior to policy implementation of equal day length and calculate the same statistics. I then calculated the percent change from the pre to post periods and compile all of these statistics into a table for visualization purposes. I created a subset for each time period of space rationing (Figure1). The first implementation ran from July 20th, 2008 to August 24th, 2008, a period of 36 days in length including the end date in the calculation (Figure 2). I then calculated the mean, median, variance, and standard deviation. Unfortunately, the number of observations from the pre and post treatment datasets are unequal, so I could not perform a paired t-test. I used an unpaired t-test to determine if the difference in means from pre and post treatment is significant or not. The p-value is less than 0.05, therefore the difference in means is significant.

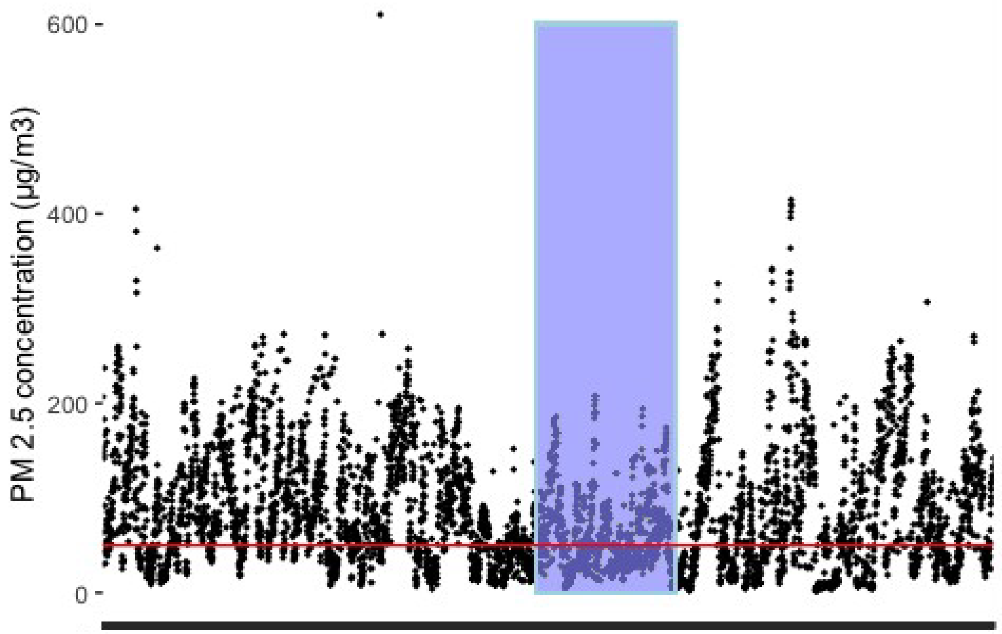

Figure 1. Particulate Matter observations in Beijing for the year of 2008. Time is on the x-axis and particulate matter concentration is on the y-axis. Each black dot represents one hourly observation taken from the U.S. Embassy's air quality monitoring site. The light blue shaded area highlights Period 1 of policy implementation from July 20th to August 20th, 2008. The dotted red line on y=50 represents the upper bound of the World Health Organization's recommended particulate matter concentration.

