Resources, Conservation & Recycling 129 (2018) 219–231

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full Length Article

Spillover effects of household waste separation policy on electricity consumption: Evidence from Hangzhou, China

Lin Xu[a], Xiaoling Zhang[b], Maoliang Ling[a,*]

[a] School of Public Affairs, Zhejiang University, Hangzhou, Zhejiang Province, China
[b] Department of Public Policy, City University of Hong Kong, Hong Kong, China

ARTICLE INFO

Keywords:
Pro-environmental behaviours
Spillover
Monetary incentives
Information campaign

ABSTRACT

China's sudden growth in solid waste production and energy consumption is challenging the government more severely than ever. The aims of this study are three-fold, to: (1) test how much intervention policies requiring householders to dispose different types of waste into separate receptacles, currently implemented in pilot cities such as Hangzhou, indirectly affect household electricity consumption; (2) investigate the importance of the form of policies (information campaigns vs. monetary incentives) and the difficulty of adopting waste disposal behaviour in considering this "spillover" effect; and (3) examine the dynamic changes of positive and negative spillover effects. Based on three-year objective panel data of two samples of Hangzhou households, this study confirms the existence of spillover, showing that, in contrast with monetary inducements, the information campaign disseminating the environmental advantages of waste separation promoted a positive spillover, although this may be influenced by difficulties in waste separation. However, positive spillover decreased more significantly over years than negative spillover, leading to the conclusion that policymakers should focus on how to maintain the positive spillover of such pro-environmental policies in the long-term.

1. Introduction

1.1. Background

A recent surge of theoretical and empirical studies has shown that a pro-environmental intervention, or policy, focusing on defined target behaviours could also indirectly affect the residents' other pro-environmental behaviours. For example, the need to separate the disposal of household waste into recycling and non-recycling bins may alert householders to their environmental responsibilities in general, manifesting in the more careful use of electricity for High Voltage Alternating Current (HVAC). This spinoff, or "positive spillover" (Thøgersen, 1999), as it is usually termed, has been detected in many domains such as energy consumption, waste disposal and climate governance (e.g. Lanzini and Thøgersen, 2014; Thøgersen and Noblet, 2012; Truelove et al., 2014; Steinhorst and Matthies, 2016). With the continuous and all-around environment crisis and limited success of direct environmental policies, especially in developing countries, knowledge of this spillover effect is clearly important for policymakers in developing improved pro-environmental strategies. Making simple and painless steps, such as providing information, incentives or facilities to encourage waste separation, functions as an indirect lever or "wedge" to obtain the far-reaching changes in consumption habits and lifestyles required to bring about the difficult private environmentally-friendly behaviours needed (Kunreuther and Weber, 2014; Vandenbergh et al., 2011; Allcott and Mullainathan, 2010; Steg and Vlek, 2009).

China is presently undergoing a speedy economic transition and huge ecological deterioration. Extreme energy consumption and the rapid growth of solid waste are approaching alarming levels because the pollution they have caused is becoming the main threat to both the quality of residential life and urban sustainable development. Households have been especially known to be responsible for the highest overall electricity consumption compared to the Service & Commercial, Agriculture & Forestry sectors,[1] as well as almost 9 percent of the total solid waste production of 246 large and medium cities (MEP, 2016), for which saving household electricity and waste separation are two major strategies in the environmental protection framework adopted by the Chinese government since the 1990s and early 21th century respectively. Governments and non-governmental organisations have advocated various large-scale awareness campaigns aimed at encouraging or inducing people to save household electricity,

* Corresponding author at: School of Public Affairs, Mengminwei Building, Zijingang Campus of Zhejiang University, Hangzhou, 310058, China.
E-mail addresses: xulin0707@zju.edu.cn (L. Xu), Xiaoling.zhang@cityu.edu.hk (X. Zhang), lingmaoliang@zju.edu.cn (M. Ling).
[1] Data source: http://www.theenergycollective.com/michael-davidson/335271/china-s-electricitysector-glance-2013 (Retrieved 28 September 2017).

http://dx.doi.org/10.1016/j.resconrec.2017.10.028
Received 14 February 2017; Received in revised form 22 October 2017; Accepted 23 October 2017
Available online 06 November 2017
0921-3449/

such as the annual nationwide "Energy Conservation Week" beginning in 1991, which focuses on disseminating information about the environmental and economic benefits of electricity conservation to the public through a variety of theme activities, but still with an average annual electricity consumption rise of 10.78% in the residential sector over 10 years.[1] The need for the majority to conserve electricity (Du et al., 2017), and the little success of the isolated campaigns to date, calls for an innovation in behavioural change strategies. As the UK Department for Environment, Food and Rural Affairs (DEFRA) advocates,

> [we] need to promote a range of behaviours as entry points in helping different groups to make their lifestyles more sustainable – including catalytic (or 'wedge') behaviours if identified through research"
>
> (DEFRA, 2008).

