

Progress and Implications of Experimental Research in the Field of International Environmental Policy

Jiayi Zhou

School of public administration, Hunan University, Changsha, China.

987239200@qq.com

Abstract. Given the importance of experimental methods in the field of environmental policy, this paper aims to analyze the trend and use of experimental methods in the environmental policy domain in the past 20 years from a methodological perspective. The sources of the literature review are 253 papers from the top 100 environmental policy SSCI-listed journals using laboratory, survey and field experiments. The analysis of the overall situation (nationality, journal) and the specific situation (research theme, experimental design and sample) reveals that most of the current experimental research in this field is focused on topics such as "energy" and "environmental protection and sustainable development", and the most common experimental designs are single-factor design and between-subjects design, with the majority of subjects participating in experimental research being the public and students. Finally, this paper discusses the prospects of experimental research in the field of environmental policy in future and gives corresponding suggestions, taking into account the analysis of the current situation and trends of experimental research in environmental policy.

Keywords: Environmental policy, laboratory experiments, field experiments, survey experiments, visibility of experimental design.

1. Introduction

With the increasing emphasis on causal inference and empirical research in the field of environmental policy, the experimental method has become an indispensable methodological tool in environmental policy research. However, no research has yet systematically analysed and sorted out experimental research in this field, which to a certain extent may affect the effective communication and methodological dissemination of experimental research. Therefore, this paper intends to systematically review the experimental research in environmental policy in the past 20 years, starting from the types and basic logic of experimental methods. In terms of chapter layout, the second part introduces the process of data selection and the selection of variables for analysis; the third part analyses the use of experimental methods in environmental policy; and on this basis, the fourth and fifth parts put forward corresponding research recommendations and implications. The aim of this paper is to analyse and understand the main features and trends of current experimental research in the field of environmental policy, in order to enrich the academic community's understanding of experimental research in this field and to enlighten future research, with a view to providing a contribution to the basic knowledge base of the relevant disciplines in a methodological sense.

2. Data and Methods

The data sources and screening methods for this paper are shown below.

Step 1: Journal screening. The top 100 journals in the category of impact factor in the field of environmental policy were selected from the Science and Technology Citation Index - Web of Science database of the Institute of Scientific Information. The journals containing experimental research were selected and irrelevant journals were excluded, leaving a total of 84 journals.

Step 2: Literature screening. Among the screened journals, a total of 3944 relevant articles were screened from the Science and Technology Citation Index - Web of Science database of the Institute of Scientific Information, with TS=(experiment*) AND SO= ("journal name"), time range "2000-2020", and literature type "article".

Step 3: Data cleaning. The 3,944 articles were manually read to determine whether they were indeed experimental articles, and if not, they were excluded. Next, studies on laboratory experiments, survey experiments and field experiments were selected, and studies on natural experiments, quasi-experiments, review papers and a small number of studies claiming to be experimental studies but are actually surveys were excluded, leaving a total of 253 articles. The literature screening process is shown in Figure 1

