Car-fuel Control, Motor Vehicle Regulation and the Air Quality of Xi’an City

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Abstract. In 2017, Xi’an city has released the latest standard of car-fuel and motor vehicle submission, at the same time, Xi’an city has issued traffic restriction of 2017. But after 2015, the air quality of Xi’an city has aggravated. This paper will conduct empirical research through single difference of 2016-2017 era. The result shows that mixed policies dimension aggravating the concentration of NO$_2$ and PM2.5 decreases, but still remarkably aggravate it at 1% significance level. This result further manifests that policy has some effects, but can’t work out ideally.

1. Introduction

With pushing development of an ecological civilization, provinces and cities pay more attention to environmental regulation issue. Xi’an is a part of Shaanxi of Fen-wei Plains, and that was regarded as key monitoring area of haze pollution by Ministry of Environmental Protection of China in 2018, which manifested that Fen-wei plains’ haze pollution is more and more obvious. Economic growth is a necessary consequence of urbanization, but if urbanization is too fast, there would be many city diseases. Especially, the increasing numbers of motor vehicles. The emission of motor vehicle is one of primary way of air pollution, Environmental Protection Administration pays much attention to this issue. Chinese government released successive standard of car-fuel quality and emission of motor vehicle. Xi’an is key area of haze pollution; it’s supervision force is so huge. In 2014, Xi’an city carried out national IV standard of car-fuel quality and emission of motor vehicle, and implemented V standard in 2017.

Standard upgrading aimed at improving air quality of Xi’an city. The worst circumstance of air quality was in 2013, and Xi’an also carried out some environmental regulation policies at that time. Terminally, these policies got some obvious effects. But in 2015, air quality aggravated, and it sustained until now. This phenomenon made many scholars majoring in environmental economic begin to suspect these policies. On the other hand, Xi’an carried out traffic restriction in winter. Did this policy also have no effects? This paper will systematically analyse via empirical research and by two aspects of car-fuel quality-motor vehicle emission double standard and traffic restriction.

2. Literature review and research innovation

In 2014, some scholars researched motor vehicle, for example, Li Meng-liang et al. (2014) claimed that in the event of motor vehicle pollution control, the actual effect of emission control was restricted by some problems, such as the inappropriate adaptability of standards, the inadequate pollution control of motor vehicles, the imperfect management system and no guarantee of monitoring quality [1]. Yuan Xiao-ling et al. (2018) used single difference method, Regression Discontinuity method and Difference-
in-difference method to analyse 2016 era’s traffic restriction and air quality data of Xi’an, and concluded that the current policies of Xi’an could improve the air quality [2]. But Sun yan et al. (2019) concluded that the traffic restriction policy cannot significantly improve the air quality based on the data of traffic restriction and air quality in Xi’an from September 1, 2016 to February 28, 2017 [3]. Today, literatures about traffic restriction of Xi’an city were just limited by these papers, but these papers are inconclusive yet. On the other hand, as for car-fuel regulations, many researches only aimed at Beijing city, the pioneer of these paper manifested that the quality of car-fuel could decide the extent of air pollution (Yu Shi-feng, 2015) [4]. Besides, more and more scholars called for implementing more harsh standard of motor vehicle emission (Yang Kun-hao et al., 2017) [5]. This paper will research relationship between single policy, mixed policies and air quality of Xi’an city, respectively whereby car-fuel quality-motor vehicle emission double standard and traffic restriction.

3. Econometric model and analysis of regression

3.1. Econometric model

Based on analysis above, this paper uses following Econometric model of equation (1) to measure the effects of car-fuel quality-motor vehicle emission double standard and traffic restriction versus air quality, respectively, as well as effects of mixed policies against air quality.

\[ Y_{it} = \alpha_i + \beta_i Policy_{it} + \delta Industry_{it} + \pi_i Control_{it} \]  

(1)

In equation (1), subscript of \( t \) is the date from January 1, 2016 to December 31, 2017; \( Y_i \) are kinds of air quality, including AQI (air quality index), concentration of NO\(_2\), CO and PM2.5; \( \alpha_i \) is a constant term; \( Policy_{i}(i=1, 2, 3) \) are dummy variables, which shows car-fuel quality-motor vehicle emission double standard, traffic restriction and mixed policies, respectively, and “1” shows execution; “0” shows un-execution. \( Industry_{it} \) is the industrial value added from enterprise above designated size, the particular descriptive statistics is below table 1.

