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THE POLICY PROCESS AND POLICY EFFECT OF CHINESE URBAN ENVIRONMENTAL POLICY-A CASE OF ZHENGZHOU CITY

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ABSTRACT

China has launched lots of environmental policies to address the serious air pollution. The effectiveness of such kinds of policies are still in debate. Whether the policy makes a difference or not, this article argues that it highly depends on policy targets recognition. To take the motor vehicle restriction policy as an example, the target of the policy may not only focus on developing the air condition, but also other objectives. This on-hand article conducts a regression discontinuity design to test two goals of Zhengzhou city's motor vehicle restrictions policy which are efficiency target ("help to complete the political assessment goal") and legitimacy target ("help to achieve pollution control goal"). This article measures the former goal based on daily data and the latter one based on monthly data, both from Jan. 2016 to Dec. 2018. Air quality is selected by monthly air monitoring station, economic activities data is sorted from the official statistic website, and government action data is collected from the government documents by hand which we follow seriously and scientifically coding rules. Other factors, like climate influences, consumption and production behavior, are also controlled in the experiment. Regression results show that the restriction policy doesn't make an obvious difference on developing the air quality before and after, but it does have statistically significant effect on helping the urban government to achieve the political assessment goal of the so-called "Qualified days". The experiment also adjusts the bandwidth of the policy timing. The results obtained were highly robust across a variety of tests. What's more, to make explanations on the restriction policy failure, this article collects the vehicle selling data and gasoline consumption data during the same period to test the policy spillover effect on consumer behavior. Results show that the driving restriction policy lead to an obvious otherwise slight increase on consumers' behavior of buying a second car or using the alternative car. This study contributes to empirical evidence and add to a new case of researches on the air pollutants governance and policy evaluation.

Keywords: Policy Analysis, Motor Vehicle restriction policy, Regression discontinuity design.

NONMENCLATURE

Abbreviations	
APEN	Applied Energy
Symbols	
n	Year

1. INTRODUCTION

Policy analysis is becoming more and more important in scientific decision-making. In recent years, China has formulated a large number of policies in response to climate change, and cities are also considered to be front-line positions for addressing environmental climate issues. The effects of urban environmental policies have been widely debated by economists. Based on the data of different measure levels and different research methods in the same case, scholars will even draw inconsistent conclusions. This seems to be a mystery. Is China's urban environmental policy effective?

As one of the measures to control air pollution, the policy of motor vehicle restriction has been debated since 1990s. At present, the existing literature mainly studies Mexico, Sao Paulo, Bogota, Beijing, Lanzhou and Xi'an, respectively, from the perspective of administrative regulations, economic benefits, road traffic and air quality. Since the inception of the policy of motor vehicle restriction, many people have studied its effectiveness, from multiple perspectives, methods and in-depth mechanism, which have brought great inspiration to readers and relevant researchers. However, most of them neglected the policy objectives themselves, which means the initial target of one environmental policy may not target on environment development. Especially under the target assessment institute in China, it is bias to simply take the motor vehicle restriction policy objectives as pollution control, for example.

We must recognize that the key to environmental policy effectiveness assessment is how to effectively identify and confirm the policy objectives of environmental policies. However, economists often ignore the identification of policy processes and policy objectives. For example, the goals of many environmental policies may not be directly related to environmental protection itself. There are many cases in China. For example, motor vehicle restrictions, coal to gas and other policies. In this case, the discussion on issues such as “whether the policy helps to improve the environment” is very unobjective. Policy analysts are better at looking at issues from the policy process. This paper is based on the perspective of policy science. The important preconditions and research background of the article are: China's "Target Responsibility Assessment System" in the field of energy and environmental economy has Chinese characteristics. On the one hand, it is an important institutional guarantee for China to deal with the problems in the field of energy and economic environment. On the other hand, it must also recognize its distortion of China's urban environmental policy objectives

This paper takes Zhengzhou City, a city in central China, as an example, mainly because the policy of motor vehicle restriction implemented in Zhengzhou City on December 4, 2017 meets the quasi-natural experimental conditions, and it is also a microcosm of China's urban energy and environment policy.

