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Key Factors Affecting Environmental Protection Values in China

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Abstract: Utilizing a total of 31 non-numerical variables on environmental protection values from 1990–2014 in the World Values Survey (WVS) database (i.e., WVS2, WVS3, WVS4, WVS5 and WVS6), this study analyses the temporal changes of environment protection values in China and identifies the key factors related to these changes. We define indices for the standardized values of action and attitudes to environmental protection after clustering the 31 variables into two categories according to the meanings of their variable labels. Through statistical analysis on the possible impacting variables (e.g., GDP (gross domestic product) per capita, carbon emissions per capita, industrial wastes, and rural township enterprises), we find that the variable rural township enterprises is the main factor that causes obvious changes in action and attitude, coupled with other environmental impacts at home and abroad, such as economic globalization, the financial crisis, and frequent natural disasters. In particular, the significant improvement in action during the period from the late 2000s to early 2010s is mainly due to switching the emphasis from quantity to quality. The structural adjustment and industrial upgrade of township enterprises were promoted as important measures to improve environmental values according to Document No. 1 of the Central Committee of the People's Republic of China in 2010.

Keywords: environmental protection values; action; attitude; rural township enterprises

1. Introduction

Environmental degradation has gained widespread attention worldwide. Environmental protection values (EPVs), which generally refer to normal anthropogenic activity in the process of harmonizing with nature, may have positive effects on improving environmental quality. In many countries, there are internal and external factors that are used to evaluate the two aspects of environmental protection values: action and attitude. The internal factors are related to the existence of action agents, such as environmental sensitivity, environmental morality and environmental knowledge. Sia [1] used the multiple linear regression method to explore the contribution of environmental literacy to environmental action. The results showed that environmental sensitivity, knowledge and skills; attitudes towards pollution and technology; and gender roles affect environmental action. Stern [2] proposed the value-belief-norm theory (VBN). The theory began from general stable values based on the belief of the relationship between humans and the environment, and then activated personalized norms and produced a sense of responsibility for environmental action in which egoistic values played a negative

role. Gatersleben et al. [3] examined the influence of attitude variables on general environmental action and the consumption of energy by residential families in The Netherlands. The results showed that the main independent variables were attitude variables and social demographic variables. H. Ziadat [4] suggests that in every single city and village, the environmental awareness of women is higher than that of men. In all urban and village environmental awareness surveys, the educational level of the interviewees plays an important role. The awareness of environmental protection is also affected by age. Through interviews with farmers, Wu [5] showed that environmental deterioration is an important indicator of self-efficacy with environmental action. Higher-level environmental awareness enables farmers to better participate in land management practices. The environmental self-efficacy of farmers also plays an important role, and their decisions change their actions, which are positive and significant environmental actions that improve the environment with greater perception. Farmers must have a clear sense of the environment before deciding to take action.

The second is external factors, such as social policies, interpersonal influence, social structure, education and other external conditions. Reardon et al. [6] mentioned the impact of policy on the environmental actions of farmers. Brooks [7] analysed whether there were better environmental action indicators apart from economic factors. If farmers make economic decisions, they do not consider saving resources. It is emphasized that it is necessary to pay attention to making plans according to local conditions to motivate environmental protection actions from farmers. Environmental awareness is closely related to environmental action. The public's environmental awareness affects their environmental actions. Environmental awareness can be enhanced through environmental education, and public participation can be encouraged. Gloria M. Lentijo [8] argues that the main limitation for the protection of birds is the lack of environmental awareness and environmental knowledge. Increasing environmental education can improve public participation in environmental protection. Dietz [9] believes that the combination of social structure variables and social psychological variables to explore environmentalism can better reveal the internal mechanisms of social structure variables affecting environmental action. David B. Rockland [10] found that there is a positive correlation between environmental education knowledge and environmental activities by investigating grade 4–12 students in the United States. Environmental protection action not only comprises individual action but also public participation. Environmental protection action is bound to be affected by other individuals and society. The existing literature highlights two types of social relations: whether society participates in environmental protection groups [11] or feels pressure [12] and accepts environmental education [10]. Brand [13] believes that the mass media plays an important role in the construction of environmental problems; that is, discussion of the public environment shapes the normative standards related to the understanding of environmental action. However, the problem lies in the abstraction and lack of theoretical explanation for internal relations among factors.