Because air quality has strong time distribution characteristics, and was easily influenced by the weather factor, so this model needs to isolate time and weather effects to accurately measure the policy effect. In equation (1), \( Control_i \) are all control variables including time and weather effect. Time effect is dummy variable including holiday and vacations dummy variable, weekend dummy variable, and months dummy variables. Weather effect includes daily temperature (highest and lowest temperature), daily wind speed, and meteorological dummy variable (whether rain or not, and whether snow or not). Besides, motor vehicle can emit O\(_3\), but industrial production does not. So this paper will get rid of \( Industry_{it} \), when it comes to policy influencing O\(_3\).

| Variable Symbol | Variable name     | Unit     | Data source | Observation | Mean   | Std. Dev | Min  | Max  |
|-----------------|-------------------|----------|-------------|-------------|--------|----------|------|------|
| AQI\(_t\)       | AQI               | Index    | Website     | 731         | 111.5  | 7        | 23   | 483  |
| PM2.5\(_t\)     | PM2.5 concentration| µg · m\(^{-3}\) | Website     | 731         | 71.39  | 63.8     | 8    | 490  |
| NO\(_2\)         | NO\(_2\) concentration| µg · m\(^{-3}\) | Website     | 731         | 53.95  | 20.2     | 13   | 134  |
| O\(_3\)          | O\(_3\) concentration| µg · m\(^{-3}\) | Website     | 731         | 49.56  | 31.2     | 5    | 41   |
| CO\(_t\)         | CO                | mg · m\(^{-3}\) | Website     | 731         | 1.57   | 0.73     | 0.67 | 5.37 |
Based on equation (1), regress AQI and policies, see Table 2.

### Table 2. Car-fuel quality-motor vehicle emission double standard, traffic restriction and AQI

| Explained Variable: AQI | (1) | (2) | (3) | (4) | (5) | (6) |
|-------------------------|-----|-----|-----|-----|-----|-----|
| Policy1                 | -20.42*** | 23.91*** |
|                         | (4.83)  |      |     |     |     |     |

**Notes:**
- **a** www.tianqihoubao.com
- **b** Xi’an Municipal Government
- **c** Xi’an Statistical Bureau
- **d** General Office of the State Council

3.2. Analysis of regression

Based on equation (1), regress AQI and policies, see table 2.

**Table 2.** Car-fuel quality-motor vehicle emission double standard, traffic restriction and AQI *a,b*
Table 3. Policies and pollutant heterogeneity $^a,b$

| Explained Variable | Policy1 | Policy2 | Policy3 | Industry | Time & weather effect | Sample size |
|--------------------|---------|---------|---------|----------|----------------------|-------------|
| NO$_2$             | 7.04*** (1.93) | 7.66*** (2.19) | 6.65*** (2.52) | -0.05 (0.11) | Yes | 731 |
| CO                 | 0.09 (0.06) | 0.02 (0.09) | -0.07 (0.10) | -0.01*** (0.003) | Yes | 731 |
| PM2.5              | 22.34*** (6.32) | 29.38*** (9.74) | 22.32* (5.92) | -0.93*** (0.37) | Yes | 731 |

$^a$ These numbers, in parenthesis, are adjusted by “newey method”; $^{**}$, $^*$ and $^*$ represent 1%, 5% and 10% significance level, respectively.

$^b$ Author estimates based on Stata.

The result of regressions (1), (2) and (3) manifests that car-fuel quality-motor vehicle emission double standard can improve air quality when there are no time and weather effects. And because traffic restriction obviously aggravates air quality, mixed policies still aggravate air quality.

When adding time and weather effects, car-fuel quality-motor vehicle emission double standard also obviously aggravates air quality, although mixed policies still aggravate it, but are not conspicuous at 1% significance level.

4. Analysis of pollutant heterogeneity

Because the method of calculating AQI which includes air pollution not only from motor vehicle is so complicated, this paper has to analyse pollutant heterogeneity for accurately measuring the influence of policies. Table 3. is the regression result.
These numbers, in parenthesis, are adjusted by “newey method”; ***, ** and * represent 1%, 5% and 10% significance level, respectively.

a Author estimates based on Stata.

According to the result of regression, and under the background of Xi’an city, improving car-fuel quality and emission of motor vehicle double standard, traffic restriction and the mixed policies all cannot improve air quality. And they obviously rise the concentration of NO$_2$ and PM2.5, but with the implementing of mixed policies, the influence dimension shrinks, which manifests the policies have certain effects, but cannot work out ideally.

5. Conclusion and suggestions
According to analysis above, these policies of Xi’an city cannot improve the air quality. This paper further research mixed policies, the result shows that it also cannot improve the air quality. but the influence dimension shrinks, and it does not be obvious any more. This Phenomenon is from the increasing vehicles. These policies should improve air quality, but the number of cars is increasing, which incurs that these policies cannot work out ideally, although car-fuel quality and the emission of motor vehicle double standard are improved timely. Government should increase the subsidy intensity of new energy vehicles to encourage citizens to purchase them, and at the same time, increase the subsidy intensity of eliminating motor vehicle which cannot up to standard to inspire citizens to eliminate them voluntarily.

Government should optimize the building of civic public transit system to increase civic traffic accessibility, which can encourage citizens to adopt green lifestyle.

6. References
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