Recently, with "garbage sieges" (Wang, 2010) becoming increasingly serious in cities, the policy of separating household waste for disposal has been raised to an unprecedented level in China's main metropolises, e.g. Beijing, Shanghai, Hangzhou, Guangzhou, although public participation still needs to be improved due to a weak consciousness, ineffective waste management systems and other internal or external factors (Zeng et al., 2016; Zhang et al., 2016). Furthermore, the National Development and Reform Commission (NDRC) and Ministry of Housing and Urban-Rural Development (MoHURD) jointly issued their "Mandatory Waste Classification System Program (Draft)" on June 2016, highlighting the urgency and importance of this work. Opportunistically, the present study explores the extent to which the household waste separation policy contributes indirectly to saving household electricity and its trend over time. We choose household waste separation and electricity conservation as the study cases for three reasons. Firstly, they can help identify a behavioural lever, that is, electricity conservation that requires far-reaching changes in consumption habits and lifestyles[2] is usually more difficult to bring about than separating household waste, which is relatively simple, painless and easier to be influenced by government intervention (Wan et al., 2015). Meanwhile, both are the outcome of the residents' daily behaviours and account for a large share of the households' carbon footprint (Du et al., 2017; Gu et al., 2015; Tiefenbeck et al., 2013), indicating a highly practical value in the test for multiple effects of waste separation policies. Additionally, this investigation is also important for the generalization of behavioural spillover, which means that an initial action might change individuals' *cross-situational* motivations (e.g. identity, guilt and/or moral perception) and, in turn, change the performance in other domains (see Section 1.3), as waste and electricity related behaviours are not very closely associated. In brief, the policy of separating household waste may be worth pursuing more vigorously if it improves household electricity conservation behaviour (i.e. positive spillover) in the long-term, or modifying if it only produces a fleeting positive spillover or even actually increases electricity consumption over time, which is a form of *negative* spillover usually caused by a single-action bias or moral licensing effect (see Section 1.3).

1.2. Overview of the spillover effect

Prior studies have different opinions in defining spillover. Lanzini and Thøgersen (2014), for example, argue that behaviour spillover implies that acting in a pro-environmental way changes (increases or decreases) the likelihood or extent of adopting other pro-environmental behaviours (also see Steinhorst and Matthies, 2016; Thøgersen, 1999). Truelove et al. (2014) define the spillover as the effect of an intervention on subsequent behaviours not directly targeted by the intervention (also see Poortinga et al., 2013). They also point out the intervention includes any attempt to encourage such changes in behaviour such as a request, infrastructure provision, tax incentives, public education campaign or regulatory policy. In this paper, we adopt the latter view as the evidence confirming completely independent decision making free of such external forces as mass media, government or people around can hardly be found in realistic settings, and this can provide more direct and clearer implications for policymakers when taking into account situational factors inclusive of economic incentives and information dissemination. Hence, a positive/negative spillover means the potential/risk of an intervention to promote/inhibit subsequent pro-environmental behaviours.

Scott (1977) first introduced the concept of "spillover" from studies stemming from explorations of the relationships between different pro-environmental behaviours. Studies in the late 20th century discovered the potential relationships between individuals' waste recycling, green consumption, water conservation and other pro-environmental behaviours, and also carried out some preliminarily tests of the moderating effects of psychological and demographic factors on the cross-sectional correlations between multiple behaviours (e.g., Thøgersen, 1999; Berger, 1997; Weber, 1997). An intense discussion on spillover has been under way since 2000. Studies have examined the prospects for the generalization of individual responses in such various environmental domains as household energy consumption, waste disposal, commuting trips and climate change (e.g., Marian et al., 2014; Austin et al., 2011; Whitmarsh and Neill, 2010; Thøgersen, 2006; Thøgersen and Ölander, 2003). However, few have found evidence in support of the spillover argument, and with only small or modest effects (Truelove et al., 2014; Thøgersen and Ölander, 2003).

Meanwhile, some studies also provide evidence of spillover from private-sphere behaviours to environmental policy support (e.g. Steinhorst and Matthies, 2016; Thøgersen and Noblet, 2012; Thøgersen and Crompton, 2009; Truelove et al., 2016), which is a typical public-sphere behaviour, and usually of high importance because it can change the behaviours of groups and organisations by influencing public policies (Stern, 2000). For example, Thøgersen and Crompton (2009) theoretically explore the correlation between the simple steps of a marginal lifestyle change and support for painful but more effective policies, and draw attention to the possible limitations of spillover in public environmental campaigns that call for "do your bit" or "every little helps". In a subsequent study, Thøgersen and Noblet's (2012) survey of a random sample of residents in the U.S. state of Maine found that green consumerism indeed helped increase the acceptance of wind power policy. Conversely, in a creative experiment conducted by Truelove et al. (2016), democrats who recycled water bottles gave less support for a campus green fund than their counterparts in the control group, indicating negative spillover.

This paper focuses on the second meaning of spillover, which concerns the effect of an external behavioural intervention on pro-environmental behaviour unrelated to the intervention target, rather than pure correlation free of external forces or actions. The number of studies pertaining to this issue is increasing, however, they are mostly carried out in laboratory settings or with recruited university students, which may restrict the external validity of their conclusions (Lanzini and Thøgersen, 2014). Furthermore, the findings from a range of field studies are also inconsistent. For example, people exposed to an environmental-framed intervention for saving electricity are more likely to support low carbon policies (Steinhorst et al., 2015; Steinhorst and Matthies, 2016). Similarly, Poortinga et al.'s (2013) opportunistic field research of the effects of a plastic bag charging policy in Wales found, compared to England with no such policy, a higher identification with environment that could produce a positive spillover in the longer term but with no immediate waste-related change. In another field study, however, Tiefenbeck et al. (2013) found evidence of negative spillover

[2] For example, with the modernization and ageing population in China, such lifestyle-related factors as the larger dwelling size, the rising popularity of home appliances and old households predict the increased residential electricity demand (Zhou and Teng, 2013), which cannot be changed without the highly individual and collective costs.

when observing the effect of a water conservation campaign on household energy use, with households in their treatment group provided with water usage feedback conserving more water but also significantly increasing their electricity use compared with the control group. In other words, the water conservation intervention caused an increase in household energy usage instead.

1.3. Key psychological determinants of spillover

Several studies have reported the phenomenon of positive spillover, with limited consensus on its genesis mechanisms to date. Many psychological theories have been proposed to explain this effect, including goal theory, self-perception theory, cognitive dissonance theory and many learning theories (for a review, see Thøgersen and Noblet, 2012 or Thøgersen and Crompton, 2009), of which the behaviour consistency effect and social identity effect are widely accepted because of their great explanatory power of positive spillover (Truelove et al., 2014).

