



How Does Urbanization Affect Citizens' Pro-Environment Behavior? A Hierarchical Analysis of the Chinese General Social Survey

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Many studies have focused on the pressure of urbanization on resources and environment, but few have explored the positive effect of urbanization on reducing environmental pressure from the perspective of urbanization affecting pro-environment behavior (PEB). To systematically explore the impact of urbanization with different dimensions on PEB, this study establishes a hierarchical theoretical framework and conducts empirical test based on the data of *Chinese General Social Survey* (CGSS) and *China City Statistical Yearbook* (CCSY) as well as a hierarchical linear model (HLM). The results reveal the following: First, urbanization can directly influence PEB and the four dimensions of urbanization (economic, social, spatial and population urbanizations) can influence PEB in different manners. Economic urbanization can positively influence private PEB; social urbanization exerts a slightly positive impact on PEB; spatial urbanization has a notably negative impact on PEB while population urbanization has no significant effect on PEB. Second, Urbanization also indirectly affects PEB by influencing individual characteristic variables. Social and economic urbanizations positively moderate the relationship between social interaction and PEB. The research results illustrate the relationship between urbanization and PEB, and can guide how to promote PEB in the process of urbanization.

Keywords: urbanization, pro-environment behavior, social interaction, environmental knowledge, hierarchical linear model, moderating effect

1 INTRODUCTION

Urbanization is the surest way toward modernization and a powerful engine for high-quality economic development. Since the reform and opening up, China has been experiencing an urbanization process with the largest scale at the highest speed in the world history, and has made remarkable achievements. According to the data from the National Bureau of Statistics, the urbanization rate of China's permanent residents increased from 17.9% in 1978 to 63.89% in 2020, an average annual growth rate of 1.09%, far higher than the global average over the same period (National Bureau of Statistics, 2021). Although urbanization promotes economic prosperity, it also causes great consumption of resources and energy and environmental pollution (Han et al., 2018; Jin et al., 2018; Zhang et al., 2021a; Zhang et al., 2021b). Statistics revealed that in the past decade, China ranked around 120th in the Global Environmental Performance Index (121th among 163 countries in the year of 2010 and 120th among 180 countries in the year of 2020), falling behind the average

level of countries with the same income (Wendling et al., 2020). Faced with severe environmental problems, the Chinese government attaches great importance to environmental protection and made strategic plans to promote ecological civilization for a beautiful China (Jin et al., 2020). The 14th Five-Year Plan for China's National Economic and Social Development (2021–2025) also clearly proposes to accelerate green and low-carbon development, continuously improve environmental quality, and integrate the concepts of “ecological civilization, greenness, low-carbon and economical and intensive utilization of resources” into the process of urbanization (Agency, 2021). However, the solution to environmental problems and the realization of green, low-carbon and high-quality urbanization not only depend on the administrative government, but also require extensive and effective participation of the public. Therefore, it is of theoretical value and practical significance to study the impact of urbanization on pro-environment behavior (PEB) and how to promote PEB in the process of urbanization.

Previous researches have analyzed the pressure of urbanization on resources and environment, but few explored the positive effect of urbanization on environmental governance, especially its impact on private PEB. First, studies on PEB failed to discuss the relationship between urbanization and PEB. Previous studies on PEB mainly focused on individual characteristics, such as attitude and awareness (Azucena Vicente-Molina et al., 2013; Gifford and Nilsson, 2014), ignoring macro factors (Wang and Han, 2016; Hong and Park, 2018; Hao and Song, 2020), especially the impact of urbanization on private PEB. Even if some scholars have studied the impacts of population density and urban population ratio on public pro-environment awareness and PEB (Franzen and Meyer, 2010), they merely took urbanization as a control variable, rather than a core explanatory variable, to explore the causal relationship between the two. Second, most previous studies reflected the process of urbanization in China through population urbanization (POU). Although population migration from rural areas to cities is the basic form of urbanization, in essence, urbanization is not a simple population agglomeration or urban sprawl, but a complex process that triggers the overall evolution of social and economic structure (Chen et al., 2020; Yao et al., 2021). In other words, previous studies failed to realize that urbanization is a multi-faceted process involving population agglomeration, economic development, formation of urban carriers with modern civilization, as well as improvement of infrastructure, public services and residents' living quality (Liu et al., 2019; Ren and Yu, 2021). Different aspects of urbanization may have different impacts on PEB. Finally, previous researches have not discussed the moderating effect of urbanization on the relationship between individual factors and PEB. The Attitude-Behavior-Condition (ABC) model proposes that external factors can affect PEB both directly and indirectly through interaction with individual factors (Guagnano et al., 1995; Steg and Vlek, 2009). PEB can be more accurately predicted by considering the direct and indirect effects of external factors. However, previous researches did not discuss the cross-level moderating effect of external factors on PEB, let alone the moderating effect of urbanization on the relationship between individual factors and PEB.

To make up for the above research defects, this study establishes a hierarchical theoretical framework. The impact of urbanization on

PEB is empirically analyzed with the data from *Chinese General Social Survey* (CGSS) 2013 and *China City Statistical Yearbook* (CCSY) 2013 by the hierarchical linear model (HLM). Special attention is paid to the impacts of different dimensions of urbanization on PEB. It also examines how urbanization moderates the relationship between individual factors and PEB. This research is of both theoretical and practical significance. First, the study expands the scope of relevant researches on the influencing factors for PEB, and grasps the complex relationship between urbanization and PEB by considering the different dimensions of urbanization. Previous researches on the influencing factors for PEB were mainly focused on the micro-level factors such as attitude, awareness and values (Azucena Vicente-Molina et al., 2013; Gifford and Nilsson, 2014), yet the macro-level factors were ignored, especially the impact of urbanization on PEB. This study investigates urbanization and PEB and finds that urbanization is an important influencing factor for PEB. The influences of different dimensions of urbanization on PEB differ greatly. Specifically, economic urbanization (ECU) significantly promotes private PEB, but has no significant impact on public PEB; social urbanization (SOU) exerts a limited positive impact on PEB; spatial urbanization (SPU) notably restricts PEB; population urbanization (POU) has no significant impact on PEB. The results reveal the complicated relationship between urbanization and PEB. Second, the study systematically analyzes how factors at city and individual levels influence PEB from the perspective of hierarchy; especially, it discusses the direct and indirect impacts of urbanization on PEB, providing an in-depth understanding of the relationship between the two. Third, since promoting the sustainable development of urbanization has become a common challenge, the theoretical framework and research findings proposed in this study are also informative for other countries. Changes in PEB will have a sustained and far-reaching impact on the reduction of urban environmental pressure. Future researches should pay more attention to the complex impact of urbanization on PEB, and consider the cross-level moderating effect. Finally, this study provides empirical evidence for PEB in urbanization. This helps China to steadily pursue green, low-carbon, sustainable and high-quality urbanization.

This paper is structured in six sections. **Section 2** reviews the relevant literature on urbanization and PEB, and puts forward research hypotheses. **Section 3** introduces the research design, including data, variables and models. **Section 4** gives the empirical analysis results. **Section 5** discusses the main research results. Finally, **Section 6** presents the research conclusions and some policy recommendations.