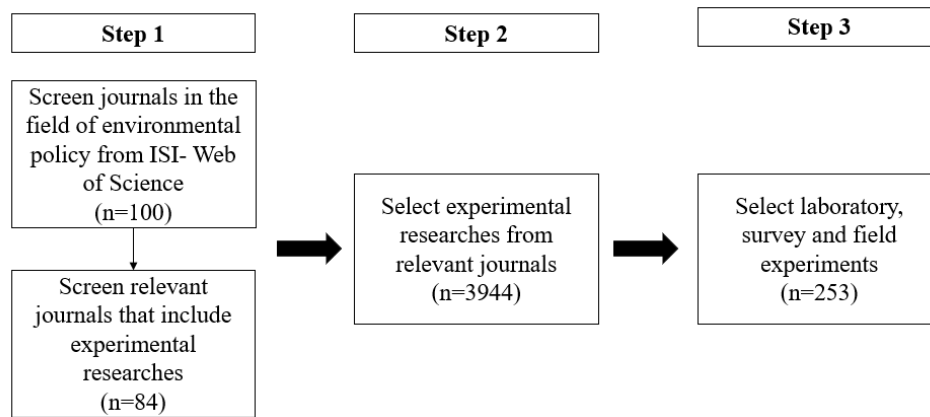


Figure 1. Literature Screening Process

3. Data Analysis

The results of the data analysis can be divided into two parts: the first part is a description of the overall situation of experimental research in the field of environmental policy, including the publication of the literature over the years and the geographical distribution characteristics of the studies; the second part is an analysis of the specific studies of the three types of experimental methods, including the themes of the studies, the use of experimental designs, the types of samples and recruitment, and the selection of dependent variables, etc.

3.1 Overview of the General Situation

First, this paper analyses the number of publications and the distribution of the three types of experimental studies in each journal over time, as shown in Figures 2, 3 and 4. In general, the number of publications of all three types of experimental studies showed an increasing trend year by year. Specifically, the journals with the largest distribution of the three types of experimental articles are *Nature Climate Change*, *Environmental Communication*, *Energy Policy*, *Global Environmental Change*, and *Ecology Economics*. These five journals account for nearly 40% of the total number of experimental articles.

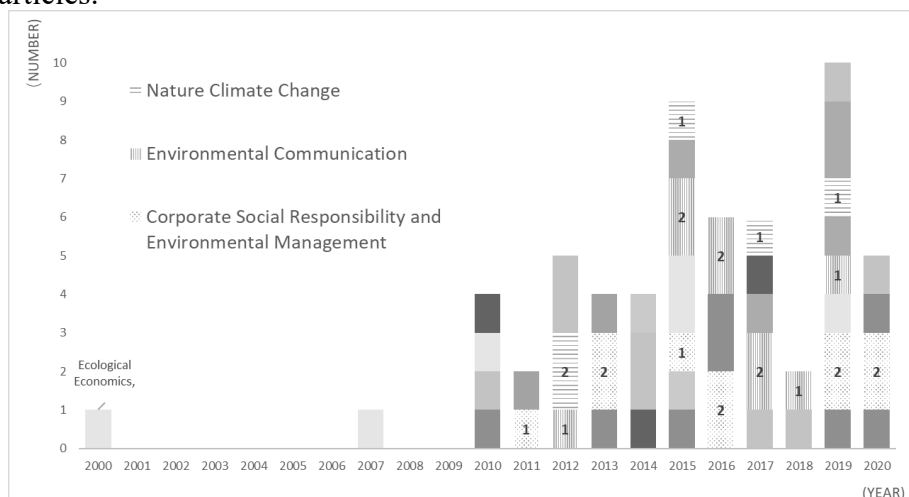


Figure 2. Trends in the Distribution and the Number of Laboratory Experiment Research Papers in Journals (2000-2020)