According to Abrahamse et al. (2005), Cialdini et al. (1995), Suh (2002) and Willis and Schor (2012), people have an intrinsic and/or social motivation to maintain *behaviour consistency* to avoid uncomfortable feelings due to *cognitive dissonance* and/or social criticism and sanctions from such spectators as family, friends, colleagues or the public who see them as "two-faced". Hence, these people are prone to act in an environmentally considerate way across domains. Exploiting this type of positive spillover is exemplified by the "foot-in-the-door" technique widely used in business marketing, environmental protection or other public education campaigns (Thøgersen and Crompton, 2009; Thøgersen and Noblet, 2012; Truelove et al., 2014) to persuade people to act in more difficult situations by encouraging them to adopt some simple and painless behaviours initially (Freedman and Fraser, 1966).

As an important component of a person's self-concept that embodies a group of beliefs about "who I am" (Myers, 2009), the perception of *social identity* also helps people determine their behavioural choices (Ariely and Norton, 2008; Burger and Caldwell, 2003; Van der Werff et al., 2013). Individuals are subordinate to specific social groups and their perceived identity as a member of these groups usually endows people with special feelings and values (Tajfel and Turner, 1979; Truelove et al., 2014). Generally, people with stronger social identities are more likely to follow the common goals of groups and adopt associated behaviours (Sturmer et al., 2003). Studies show that social identity theory extends to the realm of the environment, where acting in a pro-environmental way can make the identity of "environmentalists" more salient and further motivate them to engage in other pro-environmental behaviours (De Groot and Steg, 2007; Joireman et al., 2010; Schultz et al., 2007), which induces positive spillover. In other words, environmental identity can mediate positive spillover (Truelove et al., 2014) – a result also found in Van der Werff et al.'s (2013) two-year panel study of the relationship between eco-friendly vehicle driving and meat consumption.

Comparatively fewer studies have provided conclusive evidence of negative spillover, with the rebound, single-action bias and moral licensing effect universally acknowledged as the main factors involved (Thøgersen and Crompton, 2009; Thøgersen and Noblet, 2012; Truelove et al., 2014). The *rebound*, or "take-back", effect is widely discussed in economic and psychological studies. In economics, the rebound effect usually refers to the phenomenon of technological improvements in energy efficiency inevitably preceding increases in energy use (Schneider, 2010). This is explained as a macro or micro price effect, in that energy-saving technologies not only increase efficiency, but also at a lower price and increased disposability for consumers, which makes an incremental increase in energy consumption possible (Berkhout et al., 2000; Gillingham et al., 2013). However, Truelove et al. (2014) for instance, maintain that the spillover effect also results from a change in the disposition or motivation of a person's environmental behaviour independent of any financial drivers. Hence, psychological studies of spillover tend to focus on the role of motivation or preference.

The *single-action bias* effect suggests that individual perceptions of environmental risk or guilt for a previous environmental footprint and the necessity for subsequent and more environmentally beneficial behaviours tend to reduce after engaging in an initial single action that contributes to an incremental environmental improvement because negative mood states are usually aversive (Heath and Gifford, 2006; Leiserowitz, 2006; Lubell, 2002; Weber, 2006; Truelove et al., 2014). Single-action bias induces a subjective belief that environmental risk has been mitigated or minimized through one's own effort, together with an unwillingness to continue the environmental protection practice, triggering negative spillover (Thøgersen and Noblet, 2012; Truelove et al., 2014). Weber's (1997) survey of a sample of American farmers, for example, found farmers who complied with government requests for more environmentally friendly production practices to be less amenable to other measures or interventions proposed by the government. An alternative explanation is that decreased fear or perception of risk prompts people to reject continuation or support for farther-reaching and perhaps more environmentally beneficial practices after their initial single efforts (Weber, 2006).

In contrast with single-action bias which focuses on the mediation of risk perceptions or guilt (Truelove et al., 2014), the *moral licensing* effect highlights the determining function of moral self-image on an individual's choice (Zhong et al., 2009), so that a person's moral sense is strengthened after an ethical act such as environmental protection (i.e., moral cleansing). Most importantly, after initially engaging in easy and inexpensive environmental responsible practices based on their ethical contribution (Guagnano et al., 1994; Thøgersen and Crompton, 2009), people tend to reward themselves and feel less moral obligation. They may hold a blind efficacy such as "I have done my part" or even simply want to play a part in one ethical action to deflect any blame for inaction in another (i.e., "rest on one's laurels") (Thøgersen and Crompton, 2009). Hence, they are reluctant, or do not intend, to behave environmentally in other situations that are possibly more costly (Bamberg and Möser, 2007; Thøgersen and Crompton, 2009; Truelove et al., 2014; Steg et al., 2005; Stern, 2000). A recent investigation in Norway, for example, found that the owners of electric cars benefitting from a new car energy policy felt less moral obligation to act pro-environmentally in other areas (Klöckner et al., 2013). Similarly, Sachdeva et al. (2009) found people acting pro-socially to have a higher moral sense and less inclined to support local pollution control policies. These all provide evidence aligned with a moral licensing effect, in which people adjust their subsequent environmental behaviour choices in accordance with their own moral balance sheets.

1.4. Interventions and spillover

To date, researchers from a variety of disciplinary backgrounds have studied the genesis of behavioural spillover, while this kind of catalytic effect cannot be taken for granted and may be strongly contingent on contextual influences (Bamberg and Möser, 2007; Steinhorst and Matthies, 2016; Thøgersen and Crompton, 2009; Truelove et al., 2014). For practical purposes, it is also important to understand the difference in spillover caused by the various forms of intervention. Some clues exist in the few extant studies on this issue.

