



The effects of behavioral intention on the choice to purchase energy-saving appliances in China: the role of environmental attitude, concern, and perceived psychological benefits in shaping intention

Xianchun Liao · Shiran Victoria Shen ·
Xunpeng Shi 

Received: 8 March 2019 / Accepted: 10 September 2019 / Published online: 24 October 2019
© Springer Nature B.V. 2019

Abstract Purchasing energy-saving appliances is a sensible and practical way to reduce carbon emissions from the residential sector in China. This study examines the

Highlights

- This paper integrates psychological benefits into the theory of planned behavior.
- This study is based on a cross-sectional online survey of 942 Chinese households conducted in 2016.
- Behavioral intention positively affects the choice to purchase energy-saving appliances.
- Environmental attitude and concern positively influence the intention to buy energy-saving appliances.
- First to reveal that perceived psychological benefits positively affect behavioral intention in China.

X. Liao
Business School and Institute of Green Development, University of Jinan, Jinan 250022 Shandong, China
e-mail: liaoxian2@yahoo.com

S. V. Shen
Environmental Politics, University of Virginia, 1540 Jefferson Park Ave., Charlottesville, VA 22904, USA
e-mail: svshen@virginia.edu

X. Shi (✉)
Australia-China Relations Institute, University of Technology Sydney, Ultimo, NSW 2007, Australia
e-mail: xunpeng.shi@gmail.com

X. Shi
Center of Hubei Cooperative Innovation for Emissions Trading System & School of Low Carbon Economics, Hubei University of Economics, Wuhan 430205 Hubei Province, China

X. Shi
Energy Studies Institute, National University of Singapore, Singapore 119620, Singapore

relationship between pro-environment behavioral intention—undergirded by environmental attitude and concern as well as perceived psychological benefits—and the choice to purchase energy-saving appliances among Chinese households. Integrating psychological benefits (i.e., warm glow and self-express benefits) into the theory of planned behavior, a first of its kind for China, we designed and implemented a cross-sectional online survey in 2016. We conducted Probit regression analyses based on the 942 effective responses collected. The results reveal that behavioral intention has significantly positive effects on the choice to purchase energy-saving appliances. Environmental attitude and concern, as well as psychological benefits, have a significantly positive impact on respondents' behavioral intention to buy energy-saving devices. Also, age and household size significantly and positively correlate with purchasing energy-saving appliance decision. These results point to useful policy implications to boost consumer support for energy-saving appliances in China and provide a foundation for similar research in other developing contexts.

Keywords Energy-saving appliances · Behavioral intention · Environmental concern · Psychological benefits · China

Introduction

The extraordinary economic growth of China in the past four decades came at considerable environmental costs.

In 2007, China eclipsed the USA to become the largest greenhouse gas emitter in the world (NEAA 2008). Most of the 334 prefectural cities in China did not meet air quality standards recommended by the World Health Organization (China Environment Yearbook 2016). Many Chinese cities even rank among the most polluted cities globally (WHO 2016). It was estimated that more than one million people died each year prematurely from air pollution in China (Pope III and Dockery 2013; Lim et al. 2013). Geographically, researchers documented a 5.5-year gap in life expectancy between the heavily polluted north and the less dirty south (Chen et al. 2013). Temporally, the peak in local pollution cycles imposed high human costs (Shen 2018).

The central government has made environmental protection a top priority. At the National People's Congress in 2014, Premier Li Keqiang declared the inception of China's "war on air pollution" (Reuters 2014). Under the Thirteenth Five-Year Plan (2016–2020), the country aims to achieve a 15% reduction in energy intensity (i.e., energy consumption per unit of GDP) and an 18% decrease in carbon intensity (i.e., carbon emissions per unit of GDP). China also seeks to cap total energy consumption at 5 billion tons of standard coal equivalent by 2020 (Zhang et al. 2019). A national emission trading scheme was launched in late 2017 (Sun et al. 2019), and significant efforts have been made to restructure the economy and upgrade technologies (Wang et al. 2019; Li et al. 2019).

In addition to the top-down measures, changing human behavior from the bottom-up is another way to conserve energy. CO₂ emissions from household energy consumption are estimated to contribute to 10–20% of global CO₂ emissions (see, e.g., Long et al. 2018; Grunert and Juhl 1995). Such a significant share implies that consumers' purchasing behavior can play a critical role in curbing carbon emissions. A salient example of this is the purchasing and adoption of energy-saving appliances in China. Such appliances include solar water heaters, refrigerators, air conditioners, air purifiers, electric bikes, and electric vehicles, which are already subsidized by the Chinese government.¹ However, energy-saving appliances are still underutilized among Chinese consumers. According to an Ali Research Report, "environmentally friendly consumers" only accounted for 16% of all Ali consumers in 2015 (Ali Research Report 2016).²

¹ The latest subsidy policy on household energy-saving appliances in 2017. <http://www.jayall.com/article/73258.html>.

² The Ali platform hosts China's largest e-commerce market.

The literature on the purchasing behavior of energy-saving appliances exhibits at least three gaps. First, the findings of how environmental attitude and concern influence purchase intention are mixed, demanding more work on this increasingly critical and thriving area of research. For example, Gadenne et al. (2011) find that environmental attitude significantly affects energy-saving behavior in Australia. Similarly, Sapci and Considine (2014) reveal that households with more environmental concern tend to have lower energy use in WY, USA. Hartmann and Apaolaza-Ibáñez (2012) also confirm that consumers' environmental concern has a significant influence on the intention to buy green energy brands in Spain. By contrast, Gaspar and Antunes (2011) display that neither general nor particular environmental attitudes have significant influence on energy efficiency in Europe. Second, although previous studies have explored the impacts of residential intention on the choice to purchase energy-saving devices in developed countries like the USA (see Bang et al. 2000; Litvine and Wüstenhagen 2011), much fewer works have examined the relationship in developing countries, particularly in China (Sapci and Considine 2014). Among the few works on China, Chan and Lau (2000) find that ecological effect and knowledge have a significant and positive influence, but cultural values have only moderate effects among residents in Beijing and Guangzhou. Wang et al. (2011) indicate that environmental awareness does not influence electricity saving in households, while social norms, economic benefits, subsidy, and experience positively and significantly affect electricity-saving behavior in Beijing. Liu et al. (2012) find that information about energy-saving appliances and perception of self-responsibility affect substantially urban residents' actual green purchasing behaviors in Suzhou, Jiangsu Province. Finally, building on the first two points, existing literature suggests that the most critical factor in explaining environmental intention in developed countries such as Spain (Hartmann and Apaolaza-Ibáñez 2012) is related to psychological benefits; however, no such work has been performed for China.

In this study, we explore the determinants of the intention and the choice to purchase energy-saving appliances in Chinese households, considering environmental attitude, concern, and psychological benefits as the key determinants. Applying a Probit model to our cross-sectional online survey data of a sample of 942 responses in 2016, we find that behavioral

intention has a significant and positive effect on the choice to purchase energy-saving appliances. Further analysis indicates that environmental attitude and concern, as well as psychological benefits, have significantly positive impacts on respondents' behavioral intention to buy energy-saving appliances. Furthermore, age and household size are significantly and positively correlated with the decision to purchase energy-saving appliances.

This study contributes to a thin pile of empirical works of consumer purchasing behavior of energy-saving appliances in China, a country that has the highest greenhouse gas emissions in the world. It does so by integrating environmental concern and psychological benefits with the Theory of Planned Behavior (TPB) and testing the hypotheses based on empirical data from an online survey. In addition to examining the impacts of behavioral intention on the choice to purchase energy-saving appliances, this study attempts to explore the effects of environmental attitudes and concern as well as the influence of psychological benefits on respondents' intention to buy energy-saving devices.