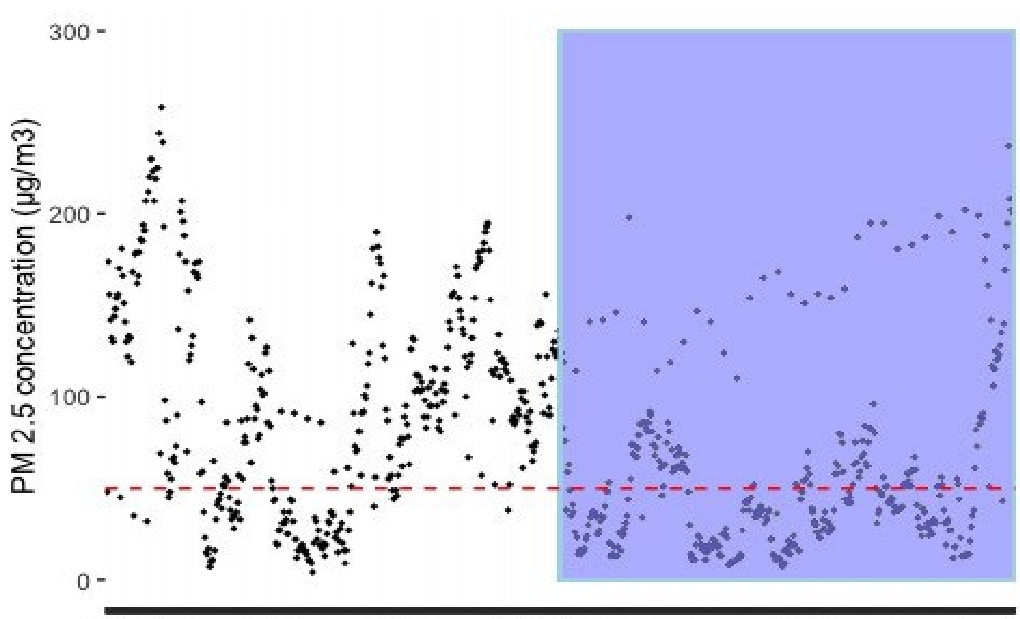

Figure 2. Particulate Matter concentration from July 20th to August 20th, 2008. Time is on the x-axis and particulate matter concentration is on the y-axis. Each black dot represents one hourly observation taken from the U.S. Embassy's air quality monitoring site. The light blue shaded area depicts the duration of the 2008 Beijing Summer Olympics from August 8th to August 20th, 2008. The dotted red line on y=50 represents the upper bound of the World Health Organization's recommended particulate matter concentration.

RESULTS

The quantitative analysis of all policy implementation periods and air quality overtime yielded mixed results. Period 1 is the only period the percent change for Mean, Median, and Standard Deviation was negative (Table 1). The average percent change for July 20th, 2008 to August 24th, 2008 was -26.10937, indicating that overall the level of PM2.5 exposure was reduced, from 95.54286 to 70.59722 for an absolute reduction of 24.95. The percent change of the median was -31.76471, indicating that the center value of the distribution was lowered by a significant amount and that at least half of the observations fell at or below the 'unhealthy' range for the PM 2.5 index, which is classifies PM2.5 µg/mg values from 55.5µg/mg to 150.4. This is consistent with my hypothesis that the short term implementation of Road Space Rationing was successful as well as the critical reception by the media organizations and the general public during the 2008 Beijing Summer Olympics (BBCWorldNewsAmerica 2008).

Table 1. Descriptive Statistics for Beijing PM2.5 Drawn from U.S. Embassy Air Quality Monitoring during each of the 5 periods of Road Space Rationing Policy implementation.

Time Period	Before	After	Percent change
July 20th, 2008 –August 24th, 2008	Mean = 95.54286 Median = 85 SD = 52.29613	70.59722 58 51.15006	-26.10937 -31.76471 -2.191491
October 11th, 2008 –January 10th, 2009	N/A	N/A	N/A
December 8th, 2015 –December 10th, 2015	Mean = 143.6458 Median = 123 SD = 121.5388	156.3889 140.5 103.0387	8.871163 14.22764 -15.22156
December 19th, 2015 –December 23rd, 2015	Mean = 208.4583 Median = 193.5 SD = 117.1789	258.7167 240.5 199.6857	24.10953 24.28941 70.41094
December 16th, 2016 –December 22nd, 2016	Mean = 97.68531 Median = 54 SD = 92.10171	235.2455 238 135.5819	140.8197 340.7407 47.20889

The short term success of the policy is a testament of the abrupt nature of this type of initiative, as well as the extent to which motor vehicles have an impact on urban air pollution. The PM2.5 concentrations from July 20th to August 24th, 2008 significantly reduced from 95.5 to 75.6 $\mu g/m^3$ (Table 1). Using the EPA's Air Quality Index, this change translates to a 10 point reduction on the AQI index. The median concentration of PM2.5 from the pre-treatment period lowering from 85 to 62 translates to a categorical change in AQI from 'Unhealthy' to 'Unhealthy for Sensitive Groups'. These observations show that the outcomes of road space rationing are consistent with the idea that reducing the amount of vehicles on the road will reduce the amount of emissions from motor vehicles, and therefore will improve air quality. Observing this reduction in PM 2.5 concentration in a 36 day period is a unique advantage to this type of policy initiative, and if these results could be replicated, then the appeal of Space Rationing is clear and the decisions by the Beijing government to continue implementing and expanding this policy given their demographic and geography circumstances is self-evident.