Based on a previous review, we find that although some current quantitative studies involve aspects of time series statistics and regression and provide specific contributions of factors affecting environmental protection, there are few analyses on synthetic or unique factors that may affect EPVs. For example, per capita gross domestic product (GDP) and per capita carbon emissions are two typical synthetic factors, while industrial wastes (including liquid waste, gaseous waste and solid waste) and rural township enterprises are special factors that only exist in China. Due to the complexity of environmental action or attitude, it is neither feasible nor helpful to establish a model that includes all factors. At the same time, existing articles are mostly based on a static inquiry into environmental actions and its influencing factors based on data at a certain time point, ignoring changes in social and economic developments, cultural reform, system settings, policy arrangements, and the dynamic influence of social status. It is necessary to follow up on the long-term inquiries of social members.

In this paper, we attempt to identify the five key factors that most dynamically and significantly affect EPVs in China. These five factors include two synthetic factors (per capita GDP and per capita carbon emissions) and three unique factors (industrial "three wastes" and the number and output

growth rates of rural township enterprises). These factors comprehensively reflect the temporal evolutions in social and economic developments, cultural reform, and policy arrangement in China.

The remainder of this paper is structured under four main sections as follows. The next section introduces the data used for this study. Section three focuses on data processing and the mechanism of analysis of factors affecting EPVs, followed by the conclusions and discussions in section four.

2. Methodology

2.1. Data Processing

The data used in this paper include variables in EPVs from the World Values Survey (WVS), including per capita GDP, per capita carbon emissions, industrial "three wastes", and rural township enterprises. These data are pre-processed to facilitate the subsequent analysis. The WVS dataset [14] is the largest international investigation on EPVs ever executed. The survey has been widely applied to topics such as democratization, religion, gender equality, social capital, and subjective well-being [15]. There are six datasets, ranging from WVS1 to WVS6. Due to the temporal discontinuity in WVS1, we use WVS2 (1990–1994), WVS3 (1995–1998), WVS4 (1999–2004), WVS5 (2005–2009), and WVS6 (2010–2014) in this paper, covering a period from 1990 to 2014. There are a total of 31 variables describing the environmental values in these five datasets (see Appendix A). Each of these 31 variables has a variable label that determines its category. As Appendix A shows, some variable labels indicate different environmental protection actions or action intentions, while others reflect various environmental protection attitudes. A variable with a label describing an action or an action intention towards environmental protection is classified into the "action" category. Otherwise, a variable with a label representing an attitude towards environmental protection belongs in the "attitude" category. In Appendix A, the labels of the variables V12 and V13 in WVS2; V33, V38, V39, V42, V43, V44, V45, and V46 in WVS3; V33 and V34 in WVS4; V29, V105 and V106 in WVS5; and V30, V82 and V83 in WVS6 express different environmental protection actions of respondents, such as participation in environmental organizations, incomes or increases in environmental taxes, the selection of products that are better for the environment, and reductions in water consumption for environmental reasons. Therefore, these variables are action variables. Other variables, including V14, V15, V16 and V17 in WVS2; V40, V41 and V49 in WVS3; V35, V36 and V37 in WVS4; V104 and V107 in WVS5; and V81 in WVS6, have labels that show various the environmental protection attitudes of respondents, including environmental vs. economic growth, human vs. nature, and personal vs. governmental responsibilities. These are attitude variables.

Each variable also has a value label that contains multiple choices for respondents (see Appendix A). For example, the value label for the action variable V38 in WVS3 has 4 choices, including (1) strongly agree, (2) agree, (3) disagree, and (4) strongly disagree. The value of this variable is that one of the series numbers in the value label is selected by the respondents. Obviously, the value of V38 obeys a rule (i.e., the larger the value is, the worse the environmental protection action). Other action variables have similar value labels, and their values obey the same rule. The attitude variables have similar value labels. However, their values do not obey the same rule. The values of some attitude variables obey the same rule as the action variables (e.g., V41 in WVS3), while those of other attitude variables satisfy an inverse rule (i.e., the larger the value is, the better the environmental protection attitude; e.g., V40 in WVS3). To maintain consistency in the values of the attitude variables, let all attitude variables obey the inverse rule. For those attitude variables that obey the same rule as the action variables, their values are processed as the difference between the maximum series numbers (plus one) and the series numbers chosen by the respondents. For example, the value of V41 is calculated as 3 minus the series number provided by the respondents. The meaningless choices in the value labels, such as "Not asked", "NA", and "DK", are all removed.

China's per capita GDP data source is from the Economy and Growth Indicators of the World Bank [16]. We first calculate its growth rate, obtain the growth rate trend data according to the periods

of the four datasets, and finally obtain the data from the same action and attitude variables using the temporal average for each WVS period.