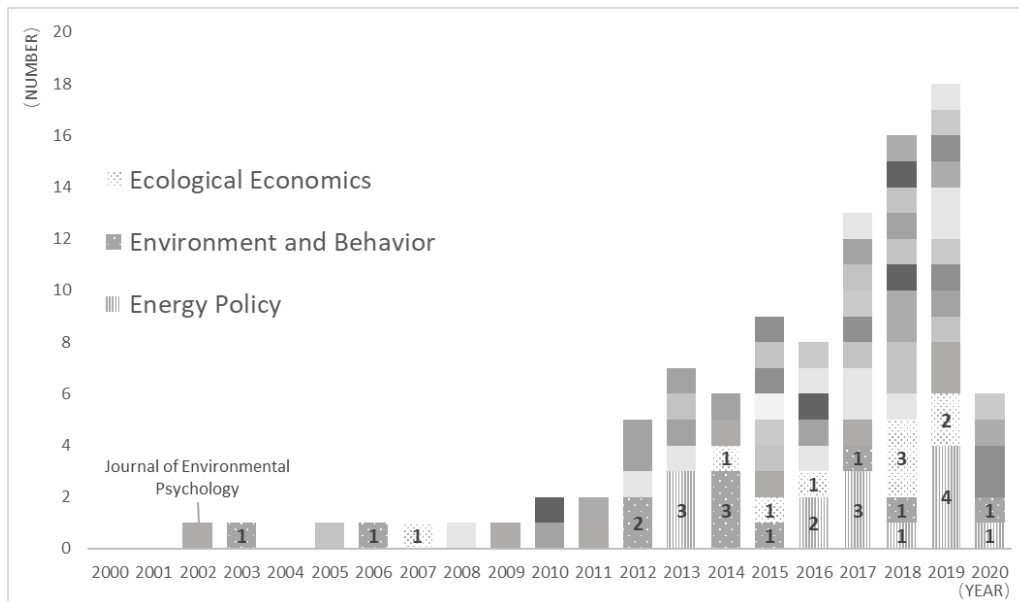


Figure 3. Trends in the Distribution and the Number of Survey Experiment Research Papers in Journals (2000-2020)

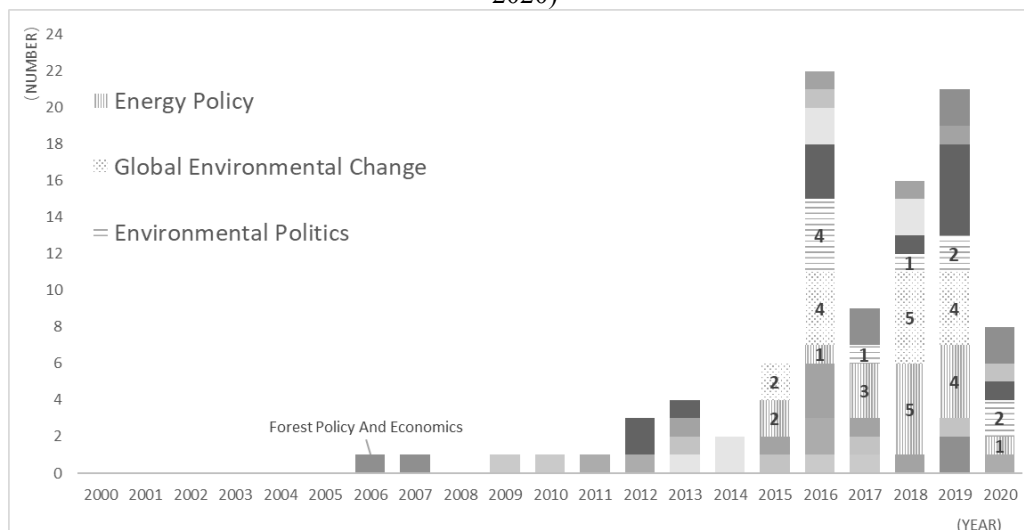


Figure 4. Trends in the Distribution and the Number of Field Experiment Research Papers in Journals (2000-2020)

Secondly, this paper analyses the geographical information (country of affiliation) of all authors in the database. In terms of geographical distribution, the authors of the three types of experimental studies are concentrated in the United States (35%), Germany (10%) and the United Kingdom (7%), mainly in developed countries such as Western Europe and North America, which account for more than one-half of the total number of studies. In terms of international collaboration, studies of cross-national survey experiment studies account for a proportion of the total number of studies (22%), while cross-national field experiment studies account for a very small proportion (3%).

3.2 Analysis of Situations in Specific Studies

3.2.1 Research Themes

Based on the analysis of the literature and keywords, it can be found that the current experimental studies in foreign environmental policy are focused on "environmental protection and sustainable development" and "energy", but with different emphases. The following paragraphs will introduce the themes of the three types of experimental articles in turn.

In laboratory experiment studies, environmental protection and sustainable development are the research themes of the majority of articles, while there are relatively few articles on the topic of

(3 articles, 5%). The most frequent sample used in survey experiment research was the public (85 articles, 86%), including the general public and specific occupations (workers, farmers, fishermen, etc.); followed by students (7 articles, 7%); and a small number of studies chose experts (2 articles, 2%) or politicians (2 articles, 2%) as the sample. The most frequently used sample in field experiment research was also the public (43 articles, 44%), with households accounting for the vast majority of experiments as the unit of study; followed by students (19 articles, 19%).