The rest of the paper is organized as follows. We survey existing literature in “[Theoretical framework and hypotheses](#)”; outline our methodology, including data connection, theoretical and econometric models in “[Methodology](#)”; describe our data in “[Survey results](#)”; discuss the empirical results in “[Econometric analysis](#)”; and finally, draw conclusions and policy implications in “[Conclusion and policy implications](#)”.

Theoretical framework and hypotheses

Traditionally, scholars have employed socioeconomic factors to explain consumers' behavior of purchasing energy-efficient household appliances (e.g., Baldini et al. 2018). Furthermore, it is widely believed that intention determines personal behavior in a designed manner, featured most prominently in the Theory of Planned Behavior (TPB) (Ajzen 1989, 1991). The TPB suggests that environmentally friendly intention involves such mental activities as planning and foresight toward pro-environment behaviors and that attitude plays a vital role in shaping people's behavioral intention to purchase energy-saving appliances (Sapci and Considine 2014; Cai et al. 2019). Among the many socioeconomic factors, scholars have zeroed in on age (Zarnikau 2003; Sardianou and Genoudi 2013; Baldini

et al. 2018), education (Ek 2005; Tabi et al. 2014), income (Borchers et al. 2007; Grösche and Schröder 2011; Sardianou and Genoudi 2013), and household size (Gerpott and Mahmudova 2010; Grösche and Schröder 2011; Baldini et al. 2018) to explain purchase behavior.

In addition to the socioeconomic factors, the TPB buds off the Theory of Reasoned Action and argues that human behavior is the result of planning and is conditioned by behavioral intention. TPB has been employed widely in social psychology and environmental economics (Fishbein and Ajzen 1975; Ajzen 1991; Oreg and Katz-Gerro 2006). Some studies have applied it to the study of green electricity or renewable energy (see Bang et al. 2000; Litvine and Wüstenhagen 2011). For example, Mi et al. (2016) demonstrate that residents' behavioral intention prods their behavior in low-carbon energy consumption. Another example is that residents' intention positively influences their behavior in bicycle-sharing commuting in China (Cai et al. 2019). Zhao et al. (2019) suggest that most residents have environmentally friendly intention to buy energy-saving products in Xuzhou, Jiangsu Province. Based on these theoretical and empirical insights, we propose our first hypothesis.

Hypothesis 1: Residents' intention has a promotive effect on their choice behavior of purchasing energy-saving appliances.

Furthermore, the TPB suggests that personal attitude determines behavioral intention. In the environmental realm, environmental attitude is defined as “the collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues” (Schultz et al. 2004, p.31). Many previous studies have explored how environmental attitudes influence the behavioral intention of green consumption (e.g., Paul et al. 2016) or energy savings and carbon reduction (e.g., Chen 2016). For example, Gadenne et al. (2011) reveal that environmental attitude tends to promote energy-saving behavior in Australia. A puzzle arises: despite much talk about using green, why has the market share of energy-saving appliances remained at 1–3% levels of the entire market (Bray et al. 2011)? The validity of the theory may be subject to country and cultural contexts, and this may be particularly true for China. Thus, we propose our second hypothesis to test our considerations.

Hypothesis 2: Residents' environmental attitude has a positive effect on their intention of purchasing energy-saving appliances.

Recently, a large and growing pipeline of studies indicates that environmental concern is a crucial driver in the adoption of energy-efficient appliances and practices. Schultz et al. (2004) define "environmental concern" as the affect (i.e., worry) associated with beliefs about environmental problems. "Environmental attitude" and "environmental concern" differ in range, where the former entails a broad general attitude toward the environment while the latter a specific attitude toward environmentally related actions or issues (Fransson and Gärling 1999). Hansla et al. (2008) suggest that environmental concern affects consumers' willingness to purchase green electricity. Hartmann and Apaolaza-Ibáñez (2012) confirm the finding that consumers' environmental concern facilitates the purchasing intention. Shimokawa and Tezuka (2014) also identify environmental consciousness as a determining factor for the success of the Home Energy Conservation Support Program in Japan. Whether environmental concern affects the intention of purchasing energy-saving appliances in China remains an empirical question. Thus, we propose our third hypothesis.

Hypothesis 3: Residents' environmental concern has a positive effect on their intention of purchasing energy-saving appliances.

Besides environmental concern, psychological benefits of purchasing energy-saving appliances can be crucial for individual decision-making (Borchers et al. 2007; Stern 2011; Sapci and Considine 2014; Sovacool 2014; Stern 2014; Noblet et al. 2015). There are two distinct categories of psychological benefits: warm glow and self-expressive benefits. Traditionally, social behavior theory holds that pure altruism contributes to the personal value structure and, by extension, induces behavior in favor of the common good (Bergstrom et al. 2006). In contrast, much evidence indicates that some consumers pay a premium price to buy energy-saving appliances for personal welfare derived from a cleaner environment rather than out of altruistic concern, although a cleaner environment is a public good (Wüstenhagen and Bilharz 2006). This is dubbed the "warm glow of giving" (Andreoni 1990).

Hartmann and Apaolaza-Ibáñez (2012) find that warm glow arising from a contribution to the environment promotes personal behavioral intention to purchase green brands. Thus, we propose our fourth hypothesis.

Hypothesis 4: Warm glow derived from contributing to the environmental common good positively influences the intention to purchase energy-saving appliances.

Another psychological benefit is self-expressiveness of being green, which helps enhance consumers' perceived status and reputation for willingness to contribute to environmental protection (Hartmann and Apaolaza-Ibáñez 2012). Signaling theory and related literature on symbolic and conspicuous consumption offer a basis for our analysis of the impact of self-expressive benefit on the intention (e.g., Aaker 1999; Bennett and Chakravarti 2009; Griskevicius et al. 2010). Because individuals think of and judge others by the products others consume, there could be a real psychological motive and self-expressive benefit for consumers to purchase energy-saving appliances. Although Hartmann and Apaolaza-Ibáñez (2012) do not find self-expressive benefits to be explanatory of participants' purchase intentions, it is a worthwhile empirical question for the context of China. Thus, we propose our fifth hypothesis.

Hypothesis 5: The expectation of self-expressive benefits derived from the conspicuous consumption of energy-saving appliances positively influences the intention to purchase energy-saving appliances.

Based on the analysis mentioned above, our empirical framework for the choice to purchase energy-saving appliances can be summarized in Fig. 1.

Methodology

Data collection

We employed *Wenjuanxing*, a professional marketing agency, to implement our surveys on a secure online platform.³ We designed our survey using a modified Dillman method (Dillman et al. 2009). At the initial stage, we organized focus groups to test our pilot survey.

³ The URL of the website is <https://www.sojump.com>.

Based on the feedback, we refined our survey questionnaire and decided on the final version during the spring of 2016. The respondents were recruited via WeChat, the most popular social media platform in China, with an estimated user base of 0.4 billion at that time. *Wenjuanxing* company has access to 2.6 million of the 0.4 billion WeChat users and maintains a stable database. The database consisted of urban residents who are little bit more than rural consumers, or 55.6% of the Chinese population as of 2015 (CIA World Factbook). Due to the sheer size and diversity of China's population, it is nearly impossible to get a sample representative of the whole population on a limited budget. Urban residents are active thinkers, avid information consumers, and keen experimenters with new things. Since energy-saving appliances are considered relatively new to Chinese consumers, urban residents in China often have more knowledge than rural residents and thus more likely to purchase and benefit from energy saving appliances (Ma et al. 2018). Therefore, a higher urban representation in our dataset enables us to gather as much as possible information on how to promote energy-saving appliances. We recognize the cross-country heterogeneity in the urban-rural divide, for example between China (Ma et al. 2018) and India (Parikh and Parikh 2016), and thus limit our interpretations only to what our sample represents."