2 LITERATURE AND HYPOTHESES

2.1 Urbanization and Pro-Environment Behavior

Urbanization refers to the process of rural population migrating to cities, which is driven by the economic structure transformation, especially the transformation of industrial structure from an agriculture-based one to a non-agriculture-based one. This process is accompanied by multi-dimensional

revolutions in economic growth mode, social organization structure and residents' lifestyle (Davis and Henderson, 2003). With the advancement of urbanization in China, new urbanization is gradually known to the public. New urbanization is not merely the urbanization of population, but a four-sphere integrated urbanization of population, economy, space and society (Liu et al., 2019; Ren and Yu, 2021; Yu, 2021). It is people-centered, pays attention to improving the quality of urbanization and strives to achieve equalization of public services.

PEB refers to the behavior actively taken by individuals in daily life to improve environmental conditions and environmental quality (Ates, 2020). There are different types of PEB: Stern and Paul (2000) were the first to classify them into three types: 1) radical PEB, such as actively participating in social movements; 2) public non-radical PEB, such as signing petitions for environmental issues and participating in processions; 3) private PEB, such as green consumption and energy-saving housing. Afterwards, many scholars combined the first two types of behaviors and further divided behaviors from two dimensions: private PEB and public PEB (Hunter et al., 2004; Hadler and Haller, 2011; Xiao and McCright, 2014). There are also other methods of classification, such as environmental activism and environmentally friendly behavior (Tindall et al., 2003), political PEB and protective PEB (Dalton, 2015). Different classification methods correspond to different research conclusions on the general pattern of environmental behavior (Xiao and McCright, 2014). To accurately investigate the influence of urbanization on different types of PEB, this study adopts the classification method of Hunter et al. (2004) and Wang and Han (2016), and divides PEB into private PEB and public PEB.

Urbanization, an inevitable process for economic development, has caused environmental pollution, but it may also improve PEB. For example, from a macro perspective, the affluence hypothesis holds that the wealth of a country or a region is positively correlated with its public pro-environment awareness and PEB (Diekmann and Franzen, 1999). Therefore, urbanization may promote PEB while contributing to economic development. Urbanization may also promote PEB by jointly improving the public services and the living quality. Studies have proven that basic education and social security can significantly promote PEB (Fan et al., 2018). From a micro perspective, urbanization contributes to education; a good education can promote PEB (Monier et al., 2009; Azucena Vicente-Molina et al., 2013; Xiao and McCright, 2014; Meyer, 2015; Zheng et al., 2019) by providing the access to pro-environment knowledge and delivering a higher level of pro-environment awareness. Therefore, theoretically, urbanization may have a complex impact on PEB.

2.1.1 Population Urbanization and Pro-Environment Behavior

Population urbanization (POU) refers to the process of population agglomeration from rural areas to urban areas. It is the product of social productivity development in a certain stage, and also the most typical phenomenon and result of urbanization. This agglomeration is not only an increase in urban population,

but also a growth of urban population density, an increase in the number of employed people in the secondary and tertiary industries and a continuous improvement of urban population quality. POU has a complex impact on PEB. First, in the process of POU, the rapid growth of urban population intensifies the demand for various resources and energy, which will cause more pollutants and greenhouse gases, bringing greater pressure to the environment (Lin et al., 2017). Studies suggest that a high population density may highlight potential conflicts between economic growth and environmental quality, so people in densely populated countries may be more concerned about the environment (Franzen and Meyer, 2010). Consequently, countries or regions with higher degrees of POU may pay more attention to environmental issues, including greater desire to participate in environmental protection (Franzen and Meyer, 2010).

Second, from the perspective of population migration, migrants may also improve their PEB by learning and interacting with local urban residents. For example, studies hold that migrants can acquire more environmental knowledge (EK) and improve their PEB by actively integrating into local community and contacting local residents (Pfeffer and Stycos, 2002). However, some studies have different views. Hunter (2000) found that migrants and local residents differ insignificantly in PEB. Ng (1998) believes that migrants exert a weaker impact on the environment of their destination, compared with social institutional factors, such as economy, political structure and religious belief. In general, few literatures explored the impact of POU on PEB, and they have not arrived at a consistent conclusion. In the context of rapid urbanization in China, compared with people in cities with lower urbanization levels, people in cities with higher urbanization levels are more willing to participate in environmental protection. This study proposes the following hypotheses:

H1a: POU can promote private PEB.

H1b: POU can promote public PEB.

2.1.2 Economic Urbanization and Pro-Environment Behavior

Economic urbanization (ECU) promotes the comprehensive development of urban economy. For one thing, ECU is demonstrated by the agglomeration of production factors in cities, resulting in economies of scale and improving the income of urban residents. For another, ECU also contributes to the upgrading of industrial structure, namely, the transformation from an agriculture-based one to an industry-based one, then to a tertiary industry-based one. The affluence hypothesis (Diekmann and Franzen, 1999) believes that economic development can promote public pro-environment awareness and PEB. It holds that first of all, environmental quality is a normal commodity whose demand rises with prosperity (Markandya et al., 1979). Therefore, economic growth leads to an increase in public demand for environmental quality. Second, budgetary constraints can be released only when individual wealth increases, making it possible for individuals to invest more resources to improve environmental quality. In short, as economy develops, the

public become more affluent; then their demand and ability to improve environmental quality also improve.

Relevant studies support the affluence hypothesis. For example, some studies find that environmental concerns at the individual level are positively correlated with a country's economic affluence measured by gross domestic product per capita (GDP) (Summers and VanHeuvelen, 2017; Welsch and Kühling, 2017). There is a clear relationship between economic development and political PEB or protective PEB (Dalton, 2015). ECU is manifested by the growth of economic output value as well as industrial transformation and upgrading. The proportion of industrial structure is closely related to the development of a region. In general, the higher the degree of industrialization in a region is, the more serious the environmental problems might be. The problems can well stimulate the environmental concern and PEB of citizens (Chen et al., 2013). Therefore, people in cities with higher levels of ECU are more willing to participate in environmental protection than those in cities with lower levels of ECU.

H2a: ECU is conducive to private PEB.

H2b: ECU is conducive to public PEB.

2.1.3 Spatial Urbanization and Pro-Environment Behavior

Spatial urbanization (SPU) is a phenomenon reflected on the carrier with ECU and POU, which is characterized by high-level organization of environment and agglomeration of material facilities (Ding and Zhao, 2011; Kuang et al., 2020). The so-called environmental organization refers to the artificial transformation of the natural environment, reflected in the existence of buildings and structures, making the environment suitable for human needs. The agglomeration of material facilities is another physical characteristic of urbanization, which is manifested in the high-density distribution of various workplaces, residences, transportation, recreation and other facilities in urban areas. Studies have shown that the construction of high and dense buildings promotes efficient and intensive use of land in urbanization, and provides amenities and services to nearby residents. These not only bring a more convenient urban life in which walking is preferred, but also stimulate social interaction, social capital and community awareness (Montgomery, 1998; Cao et al., 2019). However, the development of high-density urban space also results in a series of problems such as congestion, lack of privacy and shortage of resources and services (Conway and Adams, 1977; Wang and Chien, 1998).