The paper further analyses the sample recruitment of the three types of experimental studies. As shown in Figure 8, laboratory experiment research mostly used direct recruitment methods, including campus and social recruitment, and few studies used indirect recruitment methods. As shown in Figure 9, field experiment research also used more direct recruitment methods, including social recruitment in various venues, as well as recruitment by telephone, mail and email. Of the studies that recruited their samples indirectly, the vast majority chose to recruit through government and school online research platforms, as well as partnerships such as projects, and a very small number chose to recruit using online data from third-party survey agencies.

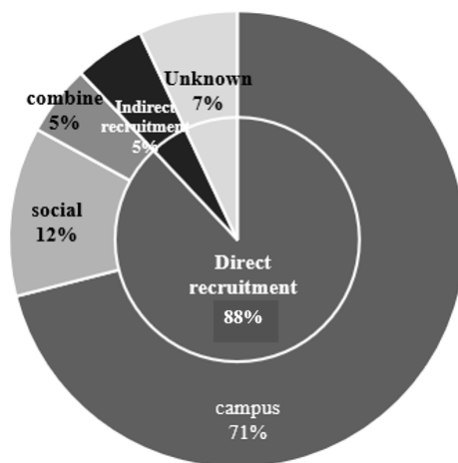


Figure 8. Recruitment of Samples for Laboratory

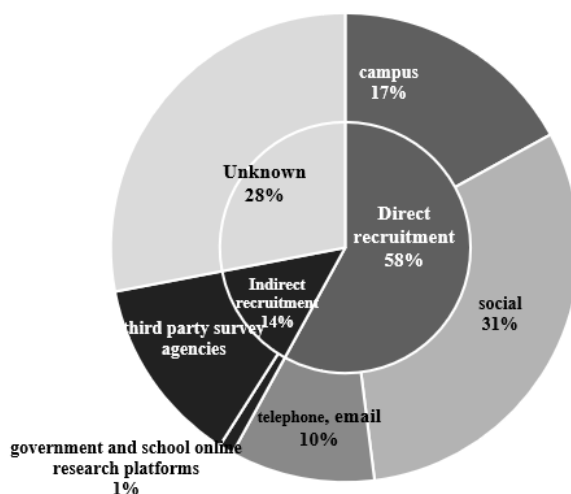


Figure 9. Recruitment of Samples for Field Experiments

Unlike the first two types of experimental studies which mostly used direct recruitment, as shown in Figure 10, indirect recruitment accounted for the majority of survey experiment research and relied primarily on third-party survey agencies for recruitment. The most commonly used ones include Amazon Mechanical Turk, YouGov, Qualtrics and others. Of the experiments that recruited samples directly, half samples were directly recruited at universities or across the community. The other half of the experiments were recruited by phone, email, maps, social platforms, etc.

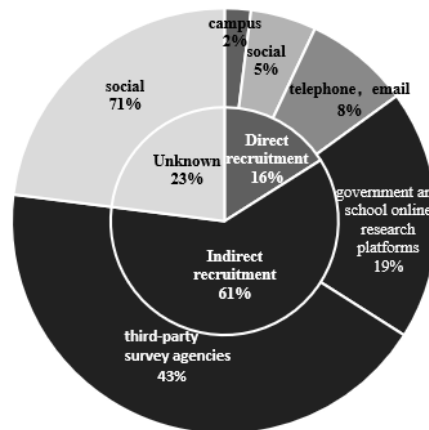


Figure 10. Recruitment of Samples for Survey Experiments

Also, the paper further analyses the sampling method for the survey experiment. Of the studies that have reported on the sampling method (63, 66%), nearly 70% of the studies were conducted using non-probability sampling, with the vast majority of them using convenience sampling and the remainder using quota and purposive sampling. The other 30% of studies were conducted through probability sampling, with stratified sampling being the most frequently used.

Finally, the paper analyses the sample sizes of the two types of experimental studies and the results are shown in Table 2. Most of the studies found in this paper do not report how the sample size was derived, but simply give the final sample size.