Respondents were solicited from the database via random sampling, and our dataset is quite representative of urban demographics. *Wenjuanxing* sent out 1500 survey requests to its database of WeChat users, among whom 942 completed the survey. The overall response rate is 62.8%, which is higher than those in comparable studies on China (Wang et al. 2011).⁴

We excluded residents who did not buy a solar heater if the reason was that they could not access rooftops when living in apartments. We could do this, because in our original questionnaire, if respondents did not buy any green appliance, we asked them why. If they provided reasons such as they could not access the rooftop, we merely sorted them into the category of "other reasons." Another two potential unbalanced factors in the sample are electric modes of transportation. Electric bikes are currently banned from ten streets in Beijing, and overweight battery cars are prohibited in Shanghai, but neither is forbidden in other localities. On a large

scale, the bans have no significant effect on the purchasing of electric bikes for residents. Due to our limited sample size, we do not consider climate variables, such as temperature, in our model—an area where future research can improve.

Measurement of key variables

It is challenging to identify behavioral intention with a subjective question. Following the literature (Biswas and Roy 2015; Mi et al. 2016), we employ the following question to gauge intention: are you willing to pay more money to buy energy-saving appliances? To obtain a robust measurement, we follow the literature and use the following question as an alternative measure of behavioral intention (e.g. Ajzen 1991; Litvine and Wüstenhagen 2011; DeCicco et al. 2015): do you think purchasing energy-saving appliances in the near future will be a good thing?

Following the Theory of Planned Behavior and existing literature (Ajzen 1991; Sapci and Considine 2014), we ask the following question to measure environmental attitude: Do you believe that energy is a scarce resource? Alternatively, the question related to environmental attitude can be gauged by: Is your attitude serious toward protecting the environment?

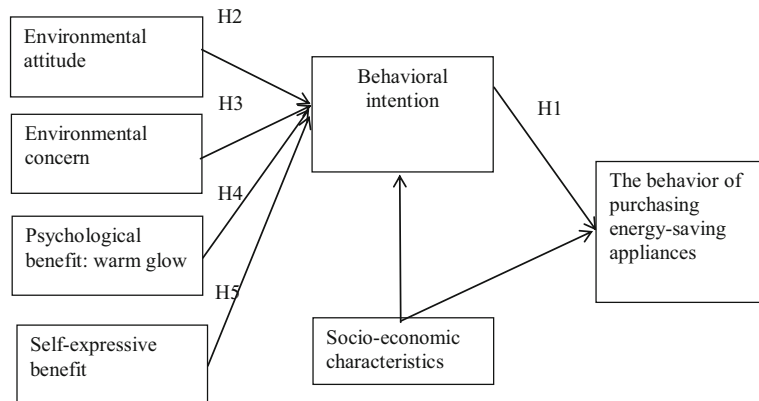
Extending the TPB, we integrate environmental concern into our model. Following the literature (e.g., DeCicco et al. 2015), we raise the following question: do you find it essential to protect the environment? To obtain a robust measurement of environmental concern, following the literature (Hartmann and Apaolaza-Ibáñez 2012), we also use the following questions as alternative measures: are you concerned about air pollution? Are you worried about climate change?

As for warm glow (WG), the literature (e.g., Hartmann and Apaolaza-Ibáñez 2012) commonly employs the following question is used as a proxy: by buying energy-saving appliances, do you feel good because you help protect the environment? Alternatively, we use the following question to measure warm glow: by purchasing energy-saving appliances, do you feel that you are contributing to the well-being of humanity and nature?

Lastly, according to the literature (e.g., Hartmann and Apaolaza-Ibáñez 2012), we measure self-expressive benefits via the following two questions: does buying energy-saving appliances help express your environmental concern? By buying energy-saving appliances,

⁴ So far, there is no standard response rate in the literature (Nachmias and Nachmias 2000).

Fig. 1 An empirical framework for the choice to purchase energy-saving appliances



can you demonstrate to your friends that you care about environmental conservation? All related statements on the measurement of subjective variables: intention, environmental attitude, concern, warm glow, and self-expressive benefit are shown in Table 1.

Empirical model

We built our empirical model by drawing from and modifying insights from the following theories. First, a rational consumer maximizes her utility subject to her budget, and as the price of the commodity increases, her demand for it decreases. Second, an increase in income leads to higher demand according to the permanent

income hypothesis (Friedman 1957). Third, consumption is determined by consumer's preferences. However, the same principle of consumer's preferences needs to be adapted to fit a more complicated situation of buying energy-saving appliances. Of particular note, if respondents realize that the economic benefits of such energy efficiency measures as efficient lighting system in the household sector manifest in the long term (Baldini and Trivella 2018), they will become more likely to purchase the new energy-efficient lighting system.

In the context of energy-saving behavior, the utility theory provides the basis for interpreting dominance in pairwise selection (McFadden 1974). Since utilities for goods or services can be categorized based on their characteristics or attributes (Lancaster 1966), the

Table 1 Indicators for measurement of subjective variables: intention, environmental attitude, environmental concern, warm glow, and self-expressive benefit

Latent variables	Observable measurements
Energy-saving intention (Int)	Are you willing to pay more money to buy energy-saving appliances? Do you think purchasing energy-saving appliances in the near future will be a good thing?
Environmental attitude (EA)	Do you believe that energy is a scarce resource? Is your attitude serious toward protecting the environment?
Environmental concern (EC)	Do you find it essential to protect the environment? Are you concerned about air pollution? Are you worried about climate change?
Warm glow (WG)	By buying energy-saving appliances, do you feel good because you help protect the environment? By purchasing energy-saving appliances, do you feel that you are contributing to the well-being of humanity and nature?
Self-expressive benefit (SEB)	Does buying energy-saving appliances help express your environmental concern? By buying energy-saving appliances, can you demonstrate to your friends that you care about environmental conservation?

relationship between choice decision behaviors and driving forces can be expressed as linear. In this specification, a dummy model is applied to our case of purchasing energy-saving appliances (Heckman 1979), and our final econometric model is as follows:

$$\text{logit}(\text{Pr}(ESA = 1)) = \alpha + \beta \text{Int} + \gamma_1 \text{Age} + \gamma_2 \text{Edu} + \gamma_3 \text{Inc} + \gamma_4 \text{HS} + \varepsilon \quad (1)$$

where ESA is the stated choice to buy energy-saving appliances, which is binary, in case 1 (decision to buy energy-saving appliances), otherwise 0 (decision not to buy energy-saving appliances); α is constant; β is the coefficient for respondents' intention to purchase energy-saving appliances (Int); γ is the coefficients vector for respondents' socioeconomic characteristics, including age (Age), education (Edu), income (Inc), and household size (HS); ε is the error term, which is assumed to be i.i.d.

Since the independent variable, the choice to purchase energy-saving appliances (ESA) is binary, the appropriate probabilistic choice models are Logit and Probit models. Although Logit and Probit are used to perform a similar type of regression, they employ different functions. Given the relatively large size of our sample, we employed a Probit model in this study.

As mentioned above, environmental attitude (EA), environmental concern (EC), warm glow (WG), and self-expressive benefit (SEB) might influence the intention to purchase energy-saving appliances. This study further investigates their effects on the intention and, subsequently, energy-saving purchasing behavior. We also include socioeconomic variables (age, education, income, and household size) as the control variables. Mathematically, it can be expressed as:

$$\text{logit}(\text{Pr}(\text{Int} = 1)) = \alpha + fEA + \lambda EC + \psi WG + \xi \text{SEB} + \gamma_1 \text{Age} + \gamma_2 \text{Edu} + \gamma_3 \text{Inc} + \gamma_4 \text{HS} + \mu \quad (2)$$

where μ represents the error term, assumed to be i.i.d. The independent variable, behavioral intention (Int), is measured via two questions. The willingness question involves a binary variable, so a Probit model is employed. In the second question, "good thing" is an ordered choice variable, so an ordered Probit model is applied.