Based on the theory of policy process, one of our previous paper (Zhang et al. 2019) uses qualitative research method to analyze the decision-making process of Zhengzhou's motor vehicle restriction policy, and identifies and quantifies the policy objectives of Zhengzhou's motor vehicle restriction policy. The result shows that the decision-making goal of Zhengzhou's motor vehicle restriction policy contains two connotations: efficiency and legitimacy. Based on the connotation of efficiency, the main goal of implementing the policy of motor vehicle restriction is to complete the assessment goal of the 2013 to 2017 Air Pollution Prevention and Control Plan. The improvement of air pollution is only to improve the wording of the legitimacy of the policy. We can see the desire of urban regulators for environmental improvement, but we cannot see their long-term consideration from the decision-making action. This paper is to use quantitative analysis technology of regression discontinuity design to evaluate the policy effects of Zhengzhou motor vehicle restriction policy efficiency target (“help to complete the political assessment goal”) and legitimacy target (“help to achieve pollution control goal”).

2. METHODOLOGY

2.1 Rationale

On December 4, 2017, Zhengzhou City implement-ed driving restriction policy， more than 1.1 million vehicles with a single number were limited to be on the road. Therefore, this day provides a perfect break for evaluating the impact of the restricted policy on air quality. Through the combing of information on policy makers, experts, scholars, and news reports, there are several key pieces of information that allow us to confirm that this study can use regression discontinuity design:

First, the driving restriction is the only policy shock. Zhengzhou issued driving restriction policy in the last month before the assessment of the "Air Pollution Prevention and Control Plan", through interviews with relevant government personnel, dialogues with experts and scholars1, etc., it can be confirmed that Zhengzhou’s driving restriction policy was introduced after all available measures were used. This means a series of other policy that improve air quality exist before the

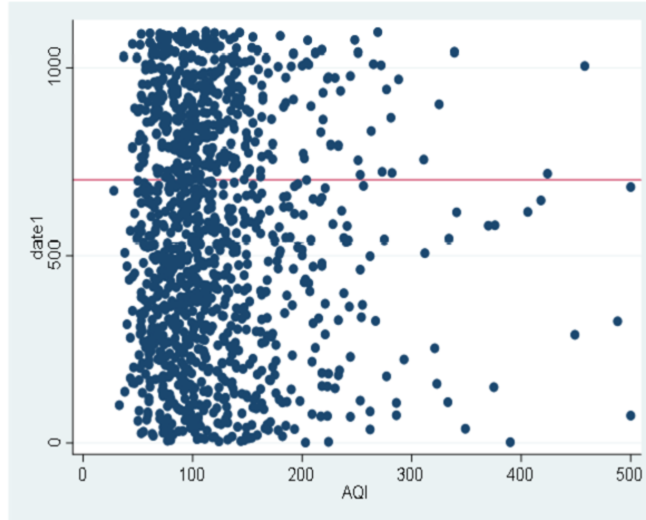
[1]Relevant information comes from the 3rd Henan Province 3E (Energy-Eco-Environment) Development Forum and Seminar on Smog Management Strategy on September 2, 2017. More than 60 experts, scholars and government officials from the local National Development and Reform Commission, the Academy of Social Sciences, the Academy of Environmental Sciences, the School of Geosciences, the Chemical Society, the Energy Efficiency Technology Association, and many local universities and research institutes discussed the “Zhengzhou Haze Management: Methods, Paths and Actions ”

implementation of the driving restriction policy;

Second, Zhengzhou's driving restriction policy is aimed at short-term sprint. The main policy objective of the restriction policy is to complete the assessment of the air pollution control plan and to achieve the short-term air assessment target. This study uses regression discontinuity design to estimate the short-term effect of the policy before and after cut-off is scientific and reasonable;