Table.2 Comparison of Sample Size for three experiments

	Minimum Value	Maximum Value	Lower Quartile	Median	Upper Quartile
Laboratory Experiments	45	616	105	180	248
Survey Experiment	36	22011	494	1042	2000
Field Experiments	12	41952	112	310	789

3.2.4 Selection of the Dependent Variable

In this paper, the dependent variables of the three types of experimental research are analysed. As can be seen from Figure 11, the dependent variables of the laboratory experiment research can be divided into three main levels: perceive, attitude and behaviour. In terms of measurement methods, nearly 30% of the studies used scales as the dependent variable, with the Likert scale being the most commonly used and the Semantic differential scale being used.



Figure 11. Word Cloud of Dependent Variables for Laboratory Experiment Research

4.2 Use of Experimental Designs

First, current experimental studies have a strong preference for the use of single-factor and between-subjects designs. Through comparison, it is found that more studies use multi-factor designs in laboratory and survey experiments than field experiments. This is mainly because laboratory and survey experiments are experimentally manipulated through a tightly controlled experimental environment, and different versions of questionnaires, thus allowing the analysis of the effects of multiple levels of independent variables on the dependent variable at once in a theoretical sense; field experiments, on the other hand, are manipulated into real-world scenarios where subjects receive a variety of realistic interventions as well as experimental interventions. This makes it difficult to differentiate and control the different levels of the independent variables, and therefore multi-factorial designs are less commonly used (Jackson & Cox, 2013).

Secondly, the number of groups in current experimental studies is generally small, and in a theoretical sense, it is undoubtedly more conducive to the researchers' manipulative treatment. However, due to the complexity of real life, a single independent variable setting often fails to solve the problem and the experimental effect can be greatly weakened (Blom-Hansen *et al.*, 2015). Therefore, in order to better simulate real-world scenarios, the use of multi-factor experimental designs can be appropriately enhanced, along with the use of within-subjects and mixed designs where conditions permit.

4.3 Sample Types and the Recruitment

In terms of sample types, laboratory experiments are problematic in terms of sample selection, with the majority of samples coming from university students and very few from the general public, so the generalisability of their findings has to be questioned. The survey and field experiments, on the other hand, represent an improvement over the laboratory experiments by extending the sample from individual groups to people from all walks of life, thus avoiding the fatigue effect caused by repeated use of the sample, reducing the influence of the "third factor" and thus improving the external validity of the study.

In terms of sample recruitment, the rapid rise in the recruitment of samples through third-party survey agencies has increased the flexibility and convenience of the recruitment process by removing the constraints of a single database. However, the quality of data obtained through third-party survey agencies is still an issue that needs to be investigated, and therefore the selection criteria for data obtained in this way should be further enhanced to improve data quality.

In terms of how the sample for the survey experiments was sampled, most of the current studies used non-probability sampling, which may be due to two reasons: firstly, experimental research seeks internal validity over external validity, i.e. researchers aim to examine causal relationships rather than to generalise to a wider population; secondly, evidence from previous studies suggests that specific non-representative samples (e.g. student samples, internet samples) have good generalisability. However, this sampling approach may lead to the presence of sample selectivity bias, which further affects the accuracy of the experimental findings. Therefore, in future experimental studies, researchers may select samples according to the objectives of their studies. If the main purpose is to validate the theoretical model and explore basic causality, then the use of non-representative samples can meet such needs; if the purpose is to generalise the findings further, then as much as possible, representative sampling of the sample can be conducted, if conditions allow extent possible in order to improve the external validity of the study.

Finally, in terms of sample size, the sample sizes of the three types of experimental studies were highly variable, ranging from a few dozen to several thousand. In terms of how the sample size was calculated, most of the experimental studies did not mention how the sample size was calculated, which could cast doubt on the reliability of the findings and thus reduce the quality of the study. Therefore, when determining the use of sample size, researchers should firstly consider the influence of various factors such as the type of experiment, the experimental design and the conditions under

which the experiment was conducted, and secondly, they can also use statistical tools such as power analysis to determine the sample size based on the expected effect size.