Survey results

Based on our literature review (e.g., Chen and Chai 2010; Hartmann and Apaolaza-Ibáñez 2012; Stern 2014; Sapci and Considine 2014; Noblet et al. 2015), we create a questionnaire that consists of two areas. The items and the results are reported in Tables 2 and 3, respectively.

The first set of seven questions (Q1–Q8a) is related to the respondents' demographic and socioeconomic characteristics (age, educational attainment, household income, and household size), household monthly electricity consumption, purchasing decision (whether or not the respondent has purchased energy-saving appliances), the amount spent on energy-efficiency home appliances, and willingness to pay more money to buy energy-saving appliances. The summary statistics are presented in Table 2.

The survey shows that more than 70% of respondents made decisions on the choice of purchasing energy-efficient home appliances, and the amount spent on energy-efficiency home appliances per household was, on average, 10,205.8 Chinese Yuan (US\$1458). Q8a uses "Are you willing to pay more money to buy energy-saving appliances? (Int(1))" to measure environmental intention. Regarding the percentage of willingness to pay more for energy-saving appliances, 85% of respondents indicated willingness to pay price premium for energy-saving appliances, which is much higher than an average of 30% in Brunei and 44–50% in Europe (Shi 2015). A comprehensive review of the amount of willingness to pay can be found in Shi (2014). Our finding on the price premium is consistent with that in Zeng et al. (2014), which shows that Chinese consumers on average are only willing to spend less than 10% of price premium. The price premium in China, however, is much lower than that in European and North American countries (Zarnikau 2003; Eurobarometer 2005; Kaenzig et al. 2013). Bear in mind, it is difficult to identify the heterogeneous impact across regions because respondents are largely concentrated in the coastal cities. They are urbanites in relatively developed regions whose preferences are likely similar.

We also inquired: why do not you choose to buy green energy-efficient appliance? Among the 58.6% of the responses that specified reasons, the most common reason was the higher price of green products compared with that of conventional products (29.1%), followed by insufficient information about green products (21.1%),

Table 2 Demographic and household characteristics of respondents (Q1–Q7)

Socioeconomic features	Definition and unit	Average	S.d.	Min.	Max.	National average
Q1 age	Mean, years	34.3	9.6	21.5	65.0	36.0
Q2 education (Edu)	Education years	17.5	2.9	9.0	22.0	10.1
Q3 income (Inc)	Annual income, 1000 RMB	144.0	105.0	25.0	350.0	134.0
Q4 household size (HS)	Household size, number of people	3.9	1.3	1.0	6.0	3.1
Q5 electricity consumption (Elec)	Electricity consumption (kW/h per month)	105.5	62.1	25.0	250.0	110.0
Q6 choice to buy energy-saving appliances	Percentage	0.70	0.46	0.00	1.00	
Q7 the amount spent on energy-efficiency home appliances	1000 RMB per household	10.21	34.58	0.0	633.0	
Q8a are you willing to pay more money to buy energy-saving appliances? (Int(1))	Dummy variable Yes = 1, otherwise, 0	0.85	0.36	0.00	1.00	

Data on the national average were taken from the Chinese Statistical Yearbooks

unreliable quality of green products (20.0%), and unreliable certification of green electricity product (16.5%).

We further investigated the questions related to respondents' degree of trust in green appliance labeling certifications. 29.6% of respondents stated they trust (8.8% completely trust and 20.8% trust) in China's environmental labeling certification. The percentages

are 34.6% for China's energy efficiency certification and 31.8% for China's energy-saving product certification. Since we focus on energy-saving behavior of respondents in this study, we save these interesting statistics for a different study.

Table 3 presents summary statistics of responses related to behavioral intention, environmental attitude,

Table 3 Descriptive statistics of environmental attitude, concern, and psychological benefits (%)

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Q8b intention (Int)					
Do you think in the near future purchasing green products will be a good thing? (Int(2))	2.0	2.3	9.4	37.4	48.8
Q9 environmental attitude					
a. Do you believe that energy is a scarce resource?	3.1	4.5	13.0	32.8	46.7
b. Is your attitude serious toward protecting the environment?	1.7	2.3	9.0	34.3	52.7
Q10 environmental concern					
a. Do you realize it is important to protect the environment?	1.7	1.4	6.6	22.1	68.3
b. Are you concern about air pollution?	1.8	1.3	6.5	22.7	67.7
c. Are you concern about climate change?	1.9	2.0	10.9	35.7	49.5
Q11 warm glow					
a. By buying energy-saving appliances, do you feel good because you help to protect the environment?	4.2	7.1	25.7	40.3	22.6
b. By buying energy-saving appliances, do you feel that you are contributing to the well-being of humanity and nature?	11.1	14.6	30.9	28.3	15.0
Q12 self-expressive benefit					
a. By buying energy-saving appliances, can you express your environmental concern?	6.9	11.1	25.8	37.5	18.7
b. By buying energy-saving appliances, can you demonstrate to your friends that you care about environmental conservation?	4.7	8.2	24.1	40.2	22.8
Average	3.91	5.48	16.19	33.13	41.28

environmental concern, and psychological benefits (warm glow and self-expressive benefit) (Q8b–Q12) with a traditional 5-point scale measuring the likelihood that participants would consider “strongly disagree,” “disagree,” “neutral,” “agree,” and “strongly agree” (Hartmann and Apaolaza-Ibáñez 2012). According to the measurement description in “[Measurement of key variables](#),” we use two indicators to measure environmental intention (Int). Alternatively, Q8b uses “do you think purchasing energy-saving appliances in the near future will be a good thing (Int(2))” to measure the environmental intention. 86.2% of respondents agree (37.4% agree and 48.8% strongly agree) that purchasing energy-saving appliances in the near future will be a good thing.

Regarding environmental attitude, 79.5% (32.8% agree, and 46.7% strongly agree) of respondents believe that energy is a scarce resource and 89% (34.3% agree and 52.7% strongly agree) of respondents’ attitude toward protecting the environment are serious as well. As for environmental concern, 90.4% (22.1% agree and 68.3% strongly agree) of respondents realize that it is important to protect the environment, which is consistent with prior research (Ellen et al. 2006; Vermeir and Verbeke 2006; Arvola et al. 2008; Liu et al. 2012). Similarly, 90.4% of respondents (22.7% agree and 67.7% strongly agree) are concerned about air pollution, and 85.2% (35.7% agree and 49.5% strongly agree) are about climate change.

Regarding psychological benefits, 62.9% of respondents (40.3% agree and 22.6% strongly agree) feel good because they help to protect the environment by buying energy-saving appliances. A bit surprisingly, less than 50% of respondents (28.3% agree and 15.0% strongly agree) feel that they contribute to the well-being of humanity and nature by buying energy-saving appliances. Likewise, 56.2% of respondents (37.5% agree and 18.7% strongly agree) express their environmental concern by buying energy-saving appliances, and 63.5% of respondents (40.2% agree and 22.8% strongly agree) demonstrate to their friends that they care about environmental conservation by buying energy-saving appliances. On average, 74.4% of respondents appear to be pro-environment (33.13% agree and 41.28% strongly agree).

Econometric analysis

Before carrying out empirical analyses, we checked the multicollinearity among the explanatory variables using Pearson and Spearman methods. The results show that

the correlation coefficients among all explanatory variables are less than 0.56, so we moved ahead to conduct econometric analyses.⁵

Behavioral intention and the choice to purchase energy-saving appliances

Table 4 presents the Probit regression results of the impacts of behavioral intention on respondents’ choice to purchase energy-saving appliances. Because the two questions associated with behavioral intention are highly correlated with each other, following the literature (Sapci and Considine 2014), each of our regressions includes only one intention question at a time. Additionally, we perform analysis both with and without control variables (household characteristics). If the sign and magnitude of the key variable (intention) in model 1 are still similar to those from model 2, we can conclude that the findings are robust. Employing different control variables is a common practice in the literature to test the robustness of results (Wooldridge 2001, p461). The results show that intention question 1 (Int(1)) has a consistently significant and positive effect on the choice to purchase energy-saving appliances, with or without household features included (models 1 and 2). This finding is in line with the literature (Biswas and Roy 2015; Mi et al. 2016; Cai et al. 2019), indicating that people who are willing to buy also translate their choice into action.