China's per capita carbon emission data are from the World Development Indicators of the World Bank [17]. The industrial waste data are from the National Environment Statistical Bulletin of the Ministry of Ecology and Environment of the People's Republic of China [18]. The rural township enterprise data come from the Statistical Yearbook of Township Enterprises in China [19]. All of these data are processed similarly to the processing of China's per capita carbon emission data.

2.2. Regression Analysis

Using the original WVS code data for China, we defined the absolute standardized indices of the EPVs in terms of action and attitude and discussed their key temporal evolution features. Using the regression analysis method, we attempted to identify the key factors impacting the indices of EPVs action and attitude and then built their regression equations. Finally, based on the established regression equations, we found the effects of rural township enterprises on the action and attitude EPVs (i.e., two different aspects of the rural township enterprises influence action and attitude).

(1) Indices of action and attitude and influencing factors

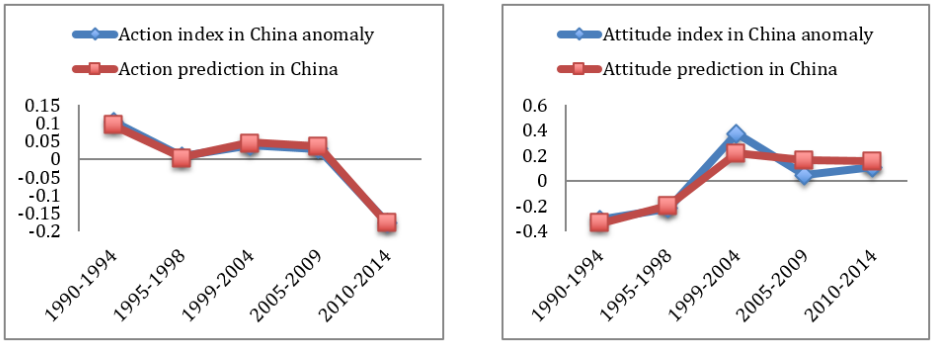
As Section 2 mentioned, the value labels of the 31 variables from the WVS data indicate different meanings for the action and attitude categories based on the aforementioned subjective classification. For the action variables, the larger the number is, the worse the degree of recognition expressed by the answer, while for the attitude variables, the larger the answer is, the better the answer. To match these rules, we define the opposite standardized indices for action and attitude:

$$I_{action} = \frac{1}{N}\sum_{i=1}^{N}\frac{Standard\ deviation\ of\ i\text{-}th\ action\ variable}{Mean\ of\ i\text{-}th\ action\ variable}, \quad (1)$$

$$I_{attitude} = \frac{1}{M}\sum_{i=1}^{M}\frac{Mean\ of\ i\text{-}th\ action\ variable}{Standard\ deviation\ of\ i\text{-}th\ action\ variable}, \quad (2)$$

where I_{action} and $I_{attitude}$ represent the averaged and standardized dimensionless indices for action and attitude, respectively; and N and M represent the number of action and attitude variables, respectively. The standard deviation of each action or attitude variable measures the degree of EPV disagreement among Chinese respondents in terms of this variable, and the mean of each action or attitude variable indicates the averaged EPV of Chinese respondents presented by this variable. For the action variables, a large mean with a small standard deviation represents bad EPV action and, thus, the smaller the index of action defined by Equation (1), the better the EPV action. For the attitude variables, a large mean with a small standard deviation refers to good EPV attitude and, therefore, the larger the index of attitude defined by Equation (2), the better the EVP attitude. Both indices are normalized only in the regional context of China itself and are, therefore, called absolute indices, which are not normalized in a global context.

According to the definitions in Equations (1) and (2), we calculated the indices of action and attitude for environmental protection in China in different WVS periods (see Figure 1, blue line). The results indicate that both the attitudes and actions of EPVs in China generally experienced good evolution. The action EPV in China experienced little change during the periods from 1990–1994 and 1995–1998 but significant improvements from 2005–2009 and 2010–2014, while the attitude EPV in China became obviously better from 1994–1998 and 1999–2004 and then tended towards a stable state. To find the reasons that caused these changes in action and attitude, possible influencing factors should be analysed, and their contributions to these changes should be quantified.



(**a**) (**b**)

Figure 1. Action (**a**) and attitude (**b**) index anomalies and predictions in China.

Industrial pollution is a major component of environmental pollution in China, accounting for 70% of the total pollution in 2015 [20]. The impact of industrial activities on the environment is mainly embodied in the three wastes produced by industrial sectors. Therefore, these three wastes may possibly be one of the factors influencing EPVs in China, which is considered in our correlation and regression analysis.