Studies have highlighted the importance of infrastructure for PEB. For example, the number (Derksen and Gartrell, 1993; Kuang and Lin, 2021), location (O'Connor et al., 2010) and availability (Timlett and Williams, 2009; Bernstad, 2014) of recycling facilities are all important factors for waste recycling. Besides, traffic conditions and urban greenness have a significant impact on public riding behavior, and people who ride bicycles prefer roads or streets with good connectivity, fewer vehicles (Sun et al., 2017), well cycle path condition (Etminani-Ghasrodashti et al., 2018) and more street greenery (Wang et al., 2020). In addition, optimizing public transport services and policies, such as offering cheap or free bus tickets, can also encourage people with high pro-environment awareness to minimize the use of private vehicles (Fan et al., 2018). As confirmed by these

examples, SPU plays an important role in changing PEB. As China's urbanization advances, infrastructure has been improved significantly, but problems such as poor infrastructure quality, low convenience and extensive operation and management become increasingly prominent, which may constrain PEB (Fan et al., 2018). The following hypotheses are proposed:

H3a: SPU may constrain private PEB.

H3b: SPU may constrain public PEB.

2.1.4 Social Urbanization and Pro-Environment Behavior

Social urbanization (SOU) is the ultimate goal of urbanization whose main task is to improve the public services, such as medical service, education and social security, and to improve the living quality of urban residents. SOU may jointly promote PEB by improving the public services and living quality. Basic public services are the most relevant to public interest and a comprehensive variable affecting public behavior in daily life. Studies have confirmed that basic education and social security levels play a significant role in promoting PEB (Fan et al., 2018). In addition, as public service and life quality in urban areas improve, people's life improves in both material and cultural terms. According to the post-materialism theory, when the material needs are met to a certain extent, people begin to care about specific social issues, such as environmental issues. Specifically, according to Inglehart (1995), the measure of individual value is determined during primary socialization. People experience primary socialization in good socio-economic conditions and form post-materialistic values in the context of economic growth, national security and widespread employment opportunities. As the social wealth accumulates, the public's transformation from the original "materialistic values" to "post-materialistic values" contributes to their concern for the environment and improves public environmental participation and support. Different from "materialistic values" which concern basic material needs, "post-materialistic values" emphasize living quality, self-expression and environmental protection. Relevant studies also provide supportive evidence. For example, Gelissen (2007) found that on average, the public with higher post-materialist tendencies were more willing to make economic sacrifices for environmental protection after investigating the degree and difference of public support for environmental protection in 50 countries. Therefore, people in cities with higher levels of SOU are more willing to participate in environmental protection than those living in cities with lower levels of SOU. This study proposes the following hypotheses:

H4a: SOU facilitates private PEB.

H4b: SOU facilitates public PEB.

2.2 Cross-Level Moderation of Urbanization on Pro-Environment Behavior

As is pointed out by the ABC model, external factors can affect PEB both directly and indirectly through interaction with individual factors (Steg and Vlek, 2009). As an important moderating mechanism, external factors can strengthen or weaken the impact of individual factors on PEB (Guagnano

et al., 1995; Stern, 2000). Researches that merely focus on the main effect are misleading (Ertz et al., 2016) because they ignore the moderating effect. In contrast, researches considering the direct and indirect effects of external factors can improve the explanatory ability of the theoretical model to predict PEB. Therefore, this research also focuses on the cross-level moderation of urbanization between individual factors and PEB.

First, some studies have emphasized the close relationship between social interaction (SI) and PEB, and found that the public not only adjust their PEB through the direct observation of the behavior of others, but also obtain pro-environment information and knowledge through SI, thus exerting a positive impact on their own behavior (Zheng et al., 2019). Compared with cities with low urbanization levels, cities with high urbanization levels are of more communication and more opportunities for interaction between different occupational groups, which is conducive to promoting SI (Sato and Zenou, 2015). Therefore, the impact of SI on PEB may vary with the level of urbanization.

H5a: Urbanization positively moderates the relationship between SI and private PEB and public PEB.

Second, the important predictive effect of EK on PEB has been confirmed by many researches. Levine and Strube (2012) found that general ecological knowledge can well predict PEB. Liu et al. (2020) and Wu et al. (2022) concluded that EK can promote PEB by shaping environmental attitudes and behavioral intentions. A recent study also revealed that changes in PEB are caused by EK (internal factor) and socio-economic factors (external factors) (Amoah and Addoah, 2021). Cities with higher urbanization levels correspond to better education and more channels to contact with the network media, which is helpful to acquire more EK. Therefore, the impact of EK on PEB may be moderated by the level of urbanization. Then the following hypothesis is proposed:

H5b: Urbanization positively moderates the relationship between EK and private PEB and public PEB.

2.3 Other Factors Affecting Pro-Environment Behavior

Education exerts superimposed effects on PEB. First, education has the social function of values, enhances people's pro-environment awareness, so that people are actively involved in environmental protection activities; second, individuals with higher education levels tend to have higher incomes and are more concerned about environmental issues. Empirical studies have also confirmed that education is an important factor in predicting pro-environment concern and behavior. For example, Meyer (2015) found that education makes individuals more concerned about social welfare and thus they act in a more environmentally friendly manner. Monier et al. (2009) found a positive correlation between education and the purchase of green food. Xiao and McCright (2014) found that education plays a significant role in promoting both private PEB and public PEB. Besides, as disclosed in many studies, there are gender differences in PEB. Compared with men, women are more frequently involved in private PEB, such as recycling and green consumption (Macias and Williams, 2016; Strapko et al., 2016;

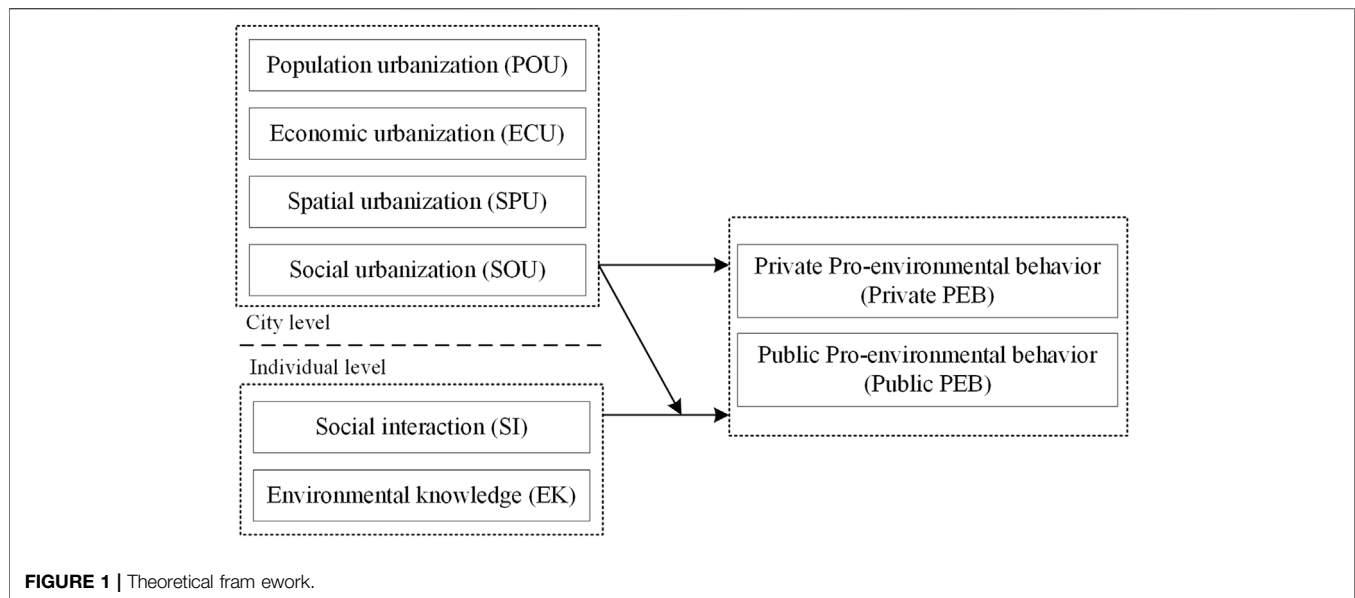
Pisano and Lubell, 2017; Ahmad et al., 2021; Fan et al., 2021). A common argument is that women have stronger pro-environment values, beliefs and attitudes than men (Xiao and Dunlap, 2007; McCright and Xiao, 2014). Some studies hold different views that women's lower levels of EK than men hinder their participation in private environmental protection (Xiao and Hong, 2018). Most studies consider that age is positively correlated with PEB, that is, the elderly are more involved in PEB than the young (Shen and Saijo, 2008; Wang et al., 2021). With the increase in age, people may increasingly seek the meaning of self-transcendence and the goal of pro-society. Therefore, the practice of PEB may become a way for the elderly to impart this wisdom and remain active (Wang et al., 2021).