Likewise, the results also show that intention Q8b (Int(2)) has consistently significant and positive effect on the choice to purchase energy-saving appliances, with or without household features (models 3 and 4), and this is consistent with several studies in the literature (e.g., Hartmann and Apaolaza-Ibáñez 2012; DeCicco et al. 2015). The two findings demonstrate that environmentally friendly behavior first requires behavioral intention, underpinned by the actors’ knowing that their potential acts to improve environmental quality may have consequences for the welfare of others. Hypothesis H1 is supported.

Regarding demographic characteristics, age and household size are both significantly and positively related to buying energy-saving appliances, which agrees with the literature (Grösche and Schröder 2011; Sardanou and Genoudi 2013). The explanation is straightforward: as respondents grow old, they become

⁵ Due to space constraints, we do not report our test results, but they will be available from the authors upon request.

Table 4 Impacts of behavioral intention on respondents' choice to purchase energy-saving appliances (ESA) in China with Probit model (buy = 1, otherwise, 0)

Variables	Model 1 Probit	Model 2 Probit	Model 3 Probit	Model 4 Probit
Energy-saving intention (Int):				
Are you willing to pay more money to buy energy-saving appliances?	0.329*** (0.101)	0.322*** (0.104)		
Do you think in the near future purchasing energy-saving appliances will be a good thing?			0.255*** (0.048)	0.247*** (0.049)
Sociodemographics				
Age		0.666*** (0.162)		0.661*** (0.163)
Education		0.027 (0.205)		0.065 (0.051)
Income		0.073 (0.051)		0.054 (0.205)
Household size		0.255** (0.107)		0.248** (0.108)
Constant	0.227*** (0.098)	- 2.656*** (0.797)	- 0.567*** (0.207)	- 3.455*** (0.826)
Obs.	942	942	942	942
Prob > chi ²	0.000	0.000	0.000	0.000

Numbers in parentheses are standard errors. ***, **, and * indicate the levels of statistical significance at 1%, 5%, and 10%, respectively

more concerned about the environment and more likely to purchase energy-saving appliances to save energy. Likewise, as the household size gets larger, respondents recognize that purchasing energy-saving devices can save more energy and reduce their expenditure in the long term. Education and income have expected signs; however, they are insignificant factors in the case of China, different from the prevailing evidence from developed countries. We identify some potential rationale from a few extant works that may suggest that our finding for China is not unique. For instance, Long et al. (2018) find that education beyond high school is no longer a significant explanatory factor for buying energy-efficient appliances in Germany and the USA. Baldini et al. (2018) indicate that income is a weak predictor, even among the well-educated in Denmark. Abrahamse and Steg (2009) also suggest that household energy savings appear not to be associated with sociodemographics in the case of the Netherlands.

Effects of environmental attitude, concern and psychological benefits on behavioral intention

Table 5 displays the Probit regression results of the effects of environmental attitude and concern as well

as psychological benefits on respondents' behavioral intention to purchase energy-saving appliances (willingness to pay: Int(1)). The results of models 5–6 in Table 5 reveal that environmental attitude has significantly positive effects on respondents' intention to purchase energy-saving appliances across different specifications. We note that the sign for age is negative in model 6, but positive in model 5. A possible explanation is that the measurement for the key variable, environmental attitude, is different (a vs. b). Since it is correlated with age (0.001 for a and 0.081 for b by Spearman test, respectively), it influences the sign and magnitude of age. Interestingly, age in both models 5 and 6 are statistically insignificant with different signs, suggesting that the correlation between the key variables and age are trivial and can be ignored (Wooldrige 2001, p78).

Environmental concern and environmental attitude have similar effects on the intention to purchase energy-saving appliances. The results of models 7–9 in Table 5 demonstrate that environmental concern also has significant positive effects on respondents' intention to purchase energy-saving appliances.

As expected, the findings confirm the positive influence of consumers' environmental attitude and concern

Table 5 Impacts of environmental attitude, and concern on behavioral intention, represented by the willingness to pay for energy-saving appliances (Int(1))

Variables	Model 5 Probit	Model 6 Probit	Model 7 Probit	Model 8 Probit	Model 9 Probit
Environmental attitude					
Do you believe that energy is a scarce resource?	0.179*** (0.046)				
Is your attitude toward protecting the environment serious?		0.171*** (0.054)			
Environmental concern					
Do you realize it is important to protect the environment?			0.162*** (0.056)		
Are you concern about air pollution?				0.103** (0.057)	
Are you concern about climate change?					0.159*** (0.054)
Sociodemographics					
Age	0.038 (0.184)	−0.018 (0.184)	−0.022 (0.184)	−0.022 (0.184)	−0.042 (0.185)
Education	0.117 (0.245)	0.109 (0.243)	0.110 (0.244)	0.105 (0.244)	0.084 (0.244)
Income	0.139** (0.058)	0.149*** (0.057)	0.147*** (0.057)	0.151*** (0.057)	0.155*** (0.057)
Household size	−0.002 (0.126)	−0.021 (0.125)	−0.012 (0.125)	−0.007 (0.124)	−0.020 (0.125)
Constant	−0.471 (0.955)	−0.257 (0.946)	−0.243 (0.952)	0.015 (0.947)	−0.057 (0.937)
Obs.	942	942	942	942	942
Prob > chi ²	0.000	0.000	0.000	0.000	0.000

Numbers in parentheses are standard errors. ***, **, and * indicate the levels of statistical significance at 1%, 5%, and 10%, respectively

on purchase intention presented in our “[Theoretical framework and hypotheses](#)” section and are in line with the existing literature (e.g., Gadenne et al. 2011; Chen 2016; Paul et al. 2016). Thus, our hypotheses H2 and H3 are supported.

Warm glow is found to be a statistically significant explanatory variable in models 10–11 of Table 6, indicating that warm glow is a primary driver of variation in the outcomes and that consumers’ expectation of personal psychological happiness potentially motivates her intention to purchase energy-saving appliances. Unlike altruism, consumers pursuing their own psychological happiness contributes to environmental protection (Hartmann and Apaolaza-Ibáñez 2012). The findings support our hypotheses and are in line with the existing literature (e.g., Hartmann and Apaolaza-Ibáñez 2012).

Lastly, the results of estimating the effects of self-expressive benefit in models 12–13 in Table 6 show a

positive influence on the intention to purchase energy-saving appliances. The findings confirm our statement in the “[Theoretical framework and hypotheses](#)” section in this study and are line with some previous studies (e.g., Griskevicius et al. 2010), although Hartmann and Apaolaza-Ibáñez (2012) do not find a significant relationship between self-expressive benefit and purchase intention. Thus, our hypotheses H4 and H5 are supported.

As to the importance of the magnitude of the estimates, the findings demonstrate that *Warm glow* “By buying energy-saving appliances, do you feel good because you help to protect the environment?” with the coefficient by 0.368 has relatively larger impact than other variables in Table 6.