Rural industry is very important for the whole industrial system of China. Its main body comprises township enterprises, which are special economic phenomena in China. The output value of rural township enterprises accounts for 45.16% of the total "output value of rural township enterprises" plus the "output value of other industrial enterprises" [21]. These rural township enterprises may most likely be one of the influencing factors for EPVs in China. According to the above analysis, we chose the industrial three wastes; rural township enterprises; and commonly used factors, including per capita GDP and per capita carbon emissions, as the main influencing factors on EPV actions and attitudes in China in the correlation and regression analysis.

(2) Regression equations for action and attitude

In this section, regression equations for the EPV action and attitude indices are built with respect to the chosen significant influencing factors. The analysis process includes three steps. In the first step, the original time series of both the EPV action and attitude indices and their influencing factors are handled as anomalous time series, which are equal to the original series minus their averages, to remove the influence of averaging with time. The second step is to calculate the correlation coefficients between these anomalous time series based on which factors are insignificantly correlated with the indices of attitude and action but significantly correlated with one of the other influencing factors that are removed. The third step is to establish the regression equations for the action and attitude indices using the factors chosen in the second step.

Each impact variable includes three possible influencing factors: the growth rate, growth trend and temporal average during the periods of different WVS datasets; thus, five impact variables have 15 influencing factors. For the convenience of the upcoming discussion, we use x1, x2, x3, . . . , x14, x15 to represent these 15 influencing factors, where x1 to x5, x6–x10 and x11–x15 indicate the five growth rates, five growth rate trends and five temporal averages generated by the five impact variables, respectively, including per capita GDP, per capita carbon emissions, the industrial three wastes number, rural township enterprise number, and rural township enterprise output. We also use y1 and y2 to represent the action and attitude indices I_{action} and $I_{attitude}$, respectively. Appendix B provides the correlation coefficients and confidence levels among y1, x1, x2, x3, . . . , x14, and x15. The results show that the correlation coefficients of x4, x5, and x10 with the action index are significant and are larger than 0.7 at confidence levels of 95%, 90%, and 80%, respectively. Because x5, x10 and x15 and x4, x9 and x14 are actually the different influencing factors (i.e., the growth rate, growth rate trend and temporal average, respectively) of different aspects (i.e., number and output, respectively) for the same

variable of rural township enterprises, x5, x10, x15, x9 and x14 are excluded, and only x4 is chosen as the main regression factor for action. From the point of view of independence between chosen factors, x1, x6 and x15 represent three factors that are most independent of x4. Because x15 has been excluded in the above analysis, and the correlation between x6 and y1 is better than that between x1 and y1, x6 is finally selected as another regression factor for action. Based on x4 and x6, the regression equation for the action index (y1) is established as follows:

$$y1 = 0.4796\ x4 + 1.0527\ x6. \quad (3)$$

The correlation coefficient between the regressed and real action indices is 0.9976, which is very significant at a very high confidence level of 99.95% (see Table 1).

Table 1. Contributions of key impact factors to the evolution of the action index anomaly (the correlation coefficient and confidence level between the predictions and actions are 0.9976 and 99.95%, respectively).

Period	1990–1994 (WVS2)	1995–1998 (WVS3)	1999–2004 (WVS4)	2005–2009 (WVS5)	2010–2014 (WVS6)
a4× (x4) (a4 = 0.4796)	0.0377	0.0730	0.0163	0.0270	−0.1540
a6× (x6) (a6 = 1.0527)	0.0566	−0.0687	0.0292	0.0074	−0.0244
a4× (x4) + a6× (x6)	0.0943	0.0043	0.0455	0.0344	−0.1784
Time gradient of a4× (x4)		0.0353	−0.0567	0.0107	−0.1810
Time gradient of a6× (x6)		−0.1253	0.0979	−0.0218	−0.0318
Time gradient of a4× (x4) + a6× (x6)		−0.0900	0.0412	−0.0111	−0.2128
Action index anomaly	0.1037	0.0076	0.0385	0.0268	−0.1766
Time gradient of the action index anomaly		−0.0961	0.0309	−0.0117	−0.2034

Similarly, x2 and x5 are used as valid regression factors for the attitude index (y2). The correlation coefficients of y2 with x2, x3 and x5 are 0.72, 0.84 and −0.81 at confidence levels of 80%, 95% and 90%, respectively (see Appendix B). Because the correlation coefficients of x3 with x2 and x5 are significantly high (0.84 and −0.73 at confidence levels of 95% and 90%, respectively), x3 is poorly independent of x2 and x5 and, therefore, x3 is excluded from the regression. Meanwhile, considering the good independence between x2 and x5 (see Appendix B), these two factors are finally chosen to build the following regression equation for the attitude index (y2):

$$y2 = 4.6017\ x2 - 1.1849\ x5. \quad (4)$$

The above regression analyses show that rural township enterprises affect both the action and attitude from two different aspects, x4 and x5, while the industrial three wastes are not chosen as key influencing factors in the regression analyses, although they are the factor that most significantly affects attitude. The reason may be the representativeness of the data. From the perspective of the attribute weight of the WVS questionnaire, the proportion of government workers in the survey respondents is very low (2.9% in WVS2, 6.1% in WVS3, 3.9% in WVS4, 3.9% in WVS5, and 0.7% in WVS6). However, in the real case, the three industrial wastes variable is more representative of the interests of large enterprises and the government. Obviously, the survey data lack representativeness.