As Truelove et al. (2014) hypothesise, the reasons for people's initial pro-environmental behaviour influence their subsequent environmentally related decisions. Furthermore, people attributing their initial behaviours to an external cause, such as through coercion or monetary inducement by the government or other organisations, undermines the intrinsic environmental motivation or preference for subsequent pro-environmental behaviours. This means an intervention framed on financial incentives or enforcement by law probably highlights a monetary motivation or excessive reliance on the government and makes people feel less obliged to undertake other actions or accept moral obligations (also see Steinhorst and Matthies, 2016) − triggering a negative spillover. Especially, monetary incentives can also prompt a

calculation-based mode heavily weighting monetary considerations, which might lead to the classic rebound effect (Truelove et al., 2014). Meanwhile, what cannot be understated is the importance of internal attribution in perceiving the performance of a special behaviour as being motivated by environmental concern (Lanzini and Thøgersen, 2014; Steinhorst and Matthies, 2016; Thøgersen and Crompton, 2009; Truelove et al., 2014). Repeated practice reinforces the environmental motivation priming a specific behaviour (Thøgersen and Crompton, 2009). Furthermore, an environmental intervention (cuing people with environmental reasons for behavioural modification) usually renders the recognition or strengthening of a pro-environmental identity and helps people engage in an initial behaviour to live up to the role of an environmentalist (i.e. rule- or role-based decisions) (Steinhorst et al., 2015; Truelove et al., 2014). Consequently, such people are more likely to perceive themselves as "environmentalists" and endeavour to maintain this consistency or follow an environmental goal due to their strengthened identity (Baca-Motes et al., 2013; Cornelissen et al., 2008; Weber and Lindemann, 2007), positive spillover thus occurs.

Several experiments have demonstrated that an environmental framed intervention (e.g. sending participants email reminders to promote environmental philosophy) can effectively spur positive spillover, compared with the controversy surrounding the effect of monetary inducement (Lanzini and Thøgersen, 2014; Steinhorst et al., 2015; Steinhorst and Matthies, 2016). Steinhorst and Matthies (2016), for example, found participants faced with an environmentally framed intervention were more inclined to support low carbon policies than those exposed to monetary inducements. However, in another longitudinal work in Demark, students were encouraged to purchase "green" products by either the non-symbolic monetary incentives, inclusive of a sum compensating for the premium, and a lottery draw for some additional prizes, or verbal inspiration stressing the contribution to optimizing policy design and protecting the environment, with others studying in the same university serving as control groups. The results of this six-week intervention study, showed that students exposed to two types of interventions act more pro-environmentally in other private domains than the control groups, indicating that, contrary to common belief, *both* non-monetary and monetary framings could generate positive spillover (Lanzini and Thøgersen, 2014). It is possible, however, that differences between actual behaviour and policy support caused these two contrary findings, or the measurement error from self-reported data used by both studies.

Except for the behavioural attribution and individual decision-mode by which the analytical processing of intervention effects can be located, the difficulty of initial behaviour targeted by intervention or policy is also anticipated to influence the likelihood of spillover (Truelove et al., 2014). Behavioural difficulty is one of the fundamental dimensions describing the characteristics of pro-environmental behaviours (Thøgersen and Ölander, 2003; Truelove et al., 2014). In general, a difficult behaviour needs more investment in time, physical exertion and knowledge, and may seem more inconvenient and uncomfortable to execute (Thøgersen and Crompton, 2009). However, according to self-perception theory that treats past experience as a crucial reference when making decisions (Bem, 1972), people with more difficult experiences usually have more salient pro-environmental identities and therefore are more likely to participate in secondary pro-environmental behaviour (Cialdini et al., 1995; Gneezy et al., 2012; Truelove et al., 2014). Hence, a highly difficult initial behaviour resulting from the rigorous demands of environmental policies or campaigns would be more likely to trigger positive spillover. Conversely, people may not adopt follow-up actions because of the single-action bias or moral licensing effect when their past behaviours are much easier (Diekmann and Preisendörfer, 2003; Truelove et al., 2016). However, few studies to date have tested these assertions.

In sum, therefore, prior studies have already explored the nature, categories, genesis mechanisms and catalytic conditions involved in spillover (Evans et al., 2013; Poortinga et al., 2013; Thøgersen and Crompton, 2009; Thøgersen and Ölander, 2003; Truelove et al., 2016; Whitmarsh and O'Neill, 2010). However, the empirical results of diverse disciplines are often ambiguous and sometimes even conflicting (Lanzini and Thøgersen, 2014; Truelove et al., 2014). This may be because of individually mutable psychological states causing measurement errors in the widely used self-report of resident's behaviour (e.g. Lanzini and Thøgersen, 2014; Steinhorst and Matthies, 2016; Thøgersen and Noblet, 2012; Thøgersen and Ölander, 2003; Truelove et al., 2016), an artificial outcome motivated by internal consistency and social desirability, or a lenience effect caused by fleeting mood swings. However, these unexpected biases would not occur in the measurement of objective data (e.g. Tiefenbeck et al., 2013). More importantly, few intervention studies have been made (Lanzini and Thøgersen, 2014) and with no special assessment of any time trends. Moreover, although there is an increasing spillover literature, all focus on cases from developed countries. It is crucial, therefore, to examine this effect in developing countries because of their different forms of government, economies, environmental and social cultural conditions.

Based on data from the city of Hangzhou, this paper presents the first spillover study from China in investigating the extent to which household waste separation policies lead to household electricity conservation over time, as well as the importance of the types of interventions and characteristics of targeted behaviours in considering this spillover effect.

