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Research on Relationship between Possession of Private Vehicles and Air Quality in China

LA RECHERCHE SUR LA RELATION ENTRE LA POSSESSION DE VÉHICULES PRIVÉS ET LA QUALITÉ DE L'AIR EN CHINE

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Abstract: This paper deals with the relationship between possession of private vehicles and air quality, applying panel data model and based on the data in 31 provinces of China from 2003 to 2009. The research shows that there is hardly positive correlation between them in the provinces in China. On the contrary, the correlation between them is negative in most of the provinces. As a result, we conclude that private vehicles don't cause serious air pollution and there must be other more essential factors that cause air pollution.
Key words: Possession of private vehicles; Air quality; Panel data model

Résumé: Cet article traite de la relation entre la possession de véhicules privés et la qualité de l'air, en utilisant le modèle de groupe de données et basé sur les données dans 31 provinces chinoises de 2003 à 2009. La recherche montre qu'il n'y a guère de corrélation positive entre eux dans les provinces en Chine. Au contraire, la corrélation entre eux est négative dans la plupart des provinces. En conséquence, nous concluons que les véhicules privés ne causent pas de pollution de l'air grave et il doit y avoir d'autres facteurs plus essentiels qui causent la pollution de l'air.
Mots clés: Possession de véhicules privés; Qualité de l'air; Modèle de groupe de données

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INTRODUCTION

Nowadays, the issue of environmental protection has become a global concern. With the development of industry and the improvement of people's living standard, the human beings are discarding more and more pollutants into the nature. The emissions of pollutants are becoming serious threat to the natural environment, without which we can't survive a second longer. There are many kinds of pollution and atmospheric pollution is one of which we concern about most. In recent years, the number of private vehicles in China is increasing at a dramatic speed. The increase of private vehicles facilitates people to travel. But at the same time, the increase of automobile exhausts emissions is becoming a serious threat to environmental protection that can't be ignored. Jiang Hao and Shi Jiafeng (2010) put forward that motor vehicle exhaust is gradually becoming one of the main factors that influence air quality in cities and we should control the emission of vehicle exhausts at first to improve air quality. Xiao Feiyu (2007) analyzed the development trend of vehicle consumption in China and the negative impacts it could make on city construction and the analysis was accomplished in a paper about the negative impacts that the fast development of cars can make on the city construction. However, in searching for related papers, we did not find anybody who researches the quantitative relationship between possession of private vehicles and air quality in detail applying econometric model. This paper is aimed to research the relationship between possession of

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private vehicles and air quality in 31 provinces (some of them are municipalities) of China. The main analyzing method in this paper is panel data model in econometrics and the data is from 31 provinces of China from 2003 to 2009.

1. INTRODUCTION TO THE THEORY OF PANEL DATA MODEL ESTABLISHMENT

The panel data, also known as spatio-temporal data, parallel data or time-series cross-section data. According to relatively authoritative definition, it is generally used to describe what happens to a given sample of the population in a time interval, thus it is necessary to observe each individual of the sample repeatedly as time goes on. In recent years, panel data model has been greatly developed, becoming one of the most important models in econometrics.

Let α be the constant term of the model, β be the coefficient of related independent variable and μ the random error term. N represents the size of sample and T is the length of time during which the sample is observed, and then the general formula of panel data model could be defined as followed:

$$y_{it}=\alpha_i+\beta_i x_{it}+\mu_{it}$$

where $i=1,2,\cdots,N$ and $t=1,2,\cdots,T$.

Generally, it is assumed that μ_{it} should be equal in terms of mean and be homogeneous in terms of variance.

Panel data models are generally divided into three types as followed:

The first type of model satisfies that $\alpha_i=\alpha_j$ and $\beta_i=\beta_j$. It's denoted that there is no individual difference and there are same coefficients for each regression equation of this model. That means there are equal intercepts and coefficients in each equation for the individuals.

In case of the second type, $\alpha_i\neq\alpha_j$, and $\beta_i=\beta_j$, and we define this type of model as variable intercept model. It means that there are individual differences in cross-sectional data. These differences are made by the variables that are not included in the model.

When it comes to the third type, we define that $\alpha_i\neq\alpha_j$, and $\beta_i\neq\beta_j$. It means that there are different coefficients in different equations for each individual, indicating that there are not only individual differences but also differences in economic structure.