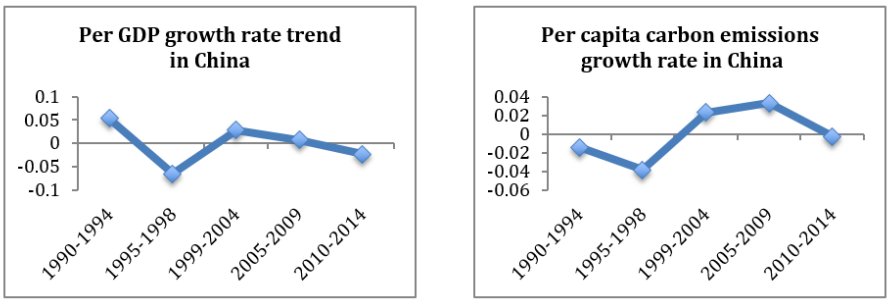
2.3. Contributions and Possible Mechanisms

Based on the regression equations, we calculated the contributions of the key impact factors to the evolutions (in particular, to the rapid changes) in the action and attitude indices during the periods from 2005–2009 to 2010–2014 and 1995–1998 to 1999–2004 (see Tables 1 and 2, respectively). As mentioned in Section 2.2, the EPV action experienced a significant improvement during the periods from 2005–2009 to 2010–2014. As Figure 1a shows, the fitting curves match well with the observed values. The time gradient for the action index during this period is −0.2034, where the absolute value is much larger than that during the other periods considered (refer to Table 1). The simulated gradient

by the regression equation for the action index anomaly (−0.2128) is close to the real one, where the factors x4 and x6 contribute −0.1810 and −0.0318, respectively (see Table 1). It is indicated that the reductions in both the per capita GDP growth rate trend (x6) and rural township enterprise number growth rate (x4) positively contribute to the aforementioned significant improvement in action (see Figures 2a and 3a, respectively). In particular, the rural township enterprise number growth rate plays a much more important role in this rapid change.

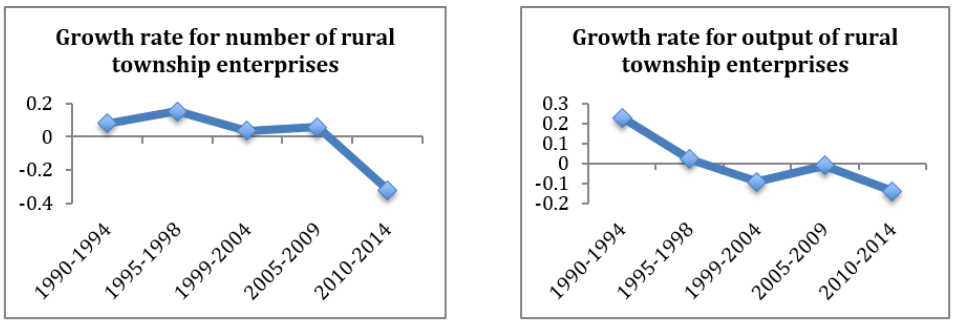
Table 2. Contributions of key impact factors to the evolution of the attitude index anomaly (the correlation coefficient and confidence level between the predictions and actions are 0.9251 and 99.95%, respectively).

Period	1990–1994 (WVS2)	1995–1998 (WVS3)	1999–2004 (WVS4)	2005–2009 (WVS5)	2010–2014 (WVS6)
a2× (x2) (a2 = 4.6017)	−0.0659	−0.1774	0.1054	0.1510	−0.0132
a5× (x5) (a5 = −1.1849)	−0.2706	−0.0229	0.1111	0.0145	0.1680
a2× (x2) + a5× (x5)	−0.3365	−0.2003	0.2165	0.1655	0.1548
Time gradient of a2× (x2)		−0.1115	0.2828	0.0456	−0.1642
Time gradient of a5× (x5)		0.2477	0.1340	−0.0966	0.1535
Time gradient of a2× (x2) + a5× (x5)		0.1362	0.4168	−0.0510	−0.0107
Attitude index anomaly	−0.3055	−0.2198	0.3720	0.0437	0.1097
Time gradient of the attitude index anomaly		0.0857	0.5918	−0.3283	0.0660



(**a**) (**b**)

Figure 2. China's per capita gross domestic product (GDP) growth rate trend anomaly (**a**) and per capita carbon emissions growth rate anomaly (**b**) (the data are from the World Development Indicators of the World Bank).