2. Hypotheses

Currently, the advocacy and education carried out by local governments and community neighbourhood committees are the main measures to encourage waste sorting and recycling in China. These awareness campaigns are environmentally framed interventions that provide residents with information concerning the environmental benefits of waste separation and how to perform the behaviour correctly. Meanwhile, monetary incentives have also been implemented in some areas, such as "using behaviour credits as an alternative currency to pay for life necessities", to induce residents by means of financial rewards, indicating that people can acquire different amounts of credits contingent on their separation performance and trade them for commodities. Raising awareness of the need to separate waste can increase people's environmental reasoning and identity, as well as their motivation and willingness to maintain behavioural consistency. Consequently, the people accustomed to waste separation may be more inclined to save household electricity. On the other hand, the goods redeemed by the disposal separation credits bring residents an additional income and reduce their daily expenses on necessities, which may increase their wasteful behaviour – a kind of rebound effect. Furthermore, the recipients of monetary inducements may also attribute their initial behaviour to a financial inducement, which cannot help them improve their moral obligation or environmental necessity, as well as the awareness to participate in another environmental action not sponsored by a monetary reward. Therefore, a monetary framed intervention makes it more likely to trigger a negative spillover from household waste separation to household electricity saving. Hence, we hypothesise that

H1a. There is a positive spillover of household waste separation to electricity-saving behaviour when residents are exposed to an awareness campaign relevant to the environmental significance of separation

H1b. There is a negative spillover of household waste separation to electricity-saving behaviour when residents actually earn monetary rewards from separation activities.

Households in Hangzhou are supplied with waste bags by neighbourhood committees and asked to load the bags with rubbish before dumping. In one of our observation fields, the inspectors assess the

quality of waste separation in terms of dumping and separating accuracy, which manifests in two standards of policy implementation. More specifically, dumping accuracy requires the disposal of waste bags to separate bins, compared to which the separating accuracy not only requires putting each kind of waste bag into its correct corresponding bin, but also the correct type of waste. The pure dumping behaviour is quite easy because people only need to match bags with the bins of the same colour. In other words, mixed or incorrectly separated household waste disposal still occurs if residents discard waste bags regardless of their content, especially when people are short of time or patience, unfamiliar with complicated guidance information and standards, or not provided with a sufficient amount of waste bags (Xu et al., 2017). Hence, waste separating accuracy measures a more difficult waste related behaviour than pure dumping accuracy. Therefore, people who maintain correct separating habits may have a more salient environmental identity and, as outlined above, are more likely to play an active role in saving household electricity (Truelove et al., 2014). Consequently, we hypothesise that

H2. Positive spillover is stronger when households initially perform a more difficult behaviour, such as separating waste into both correct bags and bins, than simply dumping waste bags into corresponding bins

A careful review of the literature confirms that few studies investigate behavioural spillover based on long-term panel (e.g. Steinhorst and Matthies, 2016; Thøgersen and Ölander, 2003). This is especially the case when there is no discussion of changing trends over time or the underlying mechanism behind this form of effect. Environmental education can increase a person's identification with greenness by information dissemination, knowledge transfer, spiritual inspiration and social mobilisation (Truelove et al., 2014). However, a long-term propaganda campaign may also risk leading to a decline in positive spillover, as supported by Steinhorst and Matthies' (2016) experimental evidence. In their first follow-up assessment almost one year after the pre-test, a pairwise comparison of participants with strong ecological norms showed a significant positive spillover to the acceptability of low carbon policies in the environmental framing group. This, however, had disappeared by the second follow-up assessment some time later. Meanwhile, they did not find any significant effects for participants with a weak personal ecological norm throughout the whole experiment. One possible explanation for this trend is the recipients' *defensive response* resulting from a highly pressured manner and low ecological norm (Schwartz and Howard, 1981; Steinhorst and Matthies, 2016). When an environmental appeal or argument is presented in a heavily pressured and repeated way and becomes a prime debate in society, the recipients, especially those with weak personal ecological norms, can become averse to the perception of being manipulated and suspicious of the motivation of the advocates. Consequently, they might turn to a denial of necessity and take a defensive reaction to subsequent environmentally responsible behaviours. This is especially the case in China, where the integral social level of ecological concern is still poor and environmental education resources for household waste separation are relatively scarce (Xu et al., 2017). Mission-based mobilisation is the government's most common strategy, the monotonous content, unitary technique and mobilised manner from top to bottom can easily result in a defensive reaction and an undermining of the necessity to perform such other pro-environmental public behaviours as electricity saving in the long term. Instead, monetary inducements would lessen the environmental responsibility and strengthen the external attribution for recipients (Steinhorst et al., 2015; Thøgersen and Crompton, 2009). Meanwhile, additional income and increased budget for electricity use might help households develop high-energy consumption habits and lead to an inability to change their lifestyle due to the ratcheting effect involved (Freeman et al., 2016). In other words, this framing for waste separation activities might strengthen a proclivity to "chase the Yuan" and consumerism, making people less willing to save electricity due to the dilution of their environmental concern and increased reluctance to adjust their energy consumption habits. Hence, we hypothesise that

H3. Waste separation education is more likely to reduce positive spillover in the long term, while negative spillover triggered by monetary inducement remains stable.

3. Materials and methods

3.1. Sample selection

The samples studied derive from the households of two residential areas named JBL and MLC in Hangzhou city. There are three main reasons for choosing these two areas. Firstly, the notion of disposing different kinds of waste separately occurred relatively late in China and a vast majority of local governments have yet to carry out a census or even a sample survey of household separation activities, which has led to a severe lack of statistics. As one of the first pilot cities in China, Hangzhou has adopted waste separation for 16 years. However, only JBL and MLC have collected waste separation statistics in their own areas, which provides valuable data for this study. Secondly, the different methods of household waste separation adopted in the two areas can help us examine the effects of environmental and financial oriented interventions on spillover. More specifically, the community neighbourhood committee in MLC has been promoting waste separation education campaign by organising door-to-door interviews and other volunteer activities to provide monthly information on the households' necessity for, and knowledge of, waste separation since 2012, which can be regarded as an environmental framed intervention. Moreover, the JBL committee has applied a monetary inducement since late 2013 in the form of consumer credits redeeming life necessities to induce participation in waste separation. Thirdly, although these two areas adopt different intervening methods for waste separation, they belong to the same sub-district, are adjacent to each other and have strong similarities in their external environment such as socio-economic, institutional culture, population structure and community construction, which makes this study more controllable and reliable.