Unexpectedly, all the control variables except income are not significant. Income turns out to have significantly positive impacts on the intention to purchase energy-saving appliances. According to the permanent income

Table 6 Impact of psychological benefits on behavioral intention, represented by the willingness to pay for energy-saving appliances (Int(1))

Variables	Model 10 Probit	Model 11 Probit	Model 12 Probit	Model 13 Probit
Warm glow				
By buying energy-saving appliances, do you feel good because you help to protect the environment?	0.368*** (0.048)			
By buying energy-saving appliances, do you feel that you are contributing to the well-being of humanity and nature?		0.302*** (0.047)		
Self-expressive benefits				
By buying energy-saving appliances, can you express your environmental concern?			0.238*** (0.044)	
By buying energy-saving appliances, can you demonstrate to your friends that you care about environmental conservation?				0.183*** (0.042)
Sociodemographics				
Age	-0.037 (0.189)	-0.086 (0.188)	-0.007 (0.186)	0.039 (0.185)
Education	0.209 (0.253)	0.171 (0.249)	0.149 (0.249)	0.146 (0.248)
Income	0.157*** (0.059)	0.176*** (0.058)	0.173*** (0.058)	0.168*** (0.058)
Household size	-0.054 (0.129)	-0.032 (0.127)	-0.060 (0.127)	-0.027 (0.126)
Constant	-1.008 (0.971)	-0.570 (0.957)	-0.478 (0.948)	-0.429 (0.951)
Obs.	942	942	942	942
Prob > chi ²	0.000	0.000	0.000	0.000

Numbers in parentheses are standard errors. ***, **, and * indicate the levels of statistical significance at 1%, 5%, and 10%, respectively

hypothesis, as income increases, respondents become more inclined to buy energy-saving devices.

Robustness check

Previous studies have employed different indicators as alternative measures to conduct robustness checks. In contrast to the regressions in Tables 5 and 6, regressions in Table 7 employ “Do you think purchasing green products in the near future will be a good thing?” as an alternative measure of environmental intention. If the sign and magnitude of the key variable in Table 7 are still similar to Table 5, the results are robust.

Tables 7 and 8 present the ordered Probit regression results of the effects of environmental attitude and concern as well as psychological benefits on respondents’ behavioral intention (Int(2)) to purchase energy-saving appliances in China.

The findings confirm the results in Tables 5 and 6. All variables—environmental attitude, environmental concern, warm glow, and self-expressive benefit—

have similar sign and magnitude. Thus, environmental attitude, environmental concern, warm glow, and self-expressive benefit have positive influences on respondents’ behavioral intention to purchase energy-saving appliances. Likewise, the only control variable, income, has significantly positive impacts on the intention to purchase energy-saving appliances. These results confirm that our findings are robust. Note that a similar explanation to age in the previous section can be applied to interpreting results from models 14 and 15 as well as all other models. In this case, the findings demonstrate that *Environmental concern* “Do you realize it is important to protect the environment?” has the relatively bigger impact than other variables in terms of the magnitude of the estimates in Table 7.

Conclusion and policy implications

In addition to top-down policies, changing human behavior—the bottom-up approach—is another way to

Table 7 Robust check: impacts of environmental attitude, and concern on behavioral intention of purchasing energy-saving appliances by ordered probit regression (Int(2))

Variables	Model 14 Ordered Probit	Model 15 Ordered Probit	Model 16 Ordered Probit	Model 17 Ordered Probit	Model 18 Ordered Probit
Environmental attitude					
Do you believe that energy is a scarce resource?	0.523*** (0.038)				
Is your attitude toward protecting the environment serious?		0.836*** (0.048)			
Environmental concern					
Do you realize it is important to protect the environment?			0.838*** (0.050)		
Are you concern about air pollution?				0.740*** (0.049)	
Are you concern about climate change?					0.731*** (0.046)
Sociodemographics					
Age	0.194 (0.141)	-0.046 (0.144)	-0.074 (0.143)	-0.132 (0.142)	-0.145 (0.143)
Education	-0.170 (0.178)	-0.166 (0.180)	-0.138 (0.179)	-0.156 (0.178)	-0.310 (0.180)
Income	0.035 (0.044)	0.067 (0.045)	0.058 (0.045)	0.050 (0.044)	0.087** (0.044)
Household size	0.082 (0.094)	0.008 (0.096)	0.033 (0.095)	0.054 (0.094)	0.004 (0.095)
Obs.	942	942	942	942	942
Prob > chi ²	0.000	0.000	0.000	0.000	0.000

Numbers in parentheses are standard errors. ***, **, and * indicate the levels of statistical significance at 1%, 5%, and 10%, respectively

conserve energy when the adverse effects of climate change are looming large. In this study, we assess the determinants of consumers' intention and the choice to purchase energy-saving appliances from the perspective of environmental attitude, concern, and psychological benefits. We narrow down on the purchase of energy-saving appliances and apply Probit models to a sample of 942 online survey responses collected in 2016.

Our findings suggest that behavioral intention has significant and positive effects on the choice to purchase energy-saving appliances. Further analysis indicates that environmental attitude and concern as well as psychological benefits have significantly positive impacts on respondents' behavioral intention to buy energy-saving appliances. One major insight is that in addition to the usual understanding that external, peer effect will increase environmentally friendly behavior, internal self-motivation can also be a key driver. Our paper's documentation that perceived psychological benefits positively affect behavioral intention is a first kind for

research in China. Furthermore, our findings show that age and household size are significantly and positively correlated with the decision to purchase energy-saving appliances.

Our study thus offers the following policy implications for promoting the purchase and adoption of energy-saving appliances in China. These implications are likely applicable to promote other environmentally friendly products. Behavioral intention offers a useful window into encouraging consumers' adoption of energy-saving appliances, and such intention is a mediator variable that is undergirded by consumers' environmental attitude and concern as well as psychological benefits. Therefore, policies that can change consumers' attitude and concern, or perceived psychological benefits, are conducive to promoting behavioral change. First, providing more relevant environmental information may shift consumers' environmental attitude. For example, the government or appliance vendors can make efforts to disseminate scientific evidence that

Table 8 Impacts of psychological benefits on behaviour intention by Ordered Probit regression results for models 19 to 22

Variables	Model 19 Ordered Probit	Model 20 Ordered Probit	Model 21 Ordered Probit	Model 22 Ordered Probit
Warm glow				
By buying energy-saving appliances, do you feel good because you help to protect the environment?	0.611*** (0.040)			
By buying energy-saving appliances, do you feel that you are contributing to the well-being of humanity and nature?		0.629*** (0.039)		
Self-expressive benefits				
By buying energy-saving appliances, can you express your environmental concern?			0.485*** (0.036)	
By buying energy-saving appliances, can you demonstrate to your friends that you care about environmental conservation?				0.305*** (0.033)
Sociodemographics				
Age	-0.009 (0.142)	-0.071 (0.143)	0.066 (0.178)	0.159 (0.140)
Education	-0.094 (0.179)	-0.091 (0.179)	-0.129 (0.053)	-0.151 (0.175)
Income	0.079** (0.044)	0.115*** (0.045)	0.108*** (0.044)	0.095*** (0.044)
Household size	-0.021 (0.095)	-0.020 (0.096)	-0.040 (0.095)	0.015 (0.093)
Obs.	942	942	942	942
Prob > chi ²	0.000	0.000	0.000	0.000

Numbers in parentheses are standard errors. ***, **, and * indicate the levels of statistical significance at 1%, 5%, and 10%, respectively

energy scarcity and climate change are at least partly due to anthropogenic activities. Disseminating information such as atmospheric emissions, energy mix, and new renewable capacity installed may also shift consumers' attitude in favor of purchasing energy-efficient appliances (Johnson and Frank 2006; Hartmann and Apaolaza-Ibáñez 2012; Long et al. 2018). Second, boosting consumers' environmental concern via public campaigns and popular channels, such as primetime TV, is another sensible policy measure. Third, changing consumers' perceived psychological benefits of using energy-saving products through public advertising can help make consumers "feel good while doing well" socially and environmentally (Wiser 1998; Hartmann and Apaolaza-Ibáñez 2012). These efforts work together to influence consumers' environmental attitude and concern as well as perceived psychological benefits and thereby bending environmental intention toward the choice of purchasing energy-efficient appliances. Lastly, from the perspective of marketing energy-saving appliances, targeting larger households with more senior residents can increase the odds of adoption.