(**a**) (**b**)

Figure 3. China's growth rate trend anomaly for the number (**a**) and growth rate anomaly for the output (**b**) of rural township enterprises (the data are from the Statistical Yearbook of Township Enterprises in China).

As shown in Figure 3a, the time-evolving curve for the number of rural township enterprises matches well with that for the action index during the periods from 2005–2009 to 2010–2014. Therefore, the following discussions focus on the contributions of township enterprises to the improvement of action since rural areas occupy a larger proportion in China. There were more than 700 million

people among the 1.3 billion people in China who lived in rural areas in 2009 [22]. The development of township enterprises has greatly promoted the transfer of the rural labour force and accelerated the development of urban–rural integration. However, due to the lack of necessary production technology in the initial development of township enterprises, these enterprises are often indifferent to environmental protection awareness [23]. Township enterprises were facing unprecedented difficulties and challenges due to the influence of internal and external socioeconomic pressures. For example, more than 40,000 township enterprises stopped production or went bankrupt in the Yangtze River Delta and Pearl River Delta regions alone in the second half of 2008. Under the impact of economic globalization, fierce market competition made the external environment of township enterprises more severe [24]. In addition, frequent natural disasters have a huge impact on production. The structural adjustment and industrial upgrade of township enterprises were promoted as important measures to improve people's livelihoods in rural areas and employment according to Document No. 1 of the Central Committee of the People's Republic of China in 2010 [25]. The concentration degree of the enterprise layout and the industrial clusters of township enterprises have been improved [26]. The development of township enterprises has changed from extensive operations with high inputs and consumption to intensive and sustainable developments to address the problems of resource limitation and environmental degradation.

As for the EPV attitude, its significant improvement occurred during the periods from 1995–1998 to 1999–2004 (Figure 1b). The time gradient for the attitude index during this period is 0.5918, which is much larger than that during the other periods considered (Table 2). This result has low credibility for such a small sample regression since the fitting degree of the regression (i.e., the square of the correlation coefficient) is less than 0.86. However, the impact of rural township enterprises does exist, although it is smaller than the impact on action. Due to the Asian financial crisis in 1998, the economy was in a recession, and industrial enterprise development began to slow. After joining the World Trade Organization (WTO) in 2001, the Chinese economy faced new challenges and pressures from overseas markets, which forced domestic enterprises to adjust their modes of operation to improve market competitiveness.

In conclusion, there may be positive correlation relationships of environmental actions and attitudes with rural township enterprises, which is a special type of economy in China. In particular, this influencing factor plays a much more important role in the improvement of action.

3. Conclusions and Discussion

By quantifying the variables from WVS2 to WVS6 in China, a dynamic analysis on the action and attitude indices is conducted to explain the temporal evolutions in EPVs. Some key influencing factors are selected, which involve economic growth, carbon emissions, rural township enterprises, and some major domestic events during the period. These factors are either comprehensive or unique, and are quite different from those in existing studies on environmental protection attitudes and actions in China that can mainly be classified into 4 categories: (1) demographic characteristics, (2) economic factors, (3) local pollution status variables, and (4) social relation variables. Demographic characteristics refer to the most basic personal information and characteristics of respondents, including gender, age, and education level [27–29]. Economic factors mainly include local economic development [30] and individual income levels [12,31,32], which have significant impacts on environmental protection action. Local pollution status variables are thought to have a relationship to EPVs, which can be expressed as a representative formulation that is pollution driven [33,34]. Social relation variables mainly refer to the degree of personal involvement in society (i.e., the degree of closeness between individuals and others or society) [31,35–37].

Actually, the influencing factors used in this study belong to the category of economic factor, but no available studies have been reported to investigate the impacts of rural township enterprises on EPVs. However, our results suggest that rural township enterprises, which are unique economic phenomena in China, are important factors impacting EPVs. Due to the increased reform of the

property rights system for township enterprises, along with the influence of the Asian financial crisis, the growth rate of rural township enterprises showed a decreasing trend with various economic indicators, which benefits the improvements of EPV action and attitude.