We conducted a panel study to capture the annual average spillover effect over a three-year period, as annual statistics can more efficiently address the impact of seasonal temperature conditions, consumption changes during holidays and other disruptive factors on household activities. The commencing year of the study is 2014, when the two areas first started to assess household waste separation. Indigenous households that had resided in our observation areas before 2014 (357 in JBL and 578 in MLC) were randomly selected and surveyed based on a sampling proportion of 30%, with four criteria used to screen the families in order to avoid the potential bias of the external schooling, population and occupational mobility of family members during the observation period. Firstly, the families must have resided in these two areas from 2014 to 2016, with no influx of new members (e.g. new born) or outflow of permanent residents (e.g. long-term or frequent travel, hospitalisation or deaths). Secondly, all members of the families must have been in continuous employment or residence in Hangzhou and not receiving schooling. Thirdly, they self-occupied their residence rather than renting out. Fourthly, the household activity data of electricity use and waste separation must be complete for the whole period. This resulted in data for 121 households, of which 57 were in JBL and 64 in MLC. These limited samples are the aggregated result of the small size and high mobility of the population in the two areas as well as data availability.

The average family size of the JBL and MLC samples is 3.1 and 2.5 respectively. The gender ratio of 62% of families is one to one, and the average proportion of female members per family is 46.1% in JBL and 50.9% in MLC. Nearly 64% of the families have members with a high school education or above, and the average proportion of members with

this education level in one family is 32.4% in JBL and 40.5% in MLC. The age distribution of 118 households basically remained stable during the observation period, the average proportion of members aged 60 or above in one family was 23.9% in 2014 (23.3% in JBL and 24.4% in MLC) and 25.4% in 2016 (25.6% in JBL and 25.2% in MLC).[3] Furthermore, the non-parametric *Mann-Whitrney U* test was used due to the abnormal distribution of the data relating to household characteristics, indicating a significant difference in family size ($p = 0.002$), the proportions of elders ($p = 0.087$) and members with a high school education ($p = 0.052$) between the two samples.

3.2. Variables and data collection

Exploring the different relationships between targeted and non-targeted behaviours under different household waste-separation intervention regimes is the main way to test their spillover effect. In this case, electricity usage is the explained variable measured by the natural logarithm of annual amount of household electricity consumption.

We measured waste separation behaviour, the key explanatory variable in our study, differently in the two areas due to data availability. JBL uses intelligent bins provided by CK Environmental Co., Ltd. for waste separation. The community neighbourhood committee sends to each household four types of garbage bags of the same size but different colour linked to different type of waste. Unique QR codes are attached to every bag help the company or committee track the waste from door to door. Residents are required to drop their garbage into intelligent bins scattered over the neighbourhood. As one of the daily services sponsored by the local government, the company staff check each bag thrown away every evening and evaluate it by the correctness of dumping (throwing different waste bags into their corresponding bins) and separation (dividing and packing garbage into appropriate bags), before shifting the refuse to a disposal plant. Specifically, they record the scores for each bag according to a grading system comprising four levels of excellence (correct dumping and accurate separation), goodness (correct dumping but not very accurate separation), qualification (correct dumping but inaccurate separation) and disqualification (wrong dumping). Residents could gain greater scores at the higher level but nothing for disqualification, and the difference in credits between two adjacent ranks is increasing with the level (e.g. the gap between excellence and goodness is bigger than that between goodness and qualification). Finally, the system automatically groups all credits inputted for the same family into a single account. Therefore, higher scores reflect more accurate separation behaviour and hence greater redemption of commodities in the company's stores. We adopted the natural logarithm of the annual sum of these credits to measure the separation behaviour of the JBL households.

For MLC, there are waste disposal bins placed outside the door of every apartment[4] and the community neighbourhood committee's inspectors (social workers and volunteers) send four types of garbage bags to each family, that are identical to those distributed in the JBL households but lack a QR code. They then check the bins and dumped bags every night, and count the bags dropped, dumped into correct bins and loaded with the correct type of waste respectively, prior to emptying the garbage bins and calculating each household's dumping and separation accuracy rates. The former is evaluated by the ratio of garbage bags correctly dumped into their corresponding bins by a family to the total this family throws away during a certain period, while the separation rate is calculated by a more stringent proportion of bags both dumped correctly and filled with required type of waste. We averaged the monthly dumping and separating rates within each year to approximate the yearly ones and measure the dumping and separation performances of the MLC households.[5]

Prior research suggests that common environmental concerns and community affinities may influence their environmental footprints (Merrill and Sintov, 2016; Thøgersen and Noblet, 2012), making it more likely that people with more environmental concerns and affinity to the community will adopt both waste separation and electricity conservation. To consider these in measuring behavioural spillover, we counted the number of family attendances at monthly environmental protection activities such as lectures and fun contests hosted by community neighbourhood committee each year. To reflect the connection to the community, a dummy variable shows whether family members had been social workers, volunteers or joined social organisations of the residential community in this year. We also measured annual disposable household income on a scale of 1–19 (10,000 RMB as one unit of income level, 1 = 60,000 RMB or below, 19 = 24,0000 RMB or above). The family size, gender and education structures of members are stable because there was no residential population flow during the observation period and the age distribution changed little. However, these time-invariant variables may also influence the separation and electricity consumption behaviours simultaneously. For example, the larger households might use more electricity and also produce and recycle more waste. To minimise the influence of these time-invariant variables, we separately counted the number of household members, proportion of females, members with high school education or above, and elders (aged 60 or above), as well as the natural logarithm of the apartment area, and further calculated the interactions between the household characteristics and waste separation performance data.