This study also provides directions for future research. For instance, future research can assess habitual energy-saving behavior other than the use of energy-saving appliances, such as turning off lights when leaving the room or shutting down the power when an appliance is not in use. Future research can also explore regional variations within China, given the known regional differences in the levels of economic development and educational attainment as well as divergences in preferences. To do that, future researchers can geolocate the respondents and explore geographical variations. To conclude, this study not only provides micro-level insights into promoting China's sustainable development but also offers a reference point for future research on purchasing energy-saving appliances in other countries, particularly the developing countries.

Acknowledgements The authors would like to thank the two anonymous reviewers for their helpful comments.

Funding information Xianchun received financial support from the National Social Science Foundation of China (17AJL008) and the Social Science Foundation by Tianjin

Education Council (2014ZD07). Xunpeng acknowledges financial support from the National Natural Science Foundation of China under Grant No. 71828401 and No. 71873029.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

- Aaker, J. L. (1999). The malleable self: The role of self-expression in persuasion. *Journal of Marketing Research*, 36(1), 45–47.
- Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *Journal of Economic Psychology*, 30, 711–720.
- Ajzen, I. (1989). Attitude structure and behavior. *Attitude structure and function*, 1, 241–274.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211.
- Ali Research Report. (2016). *Research report on Taobao village of China in 2016*. Ali Research Institute.
- Andreoni, J. (1990). Impure altruism and donations to public goods: A theory of warm-glowing giving. *The Economic Journal*, 100(401), 464–477.
- Arvola, A., Vassallo, M., Dean, M., Lampila, P., Saba, A., Lähteenmäki, L., & Shepherd, R. (2008). Predicting intentions to purchase organic food: The role of affective and moral attitudes in the Theory of Planned Behaviour. *Appetite*, 50, 443–454.
- Baldini, M., & Trivella, A. (2018). Modelling of electricity savings in the Danish households sector: From the energy system to the end-user. *Energy Efficiency*, 11, 1563–1581.
- Baldini, M., Trivella, A., & Wente, J. W. (2018). The impact of socioeconomic and behavioral factors for purchasing energy efficient household appliances: A case study for Denmark. *Energy Policy*, 120, 503–513.
- Bang, H. K., Ellinger, A., Hadjimarcou, J., & Traichal, P. (2000). Consumer concern, knowledge, belief and attitude toward renewable energy: An application of the reasoned action theory. *Psychology and Marketing*, 17(6), 449–468.
- Bennett, A., & Chakravarti, A. (2009). The self and social signaling: Explanations for consumption of CSR-associated products. *Advances in Consumer Research*, 36, 49–50.
- Bergstrom, T., Blume, L., & Varian, H. (2006). On the private provision of public goods. *Journal of Public Economics*, 29(1), 25–49.
- Biswas, A., & Roy, M. (2015). Leveraging factors for sustained green consumption behavior based on consumption value perceptions: Testing the structural model. *Journal of Cleaner Production*, 95, 332–340.
- Borchers, A. M., Duke, J. M., & Parsons, G. R. (2007). Does willingness to pay for green energy differ by source? *Energy Policy*, 35(6), 3327–3334.
- Bray, J., Johns, N., & Kilburn, D. (2011). An explanatory study into the factors impeding ethical consumption. *Journal of Business Ethics*, 98, 597–608.
- Cai, S., Long, X., Li, L., Liang, H., Wang, Q., & Ding, X. (2019). Determinants of intention and behavior of low carbon commuting through bicycle-sharing in China. *Journal of Cleaner Production*, 212, 602–609.
- Chan, Y. K., & Lau, B. Y. (2000). Antecedents of green purchases: A survey in China. *Journal of Consumer Marketing*, 17(4), 338–357.
- Chen, M. F. (2016). Extending the theory of planned behavior model to explain people's energy savings and carbon reduction behavioral intentions to mitigate climate change in Taiwan—moral obligation matters. *Journal of Cleaner Production*, 112, 1746–1753.
- Chen, T. B., & Chai, L. T. (2010). Attitude towards the environment and green products: Consumers' perspective. *Management Science and Engineering*, 4(2), 27–39.
- Chen, Y.Y., Ebenstein, A., Greenstone, M., Li, H.B. (2013). *Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy*. Proceedings of the National Academy of Sciences of the United States of America.
- China Environment Statistical Yearbooks. (2016). *Various issues*. Beijing: China Environmental Science Press.
- DeCicco, J., Yan, T., Keusch, F., Muñoz, D. H., & Neidert, L. (2015). U.S. consumer attitudes and expectations about energy. *Energy Policy*, 86, 749–758.
- Dillman, D., Smyth, J., & Christian, J. (2009). *Internet, mail, and mixed-mode surveys: The tailored design methods* (3rd ed.). New Jersey: John Wiley and Sons, Inc..
- Ek, K. (2005). Public and private attitudes towards 'green' electricity: The case of Swedish wind power. *Energy Policy*, 33(13), 1677–1689.
- Ellen, P. S., Webb, D. J., & Mohr, L. A. (2006). Building corporate associations: Consumer attributions for corporate socially responsible programs. *Journal of Academy of Marketing Science*, 34, 147–157.
- Eurobarometer. (2005). *Attitudes towards energy. A report produced by The European Commission for the Directorate-General for Research*. Luxembourg.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research* (p. 53). Addison-Wesley Publishing Company.
- Fransson, N., & Gärling, T. (1999). Environmental concern: Conceptual definitions, measurement methods, and research findings. *Journal of Environmental Psychology*, 19, 369–382.
- Friedman, M. (1957). *The permanent income hypothesis. A theory of the consumption function*. Princeton: Princeton University Press ISBN 0-691-04182-2.
- Gadenne, D., Sharma, B., Kerr, D., & Smith, T. (2011). The influence of consumers' environmental beliefs and attitudes on energy saving behaviors. *Energy Policy*, 39(12), 7684–7694.
- Gaspar, R., & Antunes, D. (2011). Energy efficiency and appliance purchases in Europe: Consumer profiles and choice determinants. *Energy Policy*, 39(11), 7335–7346.
- Gerpott, T. J., & Mahmudova, I. (2010). Determinants of green electricity adoption among residential customers in Germany. *International Journal of Consumer Studies*, 34(4), 464–473.