4.4 Selection of Dependent Variables

In terms of the dependent variables for the three types of experiments, the dependent variable for the survey experiments tends to be the subjective feelings of the person, the dependent variable for the field experiments tends to be more of an objective observable behaviour, and the dependent variable for the laboratory experiments contains both subjective feelings and objective behaviour. However, for survey experiments, there may be a distance between discussing subjective feelings alone and the desired action due to the knowledge-action gap. In the case of field experiments, due to spillover effects, the objective behaviour observed in the experiment is inevitably influenced by the social environment rather than by the objective behaviour of the individual arising from subjective feelings. Therefore, the selection of dependent variables for the two types of experiments mentioned above still needs further improvement. Attention should be paid to the comprehensiveness of the selection of dependent variables to avoid favouring one over the other.

5. Conclusion

This paper provides a general introduction to the use of laboratory, survey and field experimental methods in the field of international environmental policy. On this basis, it further analyses and explains the problems worth discussing in the application of the three types of experimental methods and puts forward corresponding countermeasure suggestions. It can be seen that experimental research in the field of international environmental policy is rapidly emerging, and these studies provide new research perspectives and empirical evidence for domestic research. At the same time, world's rapid economic development and social changes provide a large number of research questions with theoretical and practical significance for experimental approaches, and selections with significant international comparative research value may emerge. It is hoped that more researchers will join the ranks of experimental research in the field of environmental policy in the future, giving full play to the advantages of the experimental approach to study and solve theoretical and practical problems in the field of environmental policy.

References

- [1] Alniacik, U., E. Alniacik, N. J. C. s. r. Genc and e. management, 2011: How corporate social responsibility information influences stakeholders' intentions. 18, 234-245.
- [2] Andersson, K. P., N. J. Cook, T. Grillos, M. C. Lopez, C. F. Salk, G. D. Wright and E. J. N. S. Mwangi, 2018: Experimental evidence on payments for forest commons conservation. 1, 128-135.
- [3] Bergquist, M. and A. J. E. E. Nilsson, 2018: Using social norms in smart meters: the norm distance effect. 11, 2101-2109.
- [4] Blom-Hansen, J., R. Morton and S. J. I. P. M. J. Serritzlew, 2015: Experiments in public management research. 18, 151-170.
- [5] Capstick, S. B., N. F. Pidgeon, A. J. Corner, E. M. Spence and P. N. J. N. C. C. Pearson, 2016: Public understanding in Great Britain of ocean acidification. 6, 763-767.
- [6] Chakravarty, S. and R. J. E. E. Mishra, 2019: Using social norms to reduce paper waste: Results from a field experiment in the Indian Information Technology sector. 164, 106356.
- [7] Charry, K. and B. J. E. E. R. Parguel, 2019: Educating children to environmental behaviours with nudges: the effectiveness of social labelling and moderating role of age. 25, 1495-1509.
- [8] Christenson, D. P., J. L. Goldfarb and D. L. J. E. P. Kriner, 2017: Costs, benefits, and the malleability of public support for "Fracking". 105, 407-417.
- [9] Dur, R., B. J. E. Vollaard and Behavior, 2015: The power of a bad example: A field experiment in household garbage disposal. 47, 970-1000.