The environmental pollution-driving hypothesis holds that serious environmental pollution can raise the public's pro-environment awareness, and then the public would take various PEBs. This hypothesis has been partially supported by empirical evidence (Inglehart, 1995; Wang and Han, 2016). However, some scholars believe that objective environmental pollution differs from public perception of environmental pollution. Usually, pollutants cannot be directly perceived by the public and therefore fail to influence their behaviors (Hyslop, 2009). Some scholars further proposed that this hypothesis should take public perception of environmental pollution into consideration (Franzen and Meyer, 2010; Mi et al., 2021). Therefore, in this study, the impacts of objective and subjective perceptions of environmental pollution on PEB are involved.

Based on the above analysis, a theoretical framework is established (Figure 1). This research focuses on the direct effects of the four dimensions of urbanization on PEB and its cross-level moderating effect between individual factors and PEB.

3 DATA AND METHODS

The data in this study are from two databases. 1) The micro data at the individual level are from CGSS 2013, conducted by the China Survey and Data Center of Renmin University of China, which is one of the most comprehensive social surveys in China. The survey adopted a four-level stratified sampling scheme. A total of 100 counties (or districts) were selected nationwide. Four communities or rural areas were randomly selected in each county (or district), where 25 families were randomly investigated. One person from each family was randomly selected for face-to-face interview. The survey included 28 provincial administrative units, excluding China's Hong Kong SAR, Macao SAR, Tibet Autonomous Region, Xinjiang Uygur Autonomous Region and Hainan Province, with a total sample size of 11,438 people, and it was representative of the characteristics of the country. As the research object was urban residents, the final effective sample size for this study was 6,728 people distributed in 75 cities across China after rural samples and invalid data were excluded. 2) The data at the city level are from CCSY 2013, published annually by the National Bureau of Statistics of China, which is a compilation of statistical

**TABLE 1 |** Statistics of PEB (unit: %).

NO.	Environmental protection activities or behaviors	Never	Occasionally	Often
1	Garbage sorting	45.3	38.9	15.8
2	Discuss environmental issues with your friends and relatives	42.1	47.3	10.6
3	Bring your own shopping basket or shopping bag when purchasing daily necessities	18.8	35.4	45.8
4	Reuse plastic packaging	14.5	30.3	55.2
5	Donate for environmental protection	40.9	42.3	16.8
6	Actively focus on environmental issues reported in radio, television and newspapers and environmental information	75.8	21.3	2.9
7	Actively participate in environmental publicity and education activities organized by the government and organizations	70.5	24.2	5.3
8	Actively participate in environmental protection activities organized by private environmental groups	78.2	18.7	3.1
9	Self-funded forest or green space	85.8	11.1	3.1
10	Actively participate in complaints and appeals that require environmental problems	87.5	10.4	2.1

data that comprehensively reflects the economic and social development of China's cities. The data in the *CCSY 2013* consist of a series of indexes such as urban economic and social development and urban construction in 2012, covering all the 657 cities in China.

3.1 Variables and Operations

3.1.1 Dependent Variables

The dependent variable of this study is the private PEB. In 2013, CGSS measured PEB by 10 questions (**Table 1**). According to the analysis of Wang and Han (2016), this study divides PEB corresponding to 10 questions into two categories: private PEB and public PEB. Questions 1-4 and 6 belong to private PEB, which refers to the PEB in daily life. Questions 5 and 7-10 are public PEB, which refer to the non-radical actions with public's willingness to improve environmental quality. The given options are as follows: 1 = "Never", 2 = "Occasionally" and 3 = "Often." With reference to the researches (Hadler and Haller, 2011; Wang and Han, 2016), the measurement classification of PEB was indexed. Take the private PEB index as an example: First, all

the values were accumulated and divided by 5 to obtain the average value X . Then, it was processed into percent $(X-1) \times (100/2)$. Finally, the private PEB index in the range of 0-100 was obtained. 0 represents the minimum private PEB while 100 represents the maximum. Public PEB was processed in the same way.

3.1.2 Independent Variables

3.1.2.1 City Level

Urbanization is a key variable in the research. As mentioned above, most previous studies measured the level of urbanization by the proportion of urban population which merely reflects the degree of population agglomeration. In fact, urbanization is not just the urbanization of population, but a complex process that causes the overall evolution of social and economic structure (Chen et al., 2020). In recent years, some scholars have established an index system of urbanization from various perspectives and drew a relatively consistent conclusion that the level of urbanization should be measured more comprehensively and scientifically from four dimensions,

TABLE 2 | Evaluation indexes at the urbanization level.

System	First-level indications	Second-level indicators (Unit)	Variable	Positive/negative
Urbanization	Population urbanization (POU)	Proportion of urban population (%)	X ₁	+
		Urban population density (person/km ²)	X ₂	—
	Economic urbanization (ECU)	Proportion of employed persons in secondary and tertiary industries (%)	X ₃	+
		Per capita GDP (yuan)	X ₄	+
		Per capita local fiscal expenditure (yuan)	X ₅	+
	Spatial Urbanization (SPU)	The proportion of tertiary industry in GDP (%)	X ₆	+
		Proportion of urban built-up area in total area (%)	X ₇	+
		Green coverage rate of completed areas (%)	X ₈	+
		Number of buses per 10,000 people (Vehicle)	X ₉	+
	Social Urbanization (SOU)	Per capita consumption expenditure of urban residents (yuan)	X ₁₀	+
		The number of college students per 10,000 people (person)	X ₁₁	+
		Number of health technicians per thousand people (person)	X ₁₂	+
		Proportion of urban basic medical insurance participants (%)	X ₁₃	+

i.e., POU, ECU, SPU and SOU (Liu et al., 2019; Kuang et al., 2020; Yu, 2021). This research recognizes this view. Based on previous research results and scientific, systematic and feasible principles, an urbanization evaluation system consisting of four first-level indexes of POU, ECU, SPU and SOU as well as 13 second-level indexes was established (Table 2).