The concept of township enterprises was defined for the first time in the Law of the People;s Republic of China on Township Enterprises 1997 [38] that "Township enterprises refer to rural collective economy of farmers' investment exceeding 50%, or even less than 50%, but they can play a controlling or actual dominant role and undertake the responsibility of supporting agriculture in the township, including the villages under their jurisdiction." These enterprises are generally engaged in the industries of paper making, prevention and control, the chemical industry, printing and dyeing [39]. Many small township enterprises, especially those such as paper mills, building materials factories, printing and dyeing factories, and treatment refineries, have polluted water resources seriously. The atmospheric pollution of township enterprises mainly includes SO_2 and nitrogen oxide. The treatment rate of waste gases is low, especially from those township enterprises using large coal, such as brick and tile factories, glaze factories, paper mills and chemical factories. The solid waste produced by township enterprises mainly comes from the construction industry, mining industry and processing industry [40]. The establishment of rural township enterprises was to increase farmers' income and raise their living standards according to the national conditions at the earlier time when the farmers accounted for a very high proportion of the total population of China (e.g., 87% in 1955) but the per capita cultivated land was very insufficient (e.g., only 0.21 hectares in 1955) [41].

The main contribution of this study is to reveal the significant impacts of rural township enterprises on the rapid changes of EPV action and attitude in different ways, instead of the focus on other factors such as family income, age, family population and education level, and so on in existing studies. The rapid reduction of the growth rate trend for the number of rural township enterprises accounts for 85% of the contribution to the rapid improvement of EPV action during the period from 2005–2009 to 2010–2014 (see Table 1), while the decrease of the growth rate for the output of rural township enterprises accounts for 32% of the contribution to the rapid improvement of EPV attitude during the periods from 1995–1998 to 1999–2004 (refer to Table 2). In methodology, existing studies are mainly based on static analyses or dynamic analyses using short-term time series. By contrast with these analyses, this study uses a dynamic analysis for a long-term period, although the length of sample is very limited, which helps us to reveal the impacts of rural township enterprises on EPVs.

This study also shows the necessity to increase the frequency of surveys because dynamic analyses for a long-term period require time series long enough so that high credibility can be obtained. Currently, the credibility of some results in this study is limited due to the lack of survey data. When we revealed the significant impacts of rural township enterprises on EPVs, a careful analysis of the mechanism of these impacts has not been provided here, which calls for further study.

There are two environmental protection forms: government guidance and public participation. Government management needs national policies to regulate and balance interests and policy orientations. Because the number of government workers comprises a small proportion of the survey data, some aspects probably do not reveal China's environmental problems. Most of the public tends to be pro-environment, but they are probably not the largest contributors to interests, such as the interests of enterprises and the government. Therefore, survey data should increase the weighting of government and enterprise respondents.

Author Contributions: Q.L. collected and processed the data, conducted the regression analysis, and drafted the paper. B.W. designed the structure of the paper, provided the core ideas and methods for this research, and revised the paper many times. C.Y. and H.D. contributed to the understanding of the impact mechanics. L.L. and W.H. improved the paper.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Variable name, variable label and value label in the selected World Values Survey (WVS) datasets.

Dataset	Variable	Variable Label	Value Label
WVS 2	V12	Would give part of my income for the environment	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V13	Increase in taxes if used to prevent environmental pollution	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V14	Government should reduce environmental pollution	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V15	All talk about the environment makes people anxious	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V16	Combating unemployment, we have to accept environmental problems	1-strongly disagree; 2-disagree; 3-agree; 4-strongly agree
	V17	Protecting the environment and fighting pollution is less urgent than suggested	1-strongly disagree; 2-disagree; 3-agree; 4-strongly agree
	V33	Membership in voluntary organizations: environmental organizations	1-active member; 2-inactive member; 3-not a member
WVS 3	V38	I would agree to an increase in taxes if the extra money was used to prevent environmental damage	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V39	I would buy things at a 20% higher price if it helped to protect the environment	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V40	Environmental problems can be solved without any international agreements to handle them	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V41	Environment vs. economic growth	1-protecting the environment should be given priority; 2-economic growth and creating jobs should be the top priority
	V42	Environmental action: choose products that are better for the environment	1-have done; 2-have not
	V43	Environmental action: recycle something rather than throw it away	1-have done; 2-have not
	V44	Environmental action: reduce water consumption for environmental reasons	1-have done; 2-have not
	V45	Environmental action: attend meetings and sign petitions aimed at protecting the environment	1-have done; 2-have not
	V46	Environmental action: contribute to an environmental organization	1-have done; 2-have not
	V49	Human beings should master nature vs. coexist with nature	1-human beings should master nature; 2-humans should coexist with nature