Third, the driving restriction policy is strictly exogenous. Subjectively, the more serious a local pollution is, the more likely the government is to adopt policies such as vehicle restrictions, so there seems to be a two-way causal relationship between the restrictive policy and air pollution. However, according to the relevant theories of the Chinese government's decision-making process (consultation-consensus model, Chen Ling[2]) and interview information, air pollution affects the probability of policy implementation, but it has no effect on the time of policy implementation. In other words, air pollution indicators such as AQI only affect the probability of policy implementation, but it does not affect the time of policy implementation. In fact, air pollution in 2016 is significantly more serious than in 2017, but the driving restriction policy only began in 2017. It can be seen that the policy decision itself is not directly affected by the air pollution level. The regression analysis of the AQI and the policy start time during the sample period has no significant relationship (Fig. 1). Therefore, Zhengzhou's driving restriction policy is strictly exogenous, and policy implementation is a direct factor affecting changes in air pollution indicators. Air pollution levels are not a direct factor in policy implementation.

In summary, the key hypothesis of this paper is that the only reason for the discontinuous change of air pollution on the day of Zhengzhou's driving restriction policy is that the vehicles are restricted, which means the change of air quality index is completely caused by the driving restriction policy. This is especially noticeable at the daily measure level. By flexibly controlling the nonlinearity of air pollution, using polynomial time trends to control other factors, etc., the assessment of the policy effect of the restriction is not affected by other variables that affect the smooth change of air quality before and after its implementation. On this basis, we have reason to believe discontinuous changes in air quality are caused by the restrictive policy. Therefore, the policy effect can be identified by estimating the air quality before and after the driving restriction in Zhengzhou.



date1	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
aqi	-.1680015	.1520567	-1.10	0.269	-.4663574	.1303543
_cons	568.7718	20.68914	27.49	0.000	528.1769	609.3667

Fig 1 Exogenous Test of AQI(X) and Policy Date(Y)

2.2 Model

The theoretical model is as follows:

$$y_t = \alpha_0 + \beta_1 Policy_t + \sum_{i=1}^{k} \beta_2 p(\mathrm{t})^{\mathrm{i}} + Policy_t \sum_{i=1}^{k} \beta_3 p(\mathrm{t})^{\mathrm{i}} + \lambda X_t + \mu_t$$

Where y_t is measured by the daily and monthly Air Quality Index (AQI) or the concentrations of PM2.5、PM10、SO_2、CO、NO_2、O_3 at time t. $Policy_t$ represents the driving restriction in Zhengzhou, which takes a value of one for all days after December 4, 2017, otherwise, takes a value of zero. The coefficient of interest, β_1, is the effect of the driving restriction policy. The vector $p(t)$ contains a fourth-order polynomial time trend to flexibly control time-series variation in air quality that may occur without the implementation of motor vehicle restrictions. The vector of covariates, x_t, represents several control variables of the policy including: season, temperature, wind level, rainfall, snowfall, heating, industrial added value above the scale, and the area under construction. μ_t is the error term.

3. DATA

3.1 Data and resource

[2] Chen Ling. Institutions, Elites and Consensus Seeking Framework for China's Policy Process (Public Management Frontier Series) [M]. Beijing: Tsinghua University Press. 2011.

The main pollutants in the air are industrial dust, motor vehicle exhaust, building dust, ground dust and secondary pollutants generated by chemical reactions of other pollutants. Meteorology and season are also important factors affecting air quality. Since the restriction policy is implemented in winter, the air quality is greatly affected by the heating policy in northern China. Therefore, in order to eliminate the interference of the above factors on the identification of Zhengzhou's driving restriction policy, this paper incorporates the industrial added value above designated size of the city, the area under construction, refined oil product sales, automobile sales, heating, weather, and seasonal factors into the regression equation. The relevant data are all passed the adaptive test.

Since the relevant environmental protection and pollution control policies in Zhengzhou City are in a relatively stable state in 2016, the relevant assessment, reward and punishment system is completed, and the monthly sample size is required. This paper uses the relevant data of Zhengzhou from January 1, 2016 to December 31, 2018.