The specific explanation is as follows. First, the agglomeration of population from rural areas to urban areas is the most typical phenomenon and result of urbanization. This agglomeration is not only an increase in the urban population, but also a growth of urban population density and the number of people in the secondary and tertiary industries. Thus, the indexes to measure POU are X₁-X₃ (Liu and Lei, 2018). Second, the agglomeration of production factors in cities and towns has improved production efficiency, resulting in economies of scale, promoting the optimization and upgrading of industrial structure and improving the income of urban residents. Therefore, ECU is evaluated by economic development, industrial structure development and fiscal expenditure; the specific measurement indexes are X₄-X₆ (Shang et al., 2018; Yu, 2021). Third, SPU is the carrier of urbanization, and the advancement of urbanization is surely reflected in space, i.e., the external performance of urbanization in regional space, including the formation of urban carriers with modern civilization characteristics and the improvement of infrastructure such as traffic conditions. Hence, SPU is evaluated from urban coverage, green coverage in built-up areas and public transportation conditions. The specific measurement indexes are X₇-X₉ (Kuang et al., 2020; Yao et al., 2021). Fourth, SOU aims to promote the equalization of basic public services with medical service, education and social security at their core, and strives to improve public services, so that the public can enjoy the benefits brought by social resources and economic development. Therefore, SOU is evaluated from three aspects, namely medical treatment, education and social security, and the specific measurement indexes are X₁₀-X₁₃ (Liu et al., 2019; Kuang et al., 2020; Yu, 2021). This study incorporates POU, ECU, SPU and SOU into the model to explore how urbanization affects PEB. The measurement data of indexes come from CCSY 2013. As the

units of indexes are not the same, the second-level indexes were normalized. Ruxin (2017) suggested that the second-level indexes of urbanization could be assigned the same weight; then the first-level indexes were synthesized according to the equal weight, and the values of urbanization in four dimensions were obtained.

Environmental pollution index (EPI): With reference to the research of Fan et al. (2018), a comprehensive environmental pollution index was established which included industrial emissions of sulfur dioxide (SO₂), dust and fume and wastewater to evaluate environmental pollution. The measurement data are from CCSY 2013. First, to eliminate the influence of different dimensions, the indexes were normalized. Then the comprehensive score of environmental pollution index was calculated by the weighted average method; next, the index was divided by the territorial area of each city to eliminate the influence of different city scales.

3.1.2.2 Individual Level

Individual variables include EK and SI. According to previous researches (Zheng et al., 2019), the question “frequency of social entertainment activities with friends” could measure SI. The options were “almost every day,” “once or twice a week,” “several times a month,” “nearly once a month,” “several times a year,” “once a year or less” and “never.” The third and fourth options were merged, so were the fifth and sixth options; then their corresponding score assignments were 5, 4, 3, 2 and 1. A higher score suggested a higher social frequency of the respondents.

EK adopted a series of cognitive indexes of environmental problems. 1 point could be earned for correct answers while 0 point for wrong answers. Then the scores of indexes were accumulated to obtain the scores of EK (0–10). A higher score meant a higher level of EK.

Environmental pollution perception index (EPPI) was measured by respondents' perception of local environmental pollution. Furthermore, the variables were processed according to the severity assignment of the respondents' perceptions of air, water, noise, industrial waste, domestic waste and food pollution in the region, and with reference to the exponential processing

TABLE 3 | Descriptive statistics of individual-level variables and urban statistical indexes.

Variables	Definition	N	Mean	SD	Min	Max
Dependent variables	Private PEB	6,728	48.18	23.13	0	100
	Public PEB	6,728	11.88	17.19	0	100
Individual Level	Social interaction (SI)	6,728	2.85	1.03	1	5
	Environmental Knowledge (EK)	6,728	5.47	2.73	0	10
	EPPI	6,728	63.49	20.02	0	100
	Age	6,728	47.17	16.52	17	97
	Gender	6,728	0.51	0.5	0	1
City Level	Education	6,728	10.36	4.34	0	19
	POU	75	0.26	0.15	0.06	0.91
	ECU	75	0.28	0.18	0.07	0.92
	SPU	75	0.39	0.16	0.04	0.75
	SOU	75	0.32	0.14	0.11	0.8
	Environmental pollution index (EPI)	75	0.14	0.14	0	0.98

method of the above dependent variables. The obtained EPPI was in the range of 0–100.

In addition, the research also controlled variables such as age, gender and education. The variables and definitions at the individual level are detailed in **Table 3**.

3.2 Model and Analysis Strategy

Data of individual-level PEB are nested within the city. Traditional regression analysis fails to solve the problem that data nesting violates the independent hypothesis of regression. However, the HLM can not only solve the problem facing data nesting, but also provide more macro-level information (Klein et al., 2000). Therefore, this study adopted the random intercept model in HLM to analyze the data. The private and public PEB were modeled respectively. Take private PEB as an example and the operations are as follows:

First, a null model without any explanatory variables was estimated; the sources of differences in PEB were decomposed into variances within and between cities; and individual-level explanatory variables were further added to the benchmark model on the basis that the intra-group correlation coefficient was obviously not 0. The null model is as follows:

$$\text{Individual Level (Level 1): } Y_{ij} = \beta_{0j} + r_{ij}$$

$$\text{City Level (Level 2): } \beta_{0j} = G_{00} + U_{0j},$$

where Y_{ij} , the dependent variable, is PEB score obtained by the i -th respondent in the j -th city; β_{0j} is the average value of PEB in the j -th city, and the variance of the error term r_{ij} represents the variation within the group; G_{00} represents the total average of PEB, and the variance of the error term U_{0j} is the variation between groups.

Subsequently, city-level variables and environmental pollution variables were included in the model, and the four measurement variables and environmental pollution variables of urbanization were included in the model to systematically examine the direct impact of urbanization on PEB. Finally, to explore the cross-level moderation of urbanization on individual factors and PEB, the four measurement variables of urbanization were further added to the coefficient equation of intercept and the two independent

variables at individual level. The final complete model is as follows:

Individual level:

$$Y_{ij} = \beta_{0j} + \beta_{1j}(SI)_{ij} + \beta_{2j}(EK)_{ij} + \beta_{3j}(EPPI)_{ij} + \beta_{4j}(Age)_{ij} + \beta_{5j}(Gender)_{ij} + \beta_{6j}(Education)_{ij} + r_{ij}$$

Contextual level:

$$\beta_{0j} = G_{00} + G_{01}(POU)_{ij} + G_{02}(ECU)_{ij} + G_{03}(SPU)_{ij} + G_{04}(SOU)_{ij} + G_{05}(EPI)_{ij} + u_{0j};$$

$$\beta_{1j} = G_{10} + G_{11}(POU)_{ij} + G_{12}(ECU)_{ij} + G_{13}(SPU)_{ij} + G_{14}(SOU)_{ij} + u_{1j};$$

$$\beta_{2j} = G_{20} + G_{21}(POU)_{ij} + G_{22}(ECU)_{ij} + G_{23}(SPU)_{ij} + G_{24}(SOU)_{ij} + u_{2j};$$

$$\beta_{3j} = G_{30} + u_{3j};$$

$$\beta_{4j} = G_{40} + u_{4j};$$

$$\beta_{5j} = G_{50} + u_{5j};$$

$$\beta_{6j} = G_{60}.$$

In the complete model, β_{0j} shows the influence of city-level variables on the average PEB value of the j -th city. β_{1j} and β_{2j} are the estimates of intra-group relationships between SI and urbanization variables and between EK and urbanization variables, respectively. $G_{11} - G_{14}$ and $G_{21} - G_{24}$ reflect the cross-level moderation of urbanization on the relationship between individual factors and PEB. Data analysis was conducted with the aid of HLM software (version 6.08) which estimated the value of each parameter by the full maximum likelihood method.