The first step in researching panel data is to test whether the parameters in the model are constants, both in cross section and time series. The aim we do this is to determine which type of model we should employ to analyze the data collected. The most commonly used way to do this is hypothesis test. We need to test whether the following two hypothesis are true or not under certain confidence levels, that are

$$H_1:\beta_1=\beta_2=\cdots=\beta_N$$
$$H_2:\alpha_1=\alpha_2=\cdots=\alpha_N$$

We can see that if we cannot reject the hypothesis H_2 then we can choose the first type of model; and if H_2 is rejected, we should go on to test whether hypothesis H_1 is true or false to determine which one to choose from the second and the third type. When H_1 is accepted, we choose the second type, if not, we should choose the last type.

The statistics we use to test H_1 and H_2 are both F, that is F_1 and F_2. In order to get the values of the two statistics, we need to work out the sum of squared residuals of each type model. We use the letters S_1, S_2 and S_3 to represent the sum of squared residuals of the third type of model, the second type and the first type respectively. The statistic $F_2=\dfrac{(S_3-S_1)/[(N-1)K]}{S_1/[N(T-K-1)]}$ is used to test whether the second hypothesis H_2 should be rejected or not, and F_2 has the $F-$distribution with $((N-1)(K+1),N(T-K-1))$ degrees of freedom under the null hypothesis.

And similarly, the statistic $F_1=\dfrac{(S_2-S_1)/[(N-1)K]}{S_1/[N(T-K-1)]}$, which is used to test the truth of H_1, also has the $F-$distribution with $((N-1)(K+1),N(T-K-1))$ degrees of freedom under the null hypothesis.

At last, we need to compare the statistics we get with their own critical value under certain confidence level respectively to determine which model we should select to analyze the data.

2. VARIABLE SELECTION AND DATA SOURCES

The analysis process in this paper involves two variables, namely possession of private vehicles and air quality. The data of possession of private vehicles in provinces of China are collected from Chinese statistical yearbook of each year (2004 to 2009). The proportion of the days when air quality is below level 2 every year in each major city (capital city of province or municipality) is chosen as the air quality indicator. It was calculated from related original data in Chinese statistical yearbook.

3. EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN POSSESSION OF PRIVATE VEHICLES AND AIR QUALITY IN PROVINCES OR MUNICIPALITIES OF CHINA

3.1 Model design and selection

First of all, we should establish a theoretical model describing the relationship between possession of private vehicles and air quality according to related economic theory. Let y_{it} be proportion of the days that air quality is below level Ⅱ per year in each city, and α_{it} be the level of fixed effects; the degree of private vehicles impact on air quality was denoted by the letter β_{it}. x_{it} is the logarithm of the number of private vehicles, and μ_{it}, random error term. The basic model is as followed:

$$y_{it}=\alpha_{it}+\beta_{it}x_{it}+\mu_{it}$$

where $i=1,2,\cdots,N$ and $t=1,2,\cdots,T$.

Then what we should do is to test the hypothesis with the method mentioned above to determine which type of model to employ in this paper. Estimate all the three types of model with Eviews3.1 and get the sum of squared residuals. It shows $S_1 = 0.167855$, $S_2 = 0.378277$ and $S_3 = 2.559469$. And obviously we can know that $N=31$, $T=7$ and $K=1$. According to the third part of the paper, F_1 and F_2 should have freedom degree of (30,155) and (60,155) respectively, and after computing we get $F_2 = 36.81$, $F_1 = 6.48$ as a result. Both the value of F_1 and the value of F_2 are respectively larger than the critical value under confidence level of 0.05. As a result, we reject both H_2 and H_1. So we choose the third type of model to make analysis at last.

3.2 The result and interpretation of the analysis

The variable coefficient model was adopted to analyze the data of seven years in 31 provinces, applying statistic software of Eviews3.1. And the result of coefficients estimation is shown in Table1 as followed:

Table 1: Estimation of Regression Coefficients about Air Quality to Possession of Private Vehicles