Subsequent periods of observation, excluding period 2 for which the required data was unavailable, all displayed positive increases in all calculated metrics. These observations for summary statistics are at first inconsistent with the logic that the implementation of the road space rationing policy in Beijing would lower the number of vehicles on the road, and therefore reduce the overall amount of particulate matter in the air. However, there are several explanations for the observed phenomenon. Firstly, restrictions for road space rationing evolved and lessened overtime. During Period 1 in which the Beijing Municipal government was aggressively targeting air pollution and smog within the city, they implemented odd-even road space rationing which effectively lowered the amount of vehicles that could drive on the road by half. Subsequent periods of policy implementation were changed to end-license-plate number policy, in which regulations targeted which day of the week drivers could not drive on the road, dividing the restricted vehicles into 5 distinct groups rather than 2. This less aggressive policy would in theory reduce the amount of vehicles on the road by 20 percent, a marked reduction from the 50% theoretical reduction from 2008. Secondly, the road space rationing restrictions target a proportion of the overall amount of vehicles within the city, rather than limit the absolute number of vehicles which can be on the road simultaneously. The benefits of reducing the proportion of vehicles on the road on air quality can be eclipsed by an absolute increase in vehicles on the road. Road Space rationing is automatically implemented if the single day average AQI goes above 200, meaning that in the instances in which

Road Space Rationing policy is implemented the air quality conditions have already been trending in an unfavorable direction. In these instances, road congestion may not be the cause of this trend, and therefore limiting the amount of cars on the road in order to improve air quality would only treat the symptoms of the problem and not the root cause. It is important to note that a negative change in standard deviation was observed for period 3. This indicates that although the overall air quality conditions have worsened, they are stabilized by the implementation by space rationing.

Long term impacts of space rationing

Over the 9 year period from 2008 to 2017 the Mean and Median concentrations of PM 2.5 for Beijing appear to be exhibiting a negative trend (Figure 2), which is consistent with my hypothesis that overtime the impact of the Space Rationing Policy regime would result in a gradual reduction in PM 2.5 concentrations overtime. 2015, 2016, and 2017 are the first years to have an average PM 2.5 concentration below 90µg/mg (Table 2), discounting the incomplete 2008 dataset in which the 1st period of Space Rationing Implementation is proportionally over-represented. There is no strong correlation with Standard Deviation overtime, suggesting that despite the air quality improving, the frequency of environmental and behavioral events such as bad weather or major traveling days which exacerbate buildup of particulate matter.