- Griskevicius, V., Tybur, J. M., & Van den Bergh, B. (2010). Going green to be seen: Status, reputation, and conspicuous conservation. *Journal of Personality and Social Psychology*, *98*(3), 392–404.
- Grösche, P., & Schröder, C. (2011). Eliciting public support for greening the electricity mix using random parameter techniques. *Energy Economics*, *33*(2), 363–370.
- Grunert, S. C., & Juhl, H. J. (1995). Values, environmental attitudes, and buying of organic foods. *Journal of Economic Psychology*, *16*, 39–62.
- Hansla, A., Gamble, A., Juliusson, A., & Gärling, T. (2008). The relationships between awareness of consequences, environmental concern, and value orientations. *Journal of Environmental Psychology*, *28*(1), 1–9.
- Hartmann, P., & Apaolaza-Ibañez, V. (2012). Consumer attitude and purchase intention toward green energy brands: The roles of psychological benefits and environmental concern. *Journal of Business Research*, *65*, 1254–1263.
- Heckman, J. (1979). Sample selection bias as a specification error. *Econometrica*, *47*(1), 153–161.
- Johnson, B. B., & Frank, P. G. (2006). Public understanding of environmental impacts of electricity deregulation. *Energy Policy*, *34*(12), 1332–1343.
- Kaenzig, J., Heinzel, S. L., & Wüstenhagen, R. (2013). Whatever the customer wants, the customer gets? Exploring the gap between consumer preferences and default electricity products in Germany. *Energy Policy*, *53*, 311–322.
- Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy*, *74*, 132–157.
- Li, Z., Shao, B., Shi, X., Sun, Y., & Zhang, X. (2019). Structural transformation of manufacturing, natural resource dependence, and carbon emission reduction: Evidence of a threshold effect from China. *Journal of Cleaner Production*, *206*, 920–927.
- Lim, S., Flaxman, A., Danaei, G., Shibuya, K., et al. (2013). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions. *Lancet*, *380*, 2224–2260. [https://doi.org/10.1016/S0140-6736\(12\)61766-8](https://doi.org/10.1016/S0140-6736(12)61766-8). Accessed 5 January 2018.
- Litvine, D., & Wüstenhagen, R. (2011). Helping “light green” consumers walk the talk: Results of a behavioral intervention survey in the Swiss electricity market. *Ecological Economics*, *70*, 462–474.
- Liu, X., Wang, C., Shishime, T., & Fujitsuka, T. (2012). Sustainable consumption: Green purchasing behaviours of urban residents in China. *Sustainable Development*, *20*, 293–308.
- Long, C., Mills, B. F., & Schleich, J. (2018). Characteristics or culture? Determinants of household energy use behavior in Germany and the USA. *Energy Efficiency*, *11*, 777–798.
- Ma, B., Yu, Y., & Urban, F. (2018). Green transition of energy systems in rural China: National survey evidence of households’ discrete choices on water heaters. *Energy Policy*, *113*, 559–570. <https://doi.org/10.1016/j.enpol.2017.11.046>.
- McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), *Frontiers in econometrics* (pp. 105–142). Salt Lake City: Academic Press.
- Mi, L.Y., Gu, M., Yang, J., Yu, X.Y., Liu, Y. 2016. Empirical research on the psychological motivation factors of urban residents’ low carbon oriented energy consumption behavior in Xuzhou city. *Resources Science* *38*(4), 609–621.
- Nachmias, C. F., & Nachmias, D. (2000). *Research methods in the social science[M]* (6th ed. pp. 208–213). New York: Worth Publishers.
- Netherlands Environmental Assessment Agency (NEAA). (2008). China now no. 1 in CO₂ emissions, USA in second position. <http://www.mnp.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html> Accessed 2 January 2017.
- Noblet, C. L., Teisl, M. F., Evans, K., Anderson, M. W., McCoy, S., & Cervon, E. (2015). Public preferences for investments in renewable energy production and energy efficiency. *Energy Policy*, *87*, 177–186.
- Oreg, S., & Katz-Gerro, T. (2006). Predicting pro-environmental behavior cross-nationally: Values, the theory of planned behavior, and value-belief-norm theory. *Environment and Behavior*, *38*(4), 462–483.
- Parikh, K. S., & Parikh, J. K. (2016). Realizing potential savings of energy and emissions from efficient household appliances in India. *Energy Policy*, *97*, 102–111. <https://doi.org/10.1016/j.enpol.2016.07.005>.
- Paul, J., Modi, A., & Patel, J. (2016). Predicting green product consumption using theory of planned behavior and reasoned action. *Journal of Retailing and Consumer Services*, *29*, 123–134.
- Pope, C. A., III, & Dockery, D. W. (2013). Air pollution and life expectancy in China and beyond. *PNAS*, *110*, 12861–12862.
- Reuters. (2014). 4 March 4 2014. China to declare war on pollution, premier says, Available at: <http://www.reuters.com/article/us-china-parliament-pollution-idUSBREA2405W20140305>. Accessed 25 August 2016.
- Sapci, O., & Considine, T. (2014). The link between environmental attitudes and energy consumption behavior. *Journal of Behavioral and Experimental Economics*, *52*, 29–34.
- Sardianou, E., & Genoudi, P. (2013). Which factors affect the willingness of consumers to adopt renewable energies? *Renewable Energy*, *57*, 1–4.
- Schultz, P. W., Shriver, C., Tabanico, J. J., & Khazian, A. M. (2004). Implicit connections with nature. *Journal of Environmental Psychology*, *24*, 31–42.
- Shen, S.V. (2018). *The political pollution cycle*. Available at SSRN: <https://doi.org/10.2139/ssrn.2822922>. Accessed 2 December 2018.
- Shi, X. (2014). Setting effective mandatory energy efficiency standards and labelling regulations: A review of best practices in the Asia Pacific region. *Applied Energy*, *133*, 135–143.
- Shi, X. (2015). Application of best practice for setting minimum energy efficiency standards in technically disadvantaged countries: Case study of air conditioners in Brunei Darussalam. *Applied Energy*, *157*, 1–12.
- Shimokawa, M., & Tezuka, T. (2014). Development of the “home energy conservation support program” and its effects on family behavior. *Applied Energy*, *114*, 654–662.
- Sovacool, B. K. (2014). Diversity: Energy studies need social science. *Nature*, *511*, 529–530.
- Stern, P. C. (2011). Contributions of psychology to limiting climate change. *American Psychologist*, *66*(4), 303–314.
- Stern, P. C. (2014). Energy: We need all hands on deck. *Nature*, *513*(7516), 33.
- Sun, Y., Xue, J., Shi, X., Wang, K., Qi, S., Wang, L., & Wang, C. (2019). A dynamic and continuous allowances allocation

- methodology for the prevention of carbon leakage: Emission control coefficients. *Applied Energy*, 236, 220–230.
- Tabi, A., Hille, S.L., Wüstenhagen, R., 2014. What makes people seal the green power deal? – Customer segmentation based on choice experiment in Germany. *Ecological Economics* 107, 206–21.
- Vermeir, I., & Verbeke, W. (2006). Sustainable food consumption: Exploring the consumer “attitude-behavioral intention” gap. *Journal of Agricultural and Environmental Ethics*, 19, 169–194.
- Wang, Z., Zhang, B., Ying, J., & Zhang, Y. (2011). Determinants and policy implications for household electricity-saving behaviour: Evidence from Beijing, China. *Energy Policy*, 39, 3550–3557.
- Wang, K., Wu, M., Sun, Y., Shi, X., Sun, A., & Zhang, P. (2019). Resource abundance, industrial structure, and regional carbon emissions efficiency in China. *Resources Policy*, 60, 203–214.
- WHO. (2016). WHO global urban ambient air pollution database (update 2016). http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/. Accessed 2 January 2017 .
- Wiser, R. H. (1998). Green power marketing: Increasing customer demand for renewable energy. *Utilities Policy*, 7(2), 107–119.
- Wooldridge, J. M. (2001). *Introductory econometrics: A modern approach* (p. P461). South-Western College Publishing, a division of Thomson Learning.
- Wüstenhagen, R., & Bilharz, M. (2006). Green energy market development in Germany: Effective public policy and emerging customer demand. *Energy Policy*, 34(13), 1681–1696.
- Zarnikau, J. (2003). Consumer demand for ‘green power’ and energy efficiency. *Energy Policy*, 31(15), 1661–1672.
- Zeng, L., Yu, Y., & Li, J. (2014). China's promoting energy-efficient products for the benefit of the people program in 2012: Results and analysis of the consumer impact study. *Applied Energy*, 133, 22–32.
- Zhang, P., Shi, X., Sun, Y., Shao, S., & Cui, J. (2019). Have China's provinces achieved their targets of energy intensity reduction? Reassessment based on nighttime lighting data. *Energy Policy*, 128, 276–283.
- Zhao, C., Zhang, M., & Wang, W. (2019). Exploring the influence of severe haze pollution on residents' intention to purchase energy-saving appliances. *Journal of Cleaner Production*, 212, 1536–1543.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.