In terms of the analytical strategy, we conducted three regressions to fit the relationships between the variables mentioned above, of which one used credits as the proxy for household performance in waste separation, and the other two used either the separating or dumping rate to measure waste related behaviour. Furthermore, we compared the regression results concerning the dumping and separating rates to test H2. That is, the dumping and separating accuracy rates actually measure two kinds of waste disposal behaviours performed by households in MLC based on the same calculation method (the proportion of bags conforming to a certain standard), which can help compare the magnitudes of positive spillover and test the influence of the difficulty of the targeted behaviour. We also compared the separating rates and credits to test H1a, H1b and H3. More specifically, although the credits scored in JBL and separating accuracy rate calculated in MLC are different in evaluation and data processing, both indicate the separating accuracy of dumping garbage into corresponding bags and bins. In other words, the residents' higher scores or higher rates can be construed as indicating their better engagement in waste separation and *vice versa*. In this way, the different statistics allow a comparison of the different directions or polarities of the effects of the two interventions instead of their absolute strength, given that the main household characteristics have been controlled and the macro situation of two

[3] Because the age structures of only 4 households (2 in JBL, 2 in MLC) changed during the observation period, we treated the proportion of elders as a time-invariant variable and used the age data in 2015.

[4] Basically, the required effort of waste dumping in MLC is lower than that in JBL, as residents in JBL need to go downstairs to dump their garbage (see the description of the measure about waste related behaviour for JBL sample). As discussed earlier, the easier targeted behaviour is more likely to decrease follow-up behaviour (Truelove et al., 2014). Therefore, this difference might reduce the chance of positive spillover being observed in MLC.

[5] We cannot calculate the yearly dumping or separating rate because the committee had lost the numbers of trash bags counted in 2014 and 2015. However, the average of the monthly rates is a good proxy variable for the yearly ratio, that is, the incremental change in average of monthly dumping/separating rates must mean an increase in the proportion of trash bags consistent with accurate dumping/separating criterion to the total, and vice versa. The measurement error or difference between these two metrics only depends on the distribution of monthly total trash bags of a household within a year, which is not related to any metric. Hence, this operation would not threaten the unbiasedness and effectiveness in subsequent estimation (Wooldridge, 2003).

Table 1
Descriptive statistics of the time-variant control variables.

Residential areas	Year	Environmental concern (Continuous variable)				Affinity to Community (Dummy variable)				Disposable household income (Ordinal variable)			
		Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
JBL	2014	3.158	1.473	0	6	0.386	0.491	0	1	4.193	0.854	2	6
	2015	2.702	1.439	0	6	0.298	0.462	0	1	4.439	0.887	2	6
	2016	3.158	2.051	0	8	0.246	0.434	0	1	5.298	0.865	3	7
MLC	2014	3.453	1.284	0	6	0.781	0.417	0	1	4.422	0.662	3	6
	2015	2.984	1.240	0	6	0.766	0.427	0	1	4.641	0.675	3	6
	2016	2.500	1.613	0	6	0.531	0.503	0	1	5.250	1.069	4	8

areas is basically the same (see Section 3.1), even though there is a comparative measurement error.[6] Hence, it is possible to distinguish between the positive and negative spillover produced by the two types of policy measures and their own dynamic changes.

The data collected and used for this research come from various resources. Household electricity usage is from the Hangzhou power supply company; the waste separation and dumping accuracy ratios are from the MLC community neighbourhood committee; classifying credits from CK Environmental Co., Ltd.; and data for the control variables from the neighbourhood committee records of two residential areas and surveys of households. Tables 1–3 provide the descriptive statistics of the variables used in the empirical analysis.

Table 3 also shows the variability and stability of the household waste separation and electricity use. The mean values of household waste separation of the samples are close to those of the general population in both areas, and the mean values of the classifying credits increased yearly and with highly significant ($p < 0.01$) ANOVA differences, indicating an obvious improvement in the average level of household waste separation under JBL's monetary inducement scheme. However, the MLC mean values of the dumping and separating accuracy rates are essentially the same, with the ANOVA differences not statistically significant, which indicates the average waste separation of the MLC households remained stable and high during 2014–2016. The insignificantly decreasing benefit of the single publicity policy launched in late 2012 can be ascribed to some extent to reaching the limitation and the regression towards the mean in considering the direct effect of a prolonged behavioural intervention (Cohen et al., 2003; Lanzini and Thøgersen, 2014). Nevertheless, these high values still indicate an effective environmental education campaign and the active and continued separation participation during the observation period,[7] which might influence individuals' cross-situational motivation (e.g. pro-environmental identity) and then render behavioural spillover (Truelove et al., 2014). The average electricity consumption in the samples increased significantly from 2014 to 2016 ($p < 0.01$), with a higher growth in JBL, and was also slightly lower than the population in both areas, which might be due to the larger energy usage of the community stores excluded from this study. Moreover, the two pro-environmental behaviours were highly stable from 2014 to 2016 (all correlation coefficients greater than 0.48 and $p < 0.01$), which means the balance of forces determining household waste separation and electricity use behaviours remained unchanged (Ajzen, 2002; Thøgersen and Ölander, 2003).