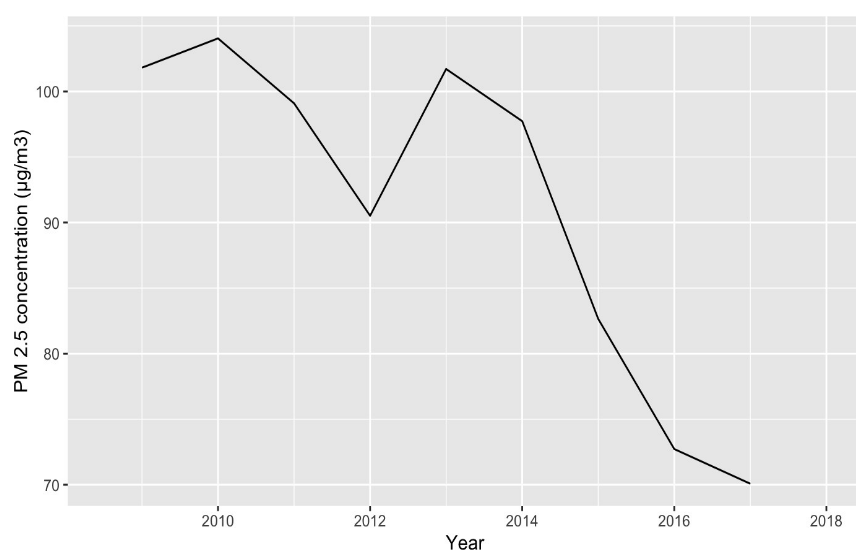

Figure 2. Average PM2.5 concentration from 2008 to 2017. Time is deployed on the x-axis in increments of 1 year and concentration of particulate matter is on the y-axis. The average for each year is displayed as one observation on the graph and is not smoothed.

Table 2. Descriptive Statistics for Beijing PM2.5 From 2008 to 2017.

Year	Mean	Median	Standard deviation
2008	*85.09334*	69	*62.39758*
2009	*101.8116*	84	*84.27866*
2010	*104.0457*	79	*92.28119*
2011	*99.09324*	71	*92.98223*
2012	*90.51694*	69	*81.72226*
2013	*101.7111*	71.5	*98.07141*
2014	*97.7341*	72	*93.5319*
2015	*82.64825*	54	*88.56031*
2016	*72.72393*	49	*77.12512*
2017	*70.07739*	43	*84.90836*

DISCUSSION

Each successive policy implementation of Space Rationing was not as successful. No policy implementation after 2008 exhibited a significant improvement in air quality. This reverse trend does not erase the positive effects of space rationing on air quality. The two periods of space rationing implementation in December of 2015 and the declining air quality over that time period cannot be attributed to a failure of space rationing policy entirely. There is little evidence that there was a severe lack of enforcement or that the policy itself was not expensive enough. Instead, we should look at the regional and seasonal trends in air quality. As previously mentioned, the predominant energy source in China is still coal power, and coal burning is used for central heating systems across the country during the winter (Fann and Risley 2013). Therefore, it is reasonable to assume that the increased burning from coal power plants during the winter to meet the demands of central heating systems within the city contributed to the rise in PM2.5 emissions during the winter of 2015. Because coal power plant operations are not as strictly regulated as vehicle emissions in China, and Space Rationing has no jurisdiction over their operations, Space Rationing as a solution to urban air quality cannot be completely disregarded.

Over the long term, it can be argued that Space Rationing has a significant impact on air quality within the city of Beijing. After the 2008 implementation of SPace rationing, the Beijing Municipal government established the POllution Red Alert system, which automatically implemented Space Rationing restrictions if the AQI exceeded 200 for more than 24 consecutive hours. The immediate success of the Space Rationing Policy has inspired and set precedent for similar environmental policy initiatives in Beijing, especially surrounding driving. In 2011the Beijing License lottery was implemented in order to ease traffic congestion and limit air pollution within the city by limiting the amount of registered vehicles. Though there were many "loopholes" for the lottery system, such as obtaining license plates from outside the capital or transferring old license plates from used vehicles onto new ones, the amount of permitted vehicle registrations decreased to 100,000 in 2018. Premier Li Keqiang declared a War on Pollution at the annual People's Congress in March 2014 (Yang et al. 2015). This was followed by a series of additional policies to improve air quality. Five years after 2013, National PM 2.5 levels declined by 40 percent, SO2 concentration declined by 65 percent, and CO levels declined by 33 percent. Despite this, the overall air pollution levels in China remain above standards set by the World Health Organization.

Critical reception

A short-lived success story. The 2008 Beijing Summer Olympics hosted outdoor events despite the announcement that air quality conditions may prevent them from doing so just a month prior. The various policies aimed at lowering air pollution, relocating large coal factories out of the city, stopping all factory operations, and instituting space rationing policies were cited as the reason for the improvement in air quality by the Beijing government, though scientists and other health officials believed otherwise. Both American researchers from Oregon State University and Chinese scientists at Peking University found that favorable weather conditions during the Olympic games were primarily responsible for the change in air quality (Joshi et al. 2016). Regardless of the cause, many cite that even in favorable conditions, Beijing's soot levels during the 2008 Olympics were several times higher than that of Athens, Sydney, and Atlanta and pollution levels were two to four times higher than Los Angeles on a normal day.