3.2 Descriptive statistics

Air quality index (AQI) and various pollutant (PM2.5、PM10、SO_2、CO、NO_2、O_3) concentrations have declined after the implementation of the driving restriction policy. Among them, the concentration of SO_2[3]、PM2.5 and PM10 decreased greatly, which was 41.33%, 13.46% and 23.1% lower than before, and AQI decreased by 9.41%. The number of good air quality days in the month[4] have no significant change after the implementation of the policy or was slightly higher than before. The daily data showed that the air quality index (AQI) and PM2.5、CO、NO_2 concentration were slightly lower than the air pollutant concentration during the implementation of the limit policy, and the concentration of SO_2 and the particulate matter was greatly reduced, which was consistent with the monthly data. According to the air quality index and various pollutant concentration data in the sample interval, it can be intuitively observed that the implementation of the restriction policy will cause the concentration of various pollutants to decrease slightly in the short term, which shortens the Peak interval of pollution concentration in winter of each indicator compared with the same period of 2017. Preliminary descriptive statistics show that there may be a negative correlation between Zhengzhou's driving restriction policy and air pollution levels. Next, through empirical analysis, the impact of Zhengzhou's motor vehicle restriction policy on air quality is more strictly quantified. Next, the impact of Zhengzhou's driving restriction policy on air quality would be more rigorously quantified through empirical analysis.

Table 1 Statistical characteristics of main variables

Variables	Unit	Obs	Mean	Std.dev	Min	Max
AQI	/	1096	120.664	62.902	28	500
PM2.5	ug/m³	1020	70.162	59.480	9	608
PM10	ug/m³	1021	124.851	75.581	16	692
SO_2	ug/m³	1094	21.814	13.425	3	98
CO	ug/m³	1079	1.248	0.563	.5	5.6
NO_2	ug/m³	1095	53.403	20.265	17	160
O_3	ug/m³	1079	106.883	59.090	5	285
Maximum temperature	℃	1096	21.110	10.315	-2	39
Minimum temperature	℃	1096	11.482	10.052	-10	29
Wind level	/	1096	1.723	1.041	0	5.5
Rainfall	0 or 1	1096	0.023	0.149	0	1
Snowfall	0 or 1	1096	0.244	0.429	0	1
Heating	0 or 1	1096	0.332	0.471	0	1
The industrial added value above designated size	One billion yuan	36	27.264	5.213	16.97	37.49
the area under constructio n	Ten million square meters	36	13.683	2.519	9.18	18.64
Refined oil product sales	Ten thousand tons	36	15.689	1.324	11.07	17.47
Automobile sales	One thousand vehicles	36	44.371	12.098	26.85	81.95

4. ANALYSIS RESULTS

4.1 Daily data analysis on "help to complete the political assessment goal"

We first use the single difference method (OLS) to analyze the impact of the driving restriction policy. The

[3] Xue Zhao, Wei Cheng, Junxian Hou. A review of the development of desulfurization and denitrification industry in 2017[J]. China's Environmental Protection Industry, 2018(07):10-24. According to the relevant information of China National Environmental Protection Industry Association Desulfurization and Denitrification Committee, the significant reduction in the concentration of SO_2 in Zhengzhou is mainly related to the industry, especially the ultra-low emissions of the power industry.

[4] The monthly good days of AQI and sub-indicators are calculated according to the "Ambient Air Quality Standards" (GB3095-2012) and the "Environmental Air Quality Index (AQI) Technical Regulations (Trial)" (HJ633-2012) issued by the Ministry of Environmental Protection.

results show that the implementation of Zhengzhou's driving restriction policy contributes to the improvement of air quality whether or not control covariates, but it is not significant. Next, we use RD regression to eliminate the bias of regression results caused by endogeneity.