Region-i	α_i	β_i	t **-statistic**	p **-value**
Beijng	1.183446	-0.166450	-4.494938	0.0000
Tianjin	0.562353	-0.097265	-3.059865	0.0026
Hebei	1.158102	-0.181398	-5.728273	0.0000
Shanxi	1.185883	-0.206188	-8.294025	0.0000
Neimenggu	0.605494	-0.118478	-4.045360	0.0001
Liaoning	0.386445	-0.058468	-2.197082	0.0295
Jilin	0.044831	0.005500	0.186843	0.8520
Helongjiang	0.300509	-0.033472	-1.057714	0.2918
Shanghai	0.216961	-0.027307	-0.956261	0.3404
Jiangsu	0.357569	-0.040096	-1.817907	0.0710
Zhejiang	0.431321	-0.051063	-1.983437	0.0491
Anhui	0.093604	0.018614	0.713773	0.4764
Fujian	0.086570	-0.012329	-0.481493	0.6308
Jiangxi	0.225676	-0.046550	-2.041355	0.0429
Shandong	1.158555	-0.170904	-7.217580	0.0000
Henan	0.374647	-0.048013	-1.760637	0.0803
Hubei	0.718970	-0.116205	-4.144200	0.0001
Hunan	1.277343	-0.251649	-8.547832	0.0000
Guangdong	0.619866	-0.091825	-2.876027	0.0046

To be continued

Continued

Region-i	α_i	β_i	t **-statistic**	p **-value**
Guangxi	0.114079	-0.021871	-0.784543	0.4339
Hainan	0.000000	0.000000	0.000000	1.0000
Chongqing	0.685671	-0.133871	-5.248864	0.0000
Sichuan	0.271460	-0.025186	-0.784459	0.4340
Guizhou	0.062856	-0.002030	-0.092366	0.9265
Yunnan	0.090987	-0.018963	-0.579915	0.5628
Xizang	0.030510	-0.006106	-0.276537	0.7825
Shanaxi	0.592308	-0.095380	-3.397266	0.0009
Gansu	0.639661	-0.099130	-3.613428	0.0004
Qinghai	0.261769	-0.024185	-0.810525	0.4189
Ningxia	0.235636	-0.045671	-1.675927	0.0958
Xinjiang	0.215455	0.021541	0.642082	0.5218

As is shown in the output result, $R^2 = 0.935$, the value of the statistic F is 73.84 and the correspond P is 0.00, with DW=2.10. We can make a judgement that the fitting effect of this model is very satisfying according to relevant econometric criteria.

With the result of Table1, when it comes to the relationship between possession of private vehicles and air quality, we can classify the 31 provinces of China into four categories according to the relationship styles between them. The first group includes 18 provinces or municipalities, such as Beijing, Tianjin, Hebei and so on. In those regions, the correlation relationship between the two variables are negative ,that is the coefficients of regression in each equation are all negative; and most of the negative correlation between them is significant under significance level of 0.05, while the others in this group is significant under level 0.1. When the correlation relationship between the two variables is negative but cannot be considered as significant in statistics, we define them as the second category, which includes 9 provinces or municipalities (including Heilongjiang, Shanghai, Fujian and so on). There are three provinces belonging to the third kind, including Jilin, Anhui and Xinjiang. In those regions, the correlation relationship between the two variables is positive, but is not significant under certain significance level. Hainan province is the last group. Of course it can be seen as a special case of the third group. In Hainan, the correlation coefficient of the two variables is zero, indicating that there is not any relationship between possession of private vehicles and air quality in Hainan.

Overall, the analysis result is inconsistent with what we usually think, i.e. the more private vehicles there are, the worse air quality becomes (the proportion of the days when air quality below level 2 becomes larger). On the contrary, in most regions of China, the correlation relationship between possession of private vehicles and air quality is negative. Even in some of the regions the relationship is positive, it is not significant under statistic criteria. There are many factors contributing to this result, one of them may be that the development degree of heavy industry in different regions are different. In the regions where there are more heavy industries, the waste gas from industry becomes one of the most serious factors of atmospheric pollution. As a result, the influence of automobile exhaust on atmospheric becomes less obvious. Another reason is that different cities have different measures in environmental protection and invest differently in environment managing. Cities developing faster may pay more attention to environmental protection, thus invest more on it, such as taking various measures to improve the waste gas processing technology and afforest environment, and so on. Meanwhile, in highly developing regions there are more private vehicles, which is more likely to be the explanation why there is negative correlation relationship between possession of private vehicles and air quality. In addition, some certain provinces have a satisfying natural environment and they are seldom affected by various pollution problems which other provinces are confronted to, and automobile exhaust's impacts on pollution could be ignored. Hainan province is an example of this kind.

CONCLUSION AND SUGGESTION

The analysis result above based on panel data indicates that private vehicles in China haven't had significant influence on natural environment yet. The key to control environmental pollution is not to control the number of private vehicle, but to improve our ability to control industry pollution and strengthen urban greening construction force. This is the right way for China to improve environmental protection ability in current situation.

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