Limitations and Future Directions

Lack of robustness. The dataset provided by the U.S. Embassy in Beijing lacks robust measurements and is vulnerable to inaccuracy as a result. The U.S. The Embassy in Beijing air quality monitoring project was only permitted to set up instruments on site, and therefore were limited to a single point within the city for data collection. Concentrations of pollutants may vary significantly throughout the city, it is therefore impossible to determine whether or not the observations from the U.S. Embassy are representative of the pollution conditions in the city as a whole. The lack of pre-treatment data severely limits the amount of conclusions that can be drawn from the post space rationing data; the only available datasets do not report PM2.5 concentrations as frequently and accurately as those measured by the Air Quality Monitoring program. This means that we are unable to study the impacts of economic and industrial growth prior to 2008 on air quality, arguably a more significant time period for the development of pollution trends. In truth, the laissez faire approach to air pollution within the city of Beijing leading up to the 21st century can never be studied and carefully disseminated like the contemporary data can be.

Government crime data and lack of transparency. Under the current administration the Beijing government does not public any crime data, doing so would set a large precedent for the Chinese government. Alternative methods of acquiring this data, such as monitoring done by a third party organization and reporting done by news organizations. According to the NGO Reporters Without Borders, China ranks 177th out of 180 in terms of press freedom due to the concerted effort by the Communist Party of China to overtly censor the press and encourage self-censorship. Overtime, government intervention and retribution has created an environment where journalists in China face large bureaucratic and political barriers, often facing imprisonment or extradition from the country (Stern 2008). Government officials' salaries depend on the ratio between crimes reported and solved, meaning that they have an incentive to underreport crimes. In addition to this, enforcement methods and data collection are not uniform throughout the country, varying depending on provincial and city level governments which have jurisdiction over law enforcement activities. This means that we are unable to quantify the amount of cars which violated the Space Rationing Policy during the periods in which it took effect. Additionally, data monitoring the amount of fines collected and revenue generated from this policy is also not publically available.

Access to data for differences in difference analysis. Currently, there exists not available data from the U.S. embassy air quality project which is robust, parallel in structure, and sufficient in pre-post treatment data to perform a difference in difference analysis for PM 2.5 air quality in Beijing. If this data were to become available in the future, it would have positive impacts on the study of air quality, eliminating confounding variables.

Location specific government jurisdiction and enforcement. Beijing is unique in that it is a municipality, therefore, it is posited that government enforcement and regulation may be stricter or more robust in response to the implementation of this policy. It follows that this may not be the case for other cities and jurisdictions within China. A study of the government and regulatory bodies within different Chinese cities and provinces would answer the question of how this policy could be enforced on a widespread, federal level and the success of this type of authoritarian policy.

Interactions and attitudes towards space rationing. Currently, there is no available data for the public reaction and attitudes towards this specific policy aside from very small surveys conducted at the start of the program. Without this data, it is impossible to measure the degree to which people within the City of Beijing have adapted and are affected by this policy, including how their attitude may have influenced their susceptibility or predisposition to violate the policy.

Broader implications

Growing global trends of space rationing. It is argued that China's adoption of exceedingly prominent and widespread public restrictions on energy consumption and use is a part of a larger global trend towards authoritarianism in response to climate change (Fritsche et al. 2012, Beeson 2010). Beijing, China was not the first country to implement space rationing in their urban cities, but it is argued that they set in motion this global trend in immediate response to urban vehicle pollution. American associate professor of environmental and molecular toxicology Staci

Simonich said: "Considering the massive efforts by China to reduce air pollution in and around Beijing during the Olympics, this was the largest scale atmospheric pollution experiment ever conducted. Beijing's space rationing regime is classified as temporary, along with other major cities such as Paris, New Delhi, and Milan. Permanent examples of road space rationing include Mexico City, Athens, Bogota, and Jakarta.

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