Table 2 Validity of the driving restriction policy: OLS regression (daily)

	(1)	(2)	(3)	(4)
The driving restriction policy	-3.392 (-0.89)	-4.139 (-1.07)		
Day relative to the implementation date			-0.008 (-1.28)	-0.004 (-0.57)
Temperature	1.178*** (5.02)	2.074*** (6.72)	1.180*** (5.04)	2.070*** (6.71)
Wind level	-5.263*** (-3.08)	-5.047*** (-3.00)	-5.092*** (-2.95)	-5.274*** (-3.10)
Rainfall	-15.030 (-0.86)	-13.413 (-0.77)	-15.628 (-0.90)	-13.712 (-0.79)
Snowfall	-18.447*** (-5.18)	-13.616*** (-3.71)	-18.459*** (-5.19)	-13.570*** (-3.70)
Summer		-25.877*** (-6.37)		-25.568*** (-6.28)
Autumn		-12.612*** (-3.36)		-11.993*** (-3.11)
Winter		22.265** (2.44)		21.915** (2.42)
Heating	64.677*** (10.07)	52.613*** (6.41)	64.155*** (10.01)	52.601*** (6.43)
Sample size	1096	1096	1096	1096

Note: The standard deviation in parentheses is modified by heteroscedasticity and sequence correlation, * p < 0.1, ** p < 0.05, *** p < 0.01.

Figure 2 shows the regression discontinuity graph of daily air quality index in the fourth-order polynomial fitting time trend. According to the chart, it can be intuitively found that the air quality index has a downward breakpoint on the day the policy is implemented. The daily AQI is reduced, which means air quality has improved due to the implementation of the driving restriction policy. The specific regression results are shown in Table 3:

Table 3 shows the regression discontinuity results for daily AQI at different bandwidths. Under different policy windows from 4 days to 42 days, whether the covariates are controlled or not, the implementation of the driving restriction policy has a significant positive effect on the improvement of air quality, significantly reducing AQI by 60-187. In other words, the policy improves air quality at least 2-3 level. Therefore, Zhengzhou's driving restriction policy significantly reduces the air quality index in the short term, which is helpful for the short-term sprint of policy tasks.

Table 3 The effectiveness of the driving restriction policy: RD regression (daily)

	AQI		
	No covariate	Covariate	Bandwidth
(1)	-183.823*** (-52.90)	-187.711*** (-4.79)	4.248
(2)	-85.900 (-1.33)	-135.716*** (-2.64)	8.495
(3)	-109.089** (-2.10)	-127.889** (-2.55)	12.743
(4)	-114.698*** (-2.79)	-110.624** (-2.39)	16.990
(5)	-114.975*** (-2.94)	-93.961** (-2.17)	21.238
(6)	-120.799*** (-3.20)	-89.527** (-2.23)	25.486
(7)	-126.025*** (-3.41)	-85.013** (-2.21)	29.733
(8)	-123.826*** (-3.55)	-77.429** (-2.17)	33.981
(9)	-121.942*** (-3.65)	-68.803** (-2.09)	38.229
(10)	-119.673*** (-3.70)	-60.315** (-1.97)	42.476

Note: The standard deviation in parentheses is modified by heteroscedasticity and sequence correlation., * p < 0.1, ** p < 0.05, *** p < 0.01.

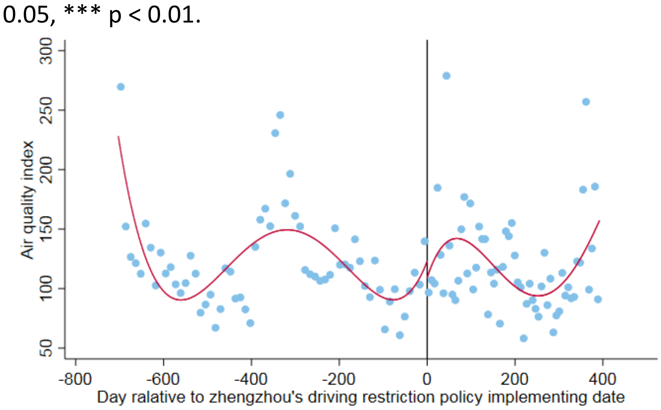


Fig 2 The regression discontinuity graph of daily air quality index

Further, the paper gives the daily average concentration regression discontinuity graph and results of six major pollutants under the time trend of the fourth-order polynomial fitting. It is preliminarily concluded that the implementation of the policy will reduce vehicle emissions, thereby reducing the concentration of PM2.5, PM10, NO_2 and CO in the air to improve air quality. After controlling the covariates, the regression results at different bandwidths all showed that the driving restriction policy reduced the concentrations of PM2.5 and PM10 significantly. Under the 27-day window, the limit policy significantly reduced the NO_2 concentration. In the 10-day window, the limit policy made the CO concentration drop significantly. Regardless of the bandwidth, the limit policy does not significantly change the concentration of O_3. Since the vehicle emissions do not contain O_3, this provides a counterfactual verification for this paper. (Due to space limitations, the figure is omitted)