The variance inflation factor (VIF) was adopted to examine the multi-collinearity of independent variables at the individual level. The test analysis shows that the VIF value lies in the range of 1.021–1.579, smaller than 10, indicating that there is no multi-collinearity between the variables at the individual level. In addition, the correlation coefficient value between city-level variables is in the range of 0.271–0.581.

TABLE 4 | Impact of urbanization on private PEB: the results of the HLM.

	Model 1	Model 2	Model 3	Model 4
Fixed Effect	Coef.	Coef.	Coef.	Coef.
Intercept	44.295***	44.275***	41.863***	41.083***
Individual Level				
SI		0.756***	0.756***	1.095***
EK		1.802***	1.802***	2.028***
EPPI		0.050**	0.050**	0.051**
Age		0.144***	0.144***	0.146***
Gender		-4.852***	-4.852***	-5.000***
Education		1.022***	1.022***	0.994***
City Level				
POU			-13.133	-13.129
ECU			17.621*	17.618*
SPU			-15.754*	-15.757*
SOU			12.391	12.391
EPI			23.099**	23.101**
Cross-Level Interaction				
POU × SI				3.640
ECU × SI				-7.476***
SPU × SI				-1.930
SOU × SI				5.116**
POU × EK				0.405
ECU × EK				-0.445
SPU × EK				-0.308
SOU × EK				-2.116
Random Effect	Variance	Variance	Variance	Variance
Level 2 effect	70.444***	70.061***	54.601***	54.626***
Level 1 effect	442.539	394.93	394.946	393.316

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; City(N) = 75, Individual(n) = 6,728.

According to Tsui et al. (1995), the critical value of correlation level for serious collinearity is generally over 0.75. Therefore, there is no serious multi-collinearity between the variables at the city level in this study. In addition, to prevent the multi-collinearity of interaction terms and original variables, the city-level urbanization variables and the individual-level SI and EK variables were centralized.

4 RESULTS

4.1 Descriptive Statistics

Table 3 gives the descriptive statistics. The average value of private PEB index is 48.18, while that of public PEB index is 11.88, indicating that the public participation in private PEB is of a high frequency, while public PEB is of a low frequency. This result is similar to the conclusions of previous study based on the data of CGSS 2003 (Wenjuan, 2008). Compared with the data of CGSS 2003, private PEB has significantly improved. For example, the proportion of people “often bringing shopping bags when purchasing daily necessities” increases from 22.7% to 55.2%. The proportion of public PEB has declined. For example, the proportion of people “never participating in complaints and appeals to solve environmental problems” rises from 82.3% to 87.5%. Overall, China’s PEB is basically consistent with the development trend of international PEB, that is, private

PEB is improving, while public PEB shows a downward trend (Dalton, 2015).

4.2 Hierarchical Model Results

4.2.1 Hierarchical Model Results for Private Pro-Environment Behavior

Table 4 gives models that influence private PEB. Model 1 is a null model to measure the contributions of private PEB at the individual and city levels. The results of intra-group correlation coefficient ($ICC = 70.444/(70.444 + 442.539) = 0.137$) suggest that nearly 13.7% of the difference in private PEB among respondents is attributable to city-level factors regardless of any explanatory variable. This demonstrates that the differences in city-level factors should not be ignored in analyzing private PEB, that is, it is necessary to adopt a hierarchical model.

Model 2 adds six individual level variables on the basis of the null model, and these six variables exert significant effects on private PEB. Consistent with previous studies, it is found that years of education have a significantly positive impact on private PEB ($b = 1.022, p < 0.01$). Women have a higher PEB index than men ($b = -4.852, p < 0.01$). The private PEB index of the elderly is higher than that of the young ($b = 0.144, p < 0.01$). The index of environmental pollution perceived by respondents contributes to their private PEB, that is, more serious environmental pollution leads to a higher private PEB index ($b = 0.05, p < 0.05$). Among the prediction variables, SI has a significantly positive impact on private PEB. A higher frequency of SI with friends raises the possibility of private PEB ($b = 0.756, p < 0.01$). EK also positively influences private PEB. Therefore, a well-acquired EK can promote private PEB ($b = 1.802, p < 0.01$).

All the city-level variables were added to Model 3 to systematically discuss the impact of urbanization on private PEB, including POU, ECU, SPU, SOU and environmental pollution index. The results show that ECU notably influences private PEB ($b = 17.621, p < 0.1$). Every 1-unit increase in ECU can cause 17.621-unit rise in the index of private PEB, consistent with Hypothesis 2a. SPU also plays a significant role in private PEB ($b = -15.754, p < 0.1$). When SPU rises by 1 unit, the private PEB index decreases by 15.754 units, consistent with Hypothesis 3a. POU and SOU exert little influence on private PEB ($p > 0.1$), which fails to support Hypotheses 1a and 4a. Environmental pollution, which serves as a control variable, has a significantly positive impact on private PEB ($b = 23.100, p < 0.05$), consistent with the pollution-driving hypothesis. Although the variance at individual level in Model 3 is similar to that in Model 2, the variance at city level decreases from 71.061 to 54.601. The results disclose that the city-level variables can explain the 23% difference in private PEB among different cities.

Model 4 is the final model to examine the moderation of urbanization between individual factors and private PEB. The results reveal that SOU positively affects the relationship between SI and private PEB ($b = 5.116, p < 0.05$), that is, SOU enhances the positive impact of SI on private PEB. However, ECU negatively affects the relationship between SI and private PEB ($b = -7.476, p < 0.01$). Four dimensions of urbanization do not play a significant moderating role in the relationship between EK and

TABLE 5 | Impact of urbanization on public PEB: the results of HLMs.

	Model 1	Model 2	Model 3	Model 4
Fixed Effect	Coef.	Coef.	Coef.	Coef.
Intercept	9.176***	9.171***	7.371***	9.275***
Individual Level				
SI		1.255***	1.255***	0.92***
EK		0.394	0.394	0.791***
EPPI		0.024*	0.024*	0.027**
Age		0.016	0.016	0.021
Gender		-0.166	-0.166	-0.292
Education		0.676***	0.676***	0.630***
City Level				
POU			5.573	5.569
ECU			4.894	4.879
SPU			-11.084*	-11.398*
SOU			11.084	11.076
EPI			-1.117	-1.100
Cross-Level Interaction				
POU × SI				-2.560
ECU × SI				4.590*
SPU × SI				-0.716
SOU × SI				0.437
POU × EK				1.572
ECU × EK				-2.418
SPU × EK				1.932
SOU × EK				-3.845**
Random Effect	Variance	Variance	Variance	Variance
Level 2 effect	28.979***	28.088***	26.336***	26.385***
Level 1 effect	264.966	251.875	251.930	248.491

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; City(N) = 75, Individual(n) = 6,728.

private PEB. Overall, the results partially support Hypothesis 5a, but do not support Hypothesis 5b.