Table A1. *Cont.*

Dataset	Variable	Variable Label	Value Label
WVS 4	V33	Would give part of my income for the environment	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V34	Increase taxes if the extra money is used to prevent environmental pollution	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V35	Government should reduce environmental pollution	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V36	Environmental and economic growth	1-protecting environment; 2-economic growth and creating jobs
	V37	Humans and nature	1-master nature; 2-coexist with nature
WVS 5	V29	Membership in an environmental organization	0-not a member; 1-inactive member; 2-active member
	V104	Environmental vs. economic growth	1-protect the environment; 2-economic growth and creating jobs
	V105	Would give part of my income for the environment	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V106	Increase taxes if the extra money is used to protect the environment	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
	V107	Government should reduce environmental pollution	1-strongly agree; 2-agree; 3-disagree; 4-strongly disagree
WVS 6	V30	Active/inactive membership: environmental organization	0-not a member; 1-inactive member; 2-active member
	V81	Protecting environmental vs. economic growth	1-protecting the environment should be given priority; 2-economic growth and creating jobs should be the top priority
	V82	Past two years: given money to an ecological organization	1-yes; 2-no
	V83	Past two years: participated in a demonstration for the environment	1-yes; 2-no

Appendix B

Table A2. Correlations among the indices of action and attitude (confidence level is in brackets).

Indices and Factors	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15
Action (y1)	−0.33 (0)	0.04 (0)	−0.21 (0)	0.89 (95%)	0.75 (90%)	0.54 (0)	0.51 (0)	0.45 (0)	0.51 (0)	0.71 (80%)	−0.58 (0)	−0.56 (0)	−0.46 (0)	−0.35 (0)	−0.51 (0)
Attitude (y2)	0.07 (0)	0.72 (80%)	0.84 (95%)	−0.39 (0)	−0.81 (90%)	0.12 (0)	0.45 (0)	0.004 (0)	−0.48 (0)	−0.18 (0)	−0.06 (0)	−0.28 (0)	0.27 (0)	0.48 (0)	−0.29 (0)
x1	1.0														
x2	0.30 (0)	1.0													
x3	0.54 (0)	0.84 (95%)	1.0												
x4	−0.07 (0)	−0.16 (0)	−0.17 (0)	1.0											
x5	−0.38 (0)	−0.38 (0)	−0.73 (90%)	0.59 (0)	1.0										
x6	−0.50 (0)	0.51 (0)	−0.007 (0)	0.09 (0)	0.44 (0)	1.0									
x7	−0.65 (0)	0.50 (0)	0.18 (0)	0.16 (0)	0.14 (0)	0.84 (95%)	1.0								
x8	−0.67 (0)	−0.41 (0)	−0.29 (0)	0.53 (0)	0.17 (0)	−0.02 (0)	0.40 (0)	1.0							
x9	0.05 (0)	−0.55 (0)	−0.30 (0)	0.83 (95%)	0.36 (0)	−0.45 (0)	−0.29 (0)	0.58 (0)	1.0						
x10	−0.55 (0)	0.26 (0)	−0.26 (0)	0.31 (0)	0.70 (80%)	0.95 (99%)	0.74 (90%)	0.09 (0)	−0.20 (0)	1.0					
x11	0.73 (90%)	−0.29 (0)	0.19 (0)	−0.15 (0)	−0.50 (0)	−0.95 (99%)	−0.89 (98%)	−0.24 (0)	0.32 (0)	−0.94 (99%)	1.0				
x12	0.83 (95%)	−0.18 (0)	0.07 (0)	−0.28 (0)	−0.25 (0)	−0.70 (80%)	−0.94 (99%)	−0.67 (80%)	0.05 (0)	−0.67 (80%)	0.84 (95%)	1.0			
x13	0.78 (90%)	0.62 (80%)	0.59 (0)	−0.49 (0)	−0.40 (0)	−0.03 (0)	−0.31 (0)	−0.94 (99%)	−0.56 (0)	−0.23 (0)	0.32 (0)	0.63 (80%)	1.0		
x14	−0.09 (0)	0.64 (90%)	0.32 (0)	−0.72 (80%)	−0.26 (0)	0.59 (0)	0.41 (0)	−0.56 (0)	−0.98 (99.9%)	0.35 (0)	−0.45 (0)	−0.16 (0)	0.54 (0)	1.0	
x15	0.52 (0)	−0.58 (0)	−0.12 (0)	−0.08 (0)	−0.31 (0)	−0.98 (99.9%)	−0.92 (99%)	−0.08 (0)	0.45 (0)	−0.89 (98%)	0.95 (99%)	0.78 (90%)	0.07 (0)	−0.59 (0)	1.0

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