4.2 Monthly data analysis on "help to achieve pollution control goal"

Based on the discussion of monthly data in the past relevant research and the assessment interval of policy target, and to explore the impact of the restricted policy on the monthly measure of air quality including information on people's behavioral changes, We first use the single difference method (OLS) to analyze the impact of the policy based on monthly data. The results show that under the control of different relevant covariates, the effect of the limit policy is not significant for the monthly mean value of AQI and the number of good air quality days. In other words, there is no result indicates that the driving restriction policy is beneficial to the realization of the policy objectives. The possible reason for this paper to explore here is that monthly measure data ignores features such as changes in people's travel behavior. This will be further explained later.

Considering that the monthly OLS regression results are not reliable, and at the same time, a series of related industrial production adjustments, such as "Shut down" and "Limited production", which cannot be directly observed, make the introduction of variables have certain endogenous problems. Reflected in the OLS regression results, there may be deviations or abnormal values, such as the increase in building area, but inhibit pollution. So next, we use regression discontinuity design to eliminate the bias caused by endogeneity.

Figure 3 shows the regression discontinuity graph of monthly air quality index in 4th-order polynomial fitting time trend. In the month of implementation of Zhengzhou's driving restriction policy, there is a downward breakpoint in the air quality index, which means the air quality has improved due to the implementation of the policy. The specific regression results are shown in Table 5.

Table 4 Validity of the driving restriction policy: OLS regression (monthly)

	Air quality index		Good air quality days	
	(1)	(2)	(3)	(4)
The driving restriction policy	13.679 (1.10)	14.491 (1.20)	-2.068 (-0.63)	-1.067 (-0.31)
Summer	15.754* (1.92)	8.098 (1.03)	1.587 (0.51)	1.514 (0.49)
Winter	38.683*** (4.15)	58.825*** (6.09)	-1.981 (-1.02)	-2.025 (-0.89)
The industrial added value above designated size	2.101*** (3.30)	1.661** (2.12)	0.084 (0.33)	0.085 (0.35)
The area under construction	-9.358*** (-3.60)	-5.264** (-2.27)	0.791 (1.07)	0.605 (1.2)
Automobile sales	1.227*** (3.26)		-0.025 (-0.23)	
Refined oil sales		8.836*** (3.33)		0.338 (0.55)
N	36	36	36	36

Note: The standard deviation in parentheses is modified by heteroscedasticity and sequence correlation, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

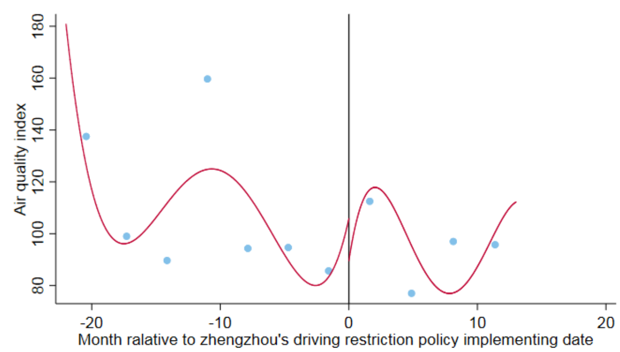


Fig 3 The regression discontinuity graph of monthly air quality index

Table 5 shows the regression discontinuity results of monthly AQI and good air quality days based on triangular kernel density function estimation in three different bandwidths. Under the optimal bandwidth estimated by the IK method, whether the control covariate is controlled or not, the implementation of the driving restriction policy does not cause a significant change in the monthly air quality index. The regression result of the good air quality days of month shows that the number of monthly good air quality days was significantly reduced by about 8-9 in the eleven months after the implementation of the driving restriction policy. Therefore, no result indicates that the implementation of Zhengzhou's driving restriction policy will help increase the number of days of good air quality or reduce the number of days of air pollution, which is not conducive to the completion of long-term policy objectives.