4.2.2 Results of Hierarchical Models for Public Pro-Environment Behavior

Table 5 gives models that affect public PEB. Model 1 is the null model whose results of intra-group correlation coefficient ($ICC = 28.979/(28.979 + 264.966) = 0.099$) suggest that around 9.9% differences in public PEB among respondents can be explained by differences among cities.

According to the results of Model 2, at the individual level, similar to the results of private PEB, years of education, perceived environmental pollution and SI still play a significant role. Gender, age and EK no longer play an important role in PEB.

All the city-level variables are included in Model 3. The results indicate that SPU still exerts a remarkably negative impact on public PEB ($b = -11.084$, $p < 0.1$), in line with Hypothesis 3b. POU, ECU, SOU and environmental pollution index do not have a significant role in public environmental protection, which fails to support Hypotheses 1b, 2b and 4b.

Model 4 includes moderating variables to examine the moderating effect of urbanization on individual factors and public PEB. The results indicate that ECU positively influences the relationship between SI and public PEB ($b = 4.590$, $p < 0.1$), that is, ECU enhances the positive impact of SI on public PEB. SOU negatively moderates the relationship between EK and public PEB ($b = -3.845$, $p < 0.05$). Other dimensions of urbanization cannot significantly moderate the relationship

between individual factors and public PEB. In general, the research results are partially in line with Hypothesis 5a yet do not support Hypothesis 5b.

5 DISCUSSION

This study aims to explore the influence of urbanization in China on PEB. Its specific goal is to examine the impacts of multi-dimensions of urbanization (i.e., POU, ECU, SPU and SOU) on PEB, and to explore the cross-level moderating effect of urbanization on the relationship between individual factors and PEB. Therefore, based on the model estimation, hypotheses of the relationship between urbanization and PEB were established and tested. The test results are given in Table 6. It is found that urbanization directly affects PEB and moderates the relationship between individual factors and PEB.

First, ECU significantly promotes private PEB, but its impact on public PEB is no significant. The results support Hypothesis 2a, yet they are in inconformity with Hypothesis 2b. Specifically, improving ECU can significantly promote private PEB. This is consistent with the affluence hypothesis. Specifically, Diekmann and Franzen (1999) held that “economic development can promote environmental concern and PEB”. The reason is that economic growth not only leads to higher requirements for the environment but also strengthens the public’s ability to improve environmental quality. Studies have shown that economic growth and urbanization can promote each other. Urbanization promotes economic growth through the accumulation of physical capital, human capital and knowledge capital; economic growth brings population agglomeration, which leads to large-scale integration of economic activities and spatial population agglomeration, thus improving urbanization (Liang and Yang, 2019). Therefore, strengthening the positive interaction between urbanization and economic growth and maintaining sustainable and healthy economic development are of great significance to promote private PEB.

ECU rarely affects public PEB. It may be because this study did not take institutional factors into consideration, such as political opportunity structure, environmental protection system and political power distribution, which may limit people’s participation in public PEB (Hadler and Haller, 2011). For example, with respect to the participation of environmental organizations in environmental governance, most studies have confirmed that environmental organizations in western countries actively promote PEB (Saunders, 2007; Grant and Vasi, 2017). However, Hong and Park (2018) found that the number of environmental non-governmental organizations (NGOs) in China has an insignificant impact on public PEB. According to Lei (2011), nearly half of China’s environmental NGOs are organized by the government. They are created and supported by the government, which limits their independent development. Thus, although ECU has contributed to the growth in the number of environmental NGOs in China, they still differ from the traditional western environmental NGOs. Therefore, they cannot efficiently perform their functions, resulting in

TABLE 6 | Hypothesis test result.

Hypotheses	Test results
Hypothesis 1a: POU can promote private PEB.	Rejected
Hypothesis 1b: POU can promote public PEB.	Rejected
Hypothesis 2a: ECU is conducive to private PEB.	Adopted
Hypothesis 2b: ECU is conducive to public PEB.	Partly adopted
Hypothesis 3a: SPU may constrain private PEB.	Adopted
Hypothesis 3b: SPU may constrain public PEB.	Adopted
Hypothesis 4a: SOU facilitates private PEB.	Rejected
Hypothesis 4b: SOU facilitates public PEB.	Rejected
Hypothesis 5a: Urbanization positively moderates the relationship between social interaction and private PEB and public PEB.	Partly adopted
Hypothesis 5b: Urbanization positively moderates the relationship between environmental knowledge and private PEB and public PEB.	Rejected

inefficient public participation in environmental governance and a weak influence on environmental policies.

Second, SPU has a significantly negative impact on private PEB and public PEB, which supports Hypotheses 3a and 3b. The formation of urban carriers with modern civilization characteristics and the improvement of infrastructure such as traffic conditions are typical characteristics of SPU. Although China has dedicated itself to improving infrastructure and increasing investment in infrastructure during urbanization, it is still faced with problems such as unsatisfying quality of infrastructure, extensive operation and management. These problems may constrain PEB (Fan et al., 2018). In recent years, an increasing number of scholars have discussed that infrastructure availability is more important than the number of facilities (Bernstad, 2014; Fan et al., 2018). Martin et al. (2006) disclosed that household waste recycling practice is hindered by its inconvenience. In China, most cities, even developed cities including Beijing and Shanghai, neglect improving the availability of infrastructure, such as the location of garbage bins. In terms of public transport facilities, "in most cities of China, public-transport-motorized trips account for less than 40% of the total trips, displaying a far cry from similar foreign cities". One important reason is that bad experience weakens the public's motivation for green travel by public transport, such as "long waiting time, low driving speed, poor riding environment and inconvenient transfer" (MOT China, 2016). Therefore, during urbanization, more attention should be paid to the availability of infrastructure and operation management services, so as to promote an active participation of the public in PEB.

Third, SOU has a positive yet slight impact on both private PEB and public PEB, which fails to support Hypotheses 4a and 4b. A possible explanation is as follows: For one thing, SOU can promote PEB by improving public services (Fan et al., 2018); however, as China's urban public services have been planned according to the household population for a long time, some cities, especially big cities, are facing higher public service pressure. For example, people choose to queue all night for the education and housing resources in shortage. Therefore, the insufficient supply of urban public services may weaken its role in promoting PEB. For another, according to the post materialism theory, with the prosperity of society and the

improvement of living quality, the public's priority values have changed from the original "materialism" to "post materialism", paying more attention to self-value and ecological environment. However, as proposed by Inglehart, China is currently in a period of great transformation. Although China has completed the transformation from a stage of food and clothing crisis, social instability, poverty and backwardness to a relatively prosperous stage in just a few decades, it has not yet entered the post materialist stage (Inglehart, 2013). Therefore, in the context of insufficient SOU development, the Chinese public may still be more concerned about the lower-level needs that are directly related to their own interests.