- [10] Evans, L., G. R. Maio, A. Corner, C. J. Hodgetts, S. Ahmed and U. J. N. C. C. Hahn, 2013: Self-interest and pro-environmental behaviour. 3, 122-125.
- [11] Hine, D. W., N. Bhullar, A. D. Marks, P. Kelly and J. G. J. J. o. e. p. Scott, 2011: Comparing the effectiveness of education and technology in reducing wood smoke pollution: A field experiment. 31, 282-288.
- [12] Hofman, K. and K. J. E. E. R. Hughes, 2018: Protecting the Great Barrier Reef: analysing the impact of a conservation documentary and post-viewing strategies on long-term conservation behaviour. 24, 521-536.
- [13] Huber, R., B. J. B. S. Hirsch and t. Environment, 2017: Behavioral effects of sustainability-oriented incentive systems. 26, 163-181.
- [14] Jackson, M. and D. R. J. A. R. o. S. Cox, 2013: The principles of experimental design and their application in sociology. 39, 27-49.
- [15] Jagers, S. C., J. Martinsson and S. J. C. p. Matti, 2019: The impact of compensatory measures on public support for carbon taxation: An experimental study in Sweden. 19, 147-160.
- [16] Kaplowitz, S. A. and A. M. J. E. P. McCright, 2015: Effects of policy characteristics and justifications on acceptance of a gasoline tax increase. 87, 370-381.
- [17] Keane, R. and J. W. J. C. M. Smith, 2015: Information presentation of coastal morphological change: potential implications for perceptions of climate change impacts. 43, 651-667.
- [18] Kotcher, J. E., T. A. Myers, E. K. Vraga, N. Stenhouse and E. W. J. E. C. Maibach, 2017: Does engagement in advocacy hurt the credibility of scientists? Results from a randomized national survey experiment. 11, 415-429.
- [19] Liao, Z., J. J. C. S. R. Cheng and E. Management, 2020: Can a firm's environmental innovation attract job seekers? Evidence from experiments. 27, 542-551.
- [20] Liebe, U., A. Bartczak and J. J. E. P. Meyerhoff, 2017: A turbine is not only a turbine: The role of social context and fairness characteristics for the local acceptance of wind power. 107, 300-308.
- [21] Maan, S., B. Merkus, J. Ham and C. J. E. E. Midden, 2011: Making it not too obvious: the effect of ambient light feedback on space heating energy consumption. 4, 175-183.
- [22] Martin, S., N. J. J. o. t. A. o. E. Rivers and R. Economists, 2018: Information provision, market incentives, and household electricity consumption: evidence from a large-scale field deployment. 5, 207-231.
- [23] McCoy, D. and S. J. E. E. Lyons, 2017: Unintended outcomes of electricity smart-metering: trading-off consumption and investment behaviour. 10, 299-318.
- [24] Nicolson, M., G. Huebner, D. J. E. r. Shipworth and s. science, 2017: Are consumers willing to switch to smart time of use electricity tariffs? The importance of loss-aversion and electric vehicle ownership. 23, 82-96.
- [25] Shen, S. V., B. E. Cain and I. J. E. P. Hui, 2019: Public receptivity in China towards wind energy generators: A survey experimental approach. 129, 619-627.
- [26] Steinhorst, J. and E. J. E. P. Matthies, 2016: Monetary or environmental appeals for saving electricity?—Potentials for spillover on low carbon policy acceptability. 93, 335-344.
- [27] Van der Linden, S., A. Leiserowitz and E. J. J. o. E. P. Maibach, 2019: The gateway belief model: A large-scale replication. 62, 49-58.
- [28] Van Der Linden, S. J. E. and Behavior, 2015: Exploring beliefs about bottled water and intentions to reduce consumption: The dual-effect of social norm activation and persuasive information. 47, 526-550.
- [29] Vlaeminck, P., T. Jiang and L. J. E. E. Vranken, 2014: Food labeling and eco-friendly consumption: Experimental evidence from a Belgian supermarket. 108, 180-190.
- [30] Walker, B. J., D. Russel, T. J. E. Kurz and Behavior, 2017: Community benefits or community bribes? An experimental analysis of strategies for managing community perceptions of bribery surrounding the siting of renewable energy projects. 49, 59-83.
- [31] White, M. P., A. Weeks, T. Hooper, L. Bleakley, D. Cracknell, R. Lovell and R. L. J. M. P. Jefferson, 2017: Marine wildlife as an important component of coastal visits: the role of perceived biodiversity and species behaviour. 78, 80-89.
- [32] Zhang, L., C. Sun, H. Liu and S. J. E. E. Zheng, 2016: The role of public information in increasing homebuyers' willingness-to-pay for green housing: Evidence from Beijing. 129, 40-49.