Table 5 The effectiveness of the driving restriction policy: RD Regression (Monthly)

	Air quality index		Good air quality days	
	(1)	(2)	(3)	(4)
1/2 optimal bandwidth	27.130*	0.000	-8.987***	-9.153***
	(1.70)	(.)	(-9.91)	(-4.29)
	4.289	4.904	5.493	5.493
Optimal bandwidth	25.266	55.562***	-8.140***	-8.479***
	(1.08)	(2.72)	(-3.38)	(-4.43)
	8.579	9.807	10.985	10.985
2 times optimal bandwidth	26.534	20.675	-2.700	-0.207
	(1.54)	(1.47)	(-0.81)	(-0.06)
	17.157	19.614	21.970	21.970
covariate	NO	YES	NO	YES
Sample size	36	36	36	36
Polynomial order	4	4	4	4

Note: The standard deviation in parentheses is modified by heteroscedasticity and sequence correlation, * p < 0.1, ** p < 0.05, *** p < 0.01.

Inevitably, there are some unobservable factors in the monthly data, and there may still be endogenous problems in the regression results. In addition, the driving restriction policy of Zhengzhou was implemented at the end of 2017, so the monthly sample size is relatively small, which may also lead to deviations in the model regression results. This makes the interpretation of the monthly regression results limited, so the next step is to reduce the observation scale of the data. By regressing the daily air quality index and the main air pollutant concentration data, the results would be more stable and reliable.

4.3 Why policy have no effect on air pollution control?

Based on the above analysis, it can be concluded that the contribution of Zhengzhou's driving restriction policy is limited in reducing the monthly average of AQI and increasing the number of good air quality days in the month. The empirical results show an insignificant positive correlation. In order to further analyze why the driving restriction policy has no significant effect on improving air pollution at the monthly observation level, this paper has made a preliminary judgment through the exploration and analysis: the driving restriction policy restricts the motor vehicle on the road in the short term (this paper uses the gasoline consumption as the proxy variable). Because no measures such as restriction of purchase have been taken at the same time, consumers tend to buy a second car to avoid the impact of the policy on personal travel within a certain period of time when the policy is implemented (this paper uses the purchase volume of new cars as the proxy variable). Therefore, the hypothesis that can be tested is initially drawn: the influence of Zhengzhou's driving restriction policy on gasoline consumption will be reduced first and then increased; the effect of driving restriction policy on automobile consumption (lag period) will be significantly increased.

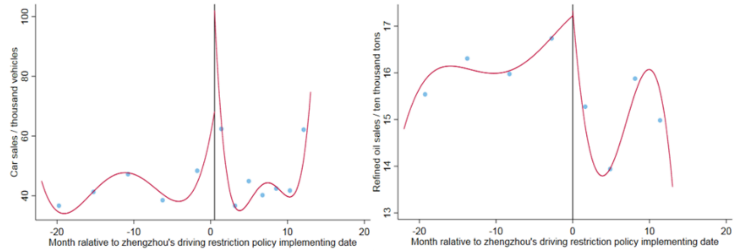


Fig 4 The regression discontinuity graph of monthly sales of automobiles and refined oil products

From the regression discontinuity graph (Fig.4) of monthly sales of automobiles and refined oil products under the 4th-order polynomial fitting time trend, it can be seen that the car sales volume in the left figure 4 has an upward breakpoint after the implementation of the driving restriction policy. Therefore, we can think that the implementation of the driving restriction policy has a certain stimulating effect on the car sales. The picture on the right does not show a sudden change in the volume of refined oil sales after the implementation of the policy.