Fourth, POU has no significant effect on both private PEB and public PEB, which fails to support Hypotheses 1a and 1b. A previous study displayed the same results (Franzen and Meyer, 2010). In the cross-country study involving 26 countries, Franzen and Meyer (2010) found that a country's population density or the proportion of urban population did not significantly influence the public's concern about the environment. A possible explanation is as follows: First, most studies believe that population density and population agglomeration can cause serious environmental pressure and pollution, so people in densely populated cities may be more concerned about the environment and are more willing to participate in PEB. However, through years of longitudinal researches on China's cities, Glaeser and Kahn (2010) found that urban population agglomeration is not bound to bring more serious environmental pollution. For example, a dense subway network supported by a high population density can reduce the number of private car trips instead. In other words, POU will not necessarily cause higher environmental pressure. Direct confrontation with environmental issues is not the only factor that causes greater pro-environment awareness and willingness to participate in environmental protection. Besides, from the perspective of population migration, although some study held the view that migrants can improve their PEB through learning (Pfeffer and Stycos, 2002), other study found that migrants have less impact on the environment than social institutional factors such as economic, political structures and religious beliefs (Ng, 1998). This means social factors including economic and political structures may weaken the impact of population factors on PEB in the process of urbanization.

Fifth, it is found that the level of urbanization significantly moderates the relationship between SI and PEB, while its moderating effect on EK and PEB is insignificant. SI significantly improves both private and public PEB, which is consistent with the conclusions of previous studies (Franzen and Meyer, 2010; Wang and Han, 2016; Zheng et al., 2019). According to those studies, during SI, the public can moderate their PEB by observing the PEB of others. In addition, the public can actively moderate their PEB by acquiring EK. Compared with cities with lower urbanization levels, cities with higher urbanization levels provide more communication and interaction opportunities between different occupational groups, which is more conducive to promoting SI of the public. Therefore, the level of urbanization can moderate the relationship between SI and PEB of the public.

ECU strengthens the positive relationship between SI and public PEB, that is, ECU can indirectly affect public PEB through SI. Munro (2014) found that social capital is related to greater environmental concern and causes a greater possibility of participation in collective action. In environmental practice, because of the cost and risk of resistant public PEB (Wiltfang and McAdam, 1991), people may not have enough economic capacity and risk resistance to support public PEB, even if they are more willing to accept the views from friends and more likely to learn and imitate their behavior. However, in this case, a higher level of ECU plays a catalytic role (Gillham, 2008). In addition, ECU weakens the positive relationship between SI and private PEB. The positive effect of ECU is mainly reflected in its direct impact on private PEB. In other words, when ECU improves, the public will pay attention to environmental issues and actively participate in private PEB, which is consistent with the affluence hypothesis (Diekmann and Franzen, 1999). Therefore, ECU may weaken SI, which serves as a prerequisite for private PEB. Next, SOU can strengthen the relationship between SI and private PEB. This is also in line with Maslow's hierarchy of needs theory, which holds that when people's physiological needs and safety needs are basically met, social needs become a strong motivation, and people begin to desire to establish emotional connections or relationships with others (Maslow, 1981). In a society with a higher level of urbanization, people have stronger social needs and more frequent SI, thus promoting private PEB. EK actively promotes private PEB, which agrees with previous studies (Liu et al., 2020; Amoah and Addoah, 2021). This means that the publicity and education of EK remain important means in environmental protection. However, the moderating effect of urbanization on the relationship between EK and PEB has not been confirmed in this study. A possible explanation is that although urbanization has improved the overall education level, environmental education should be further improved (Fan et al., 2018). Therefore, in urbanization development, it is necessary to improve the publicity and education of EK to promote the transformation of EK to PEB (Fan et al., 2018).

6 CONCLUSION

6.1 Research Conclusion

Many studies have focused on the pressure brought to resources and environment by urbanization, but few have explored the positive effect of urbanization on reducing environmental pressure from the perspective of urbanization affecting PEB. This research reveals that urbanization not only directly affects PEB, but also moderates the relationship between individual characteristics and PEB. The impacts of urbanization with different dimensions on PEB differ. First, ECU can promote private PEB, indicating that economic development increases the public demand for environment and the ability to improve the environment. However, due to institutional constraints, ECU exerts no direct influence on public PEB. Second, SOU has a positive yet slight impact on PEB, indicating an insufficient social development in China and an imbalance between supply and demand of urban public services. Third, SPU has a significantly negative impact on PEB. Although China continuously increases investment in urban infrastructure, prominent problems may constrain PEB, such as unsatisfying quality of infrastructure and extensive operation and management. In addition, consistent with previous studies, it is found that POU has no significant impact on PEB. Finally, SI actively promotes PEB; this promotion effect can be positively moderated by SOU and ECU. In the process of SI, people can moderate and promote their PEB by observing the PEB of others and acquiring EK. Compared with people in cities with relatively lower SOU levels, people in cities with higher SOU levels correspond to stronger social desires and more frequent SI, which promote the private PEB. Compared with people in cities with relatively lower ECU levels, people in cities with higher ECU levels have more social capital accumulation and can handle risks better, so they are more likely to participate in costly and risky public PEB.

6.2 Practical Implications

These findings are of important theoretical guiding significance for capturing the complex relationship between urbanization and PEB, and of certain practical reference value for promoting the specific policy design of PEB. In practice, first, a green and sustainable ECU should be promoted, because it is not only an important prerequisite for building an environment-friendly society (Wang and Han, 2016), but also the basis for promoting PEB. Second, SOU should be strengthened. PEB can be promoted by improving public services and the life quality of residents. Third, attention should be given to the smart integration of the availability of urban infrastructure and residents' life (Ma et al., 2018), hereby promoting residents to have a green lifestyle. Finally, SI can be improved by enriching community activities, so as to promote public participation in environmental protection (Zhu et al., 2021).

6.3 Limitations and Future Studies

Though this study expands the scope of studies on the relationship between urbanization and PEB, certain limitations remain in this study. First, though this study explores the direct and indirect effects of urbanization on PEB, urbanization is actually a complex systematic project, which influences PEB from various aspects. Hence, future researches should consider the impacts of institutional factors on PEB, such as social institutional

arrangements, social governance framework and effectiveness. These factors may further reveal the internal causes and behavioral mechanisms of the differences in private PEB and public PEB at different urbanization levels. Second, in terms of research methods, the data of independent variables and dependent variables in this study were taken at different times, which are more favorable for testing the effect of independent variables on dependent variables than cross-sectional data. This is conducive to the test of causality. However, it still lacks longitudinal studies in the same area, which fails to display the dynamic effect of urbanization on PEB. Therefore, future researches can further explore the impact of urbanization on PEB from the perspective of vertical design by combining the continuous multi-year indexes of databases. Third, with respect to the measurement index, the limitation of data sources may lead to deficiencies in the established urbanization index system. In the future study, a more comprehensive assessment of the level of urbanization will be conducted, especially a more accurate assessment of its specific dimensions.

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DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: <http://cgs.ruc.edu.cn/>.

AUTHOR CONTRIBUTIONS

WQ conceived and wrote the first manuscript. YW conceptualized and supervised the study. JH and CL acquired the data and conducted the data analysis. WQ and YZ revised the manuscript. All authors read and approved the final manuscript.

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