After controlling the seasonal factors, the implementation of the driving restriction policy has caused a short-term rise in car sales and gasoline consumption. The results showed that the consumption of gasoline increased significantly in the 3-4 months after the implementation of the policy, the policy effect was 0.56, and car sales showed no insignificant positive impact. In the 6-7 months after the implementation of the policy, the volume of the vehicle sales increased significantly, and the policy effect was 11.79. During the same period, the consumption of gasoline has increased significantly too. The policy effect has gradually disappeared in about 12 months. In addition, relevant research indicates that the implementation of the restriction policy has caused the average speed of primary and secondary roads in Zhengzhou to increase by nearly 20% in the morning, and the passenger flow of taxis increased by about 26.5% compared with the same period. The passenger flow of subways increased by 110,000 times, an increase of 16.1% over the same period of last week. Therefore, we infer that the implementation of the restrictive policy reduced the total emissions of automobiles and improved the air quality by enabling most people to turn to the environmentally friendly commuting tools at the beginning. During the period, some consumers chose to purchase a second car. The policy effect is gradually diluted. However, due to the lack of long-term used car transaction data and public transportation data in Zhengzhou, we are unable to accurately determine the behavior changes of consumers under the impact of the driving restriction policy, which needs to be further explored and verified.

Table 6 The regression discontinuity results of refined oil and automobile sales

	Refined oil sales			Car sales		
	(1)	(2)	(3)	(4)	(5)	(6)
No covariate	0.535	-0.230	-1.700*	13.106	18.750	10.411
	(1.42)	(-0.23)	(-1.80)	(1.17)	(1.21)	(1.07)
Covariate	0.560**	0.810***	-0.174	10.260	11.790***	5.331
	(1.13)	(2.20e+8)	(-0.16)	(1.45)	(1.86e+14)	(0.74)
Bandwidth	3.155	6.309	12.618	3.813	7.625	15.25

Note: The standard deviation in parentheses is modified by heteroscedasticity and sequence correlation., * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. DISCUSSION AND CONCLUSION

This paper is to use quantitative analysis technology of regression discontinuity design to evaluate the policy effects of Zhengzhou motor vehicle restriction policy efficiency target (“help to complete the political assessment goal”) and legitimacy target (“help to achieve pollution control goal”). It is an innovation to take use of different data level to elaborate the different targets evaluation. The results showed that within 43 days after the implementation of the policy, the policy of motor vehicle restriction had significant negative effects on air quality index (AQI), PM2.5, PM10, etc. It could reduce the air quality index by 60-187, that is to say, within one month after the implementation of the policy, it could strive for a better number of days (to help achieve the sprint target of power air quality assessment); however, within 3-8 months after the implementation of the policy, the monthly air quality index could be reduced by average 60-187. Limitation policy has no significant positive effect on monthly AQI, but has significant negative effect on monthly fine-air-quality days in 5-11 months. The restriction policy has no effect on improving air quality long run.

Considering why the motor vehicle restriction policy is not effective in the long-term performance, through exploratory analysis, the article finds that the implementation of the motor vehicle restriction policy may have a significant impact on residents' travel behavior. This paper tested the hypothesis of policy spillover effect on gasoline and vehicle markets. The paper further identifies the impact of motor vehicle restriction policy on residents' travel behavior through automobile sales data and gasoline consumption data. The test shows that the gasoline consumption decreases significantly within 3-4 months of policy implementation, while the automobile sales show no significant positive impact. During 6-7 months of policy implementation, the automobile sales increase significantly, and the gasoline consumption increases significantly during the same period. Therefore, the implementation of motor vehicle restriction policy is only conducive to the short-term air quality assessment to reach the standard sprint, the effect of improving air pollution is very little.

The results of this analysis also have an explanation for other environmental policies in Chinese cities. It shows that under the pressure of the Chinese characteristics assessment system, the decision of the city-level government on environmental issues is short-sighted. Although in the short term, the policies adopted are rational and effective. But in the long run, urban environmental policies are irrational and have poor results.

The innovation of this paper is that it makes up for the deficiency of paying insufficient attention to the policy process and policy objectives with Chinese characteristics in the past energy and environment policy evaluation studies. The treatment of endogenies in this article is also a good reference for other related research.

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