3.3. Econometric model

As the two main analytical models for panel data, the two-way fixed and random effect model can more efficiently mitigate the potentially endogenous bias resulting from the omitted variables problem than ordinary least square regression by means of controlling for the unobserved individual effect at different time points and the overall time effect. Their difference lies mainly in the relationship between the individual effect and explanatory variables (correlation in the fixed effect model but zero correlation in the random effect model). Due to the different measurements of household waste separation behaviour, the *Hausman* test was used to confirm the specific form of panel model for each regression, where waste related behaviour was measured by either credits or one of the two accuracy rates. Both ordinary and robust Hausman tests[8] indicated the applicability of the fixed effect model regardless of the measures, which was therefore chosen to examine the

[6] Two steps, including a mathematical deduction help elaborate this. We will first assume that the scoring and separating rate are both applied to the sample in JBL. Let y_i denote the natural logarithm of household electricity usage, then $y_i = \beta_0 + \beta_1 x_{1i} + \sum_2^k \beta_k x_{ki} + u_i$, where x_{1i} is the natural logarithm of household separating scores, x_{ki} is any other potential control variable, $\beta_1 to \beta_k$ are their coefficients, β_0 and u_i represent the intercept and disturbance separately. In accordance with Gauss-Markov assumptions, we can also obtain $E(u_i|X) = 0$. Furthermore, let m_{1i} denote the household waste separating rate, then $m_{1i} = x_{1i} + e_{1i}$, e_{1i} is the potential measurement error when substituting m_{1i} for x_{1i}. Therefore, $d(x_{1i})/d(m_{1i}) > 0$ since scores increase with the proportion of the number of bags conforming to the accurate separating standard. Because $d(y_i)/d\left(x_{1i}\right) = d[\beta_0 + \beta_1 x_{1i} + \sum_2^k \beta_k x_{ki} + u_i]/d(x_{1i}) = \beta_1$, $d(\beta_0)/d(x_{1i}) = 0$, and $d(u_i)/d(x_{1i}) = 0$ $(E(u_i|X) = 0)$, we have $d\left(\sum_2^k \beta_k x_{ki}\right)/d(x_{1i}) = 0$. Moreover, $y_i = \beta_0 + \beta_1 m_{1i} + \sum_2^k \beta_k x_{ki} + u_i - \beta_1 e_{1i}$ in that $m_{1i} = x_{1i} + e_{1i}$. Hence . Hence $d(y_i)/d(m_{1i})$ shares the same symbol but actual size with $d(y_i)/d(x_{1i})$ in that $d(x_{1i})/d(m_{1i}) > 0$ and $x_{1i} \neq m_{1i}$, which indicates that the direction of spillover would not altered if ratings were used to analyse the behaviours practised by a group of JBL residents. The estimation bias due to the missing explanatory variable, however, comes from our case where $cov(m_{1i}, e_{1i}) \neq 0$, and $cov(m_{1i}, u_i - \beta_1 e_{1i}) \neq 0$ (and $cov(x_{1i}, e_{1i}) \neq 0$ since$d(x_{1i})/d(m_{1i}) \neq 0$), which would lead to inaccurate significance tests of explanatory variables (Wooldridge, 2003). To be precise, the separating rate cannot present the situation characterized by grades "goodness" or "qualification" existing in JBL, which means there is an inconsistency (comparative measurement error) between two measures, especially when the mixed waste disposal prevails. Fortunately, this situation was uncommon in JBL during our observation period because of a much stronger incentive from the grade "excellent" compared with the other two levels. Meanwhile, we have also incorporated many variables, possibly resulting in mixed separation such as household size and environmental identity into our two-way fixed model, it seems we could mitigate the bias resulting from this type of error effectively. Therefore, a difference in direction of spillover found between two samples in JBL and MLC, if so, may be more likely due to the differentiable effects of framed interventions and the heterogeneities of time-variant and −invariant household characteristics. Obviously, the former is what we want to test, given the latter could be controlled through a series of econometric methods.

[7] According to a preliminary survey conducted by the neighbourhood committee, nearly 95% of households in MLC did not engage in separation activities before the promotion of waste separation, indicating the very low participation at the beginning. After this long-term intervention, all households have performed waste separation in late 2016, with 91% dumping accuracy and 83% separating accuracy averagely (as described in Table 3), which also supports the effectiveness of the education campaign in MLC.

[8] The ordinary Hausman test may not work well when cross-sectional dependence, autocorrelation or heteroscedasticity exists in the longitudinal data, which could be diagnosed by means of *Pesaran's* test, *Wooldridge* test and *Wald* test respectively. According to the test results, cross-sectional dependence was not the case in our study; autocorrelation only existed when credits was involved ($F = 59.330$, $p = 0.000$); heteroscedasticity always existed no matter how the waste behaviour was measured (all Chi-square values were significant at 1% level). Therefore, we also conducted robust Hausman tests by introducing a weighted least squares auxiliary regression. Full details can be found in Arellano (1993).

Table 2
Descriptive statistics of the time-invariant control variables.

Residential areas	Statistics	Household size (count)	Female (proportion)	Elder (proportion)	Education (proportion)	Housing area (natural logarithm)
JBL	Mean	3.12	0.46	0.26	0.32	4.60
	SD	1.17	0.17	0.33	0.32	0.19
	Min	1	0	0	0	4.29
	Max	6	0.8	1	1	4.92
MLC	Mean	2.50	0.51	0.25	0.41	4.58
	SD	0.67	0.12	0.38	0.37	0.14
	Min	2	0.33	0	0	4.45
	Max	4	1	1	1	4.91

Table 3
Variability and stability of household waste separation and electricity use behaviours (2014–2016).

Residential areas	Variable	Mean[a]			Mean[b]		ANOVA[b](F-Value)		Correlation[b]		
		2014	2015	2016	2014	2015	2016		(2014–2015)	(2015–2016)	(2014–2016)
JBL	Classifying credits (natural logarithm)	6.318	7.504	8.254	6.615	7.367	8.083	13.80***	0.871***	0.582***	0.486***
	Household electricity usage (natural logarithm)	7.967	8.029	8.227	7.710	7.907	8.075	7.31***	0.814***	0.849***	0.690***
MLC	Dumping accuracy rate (%)	88.551	89.127	91.251	89.891	89.813	90.844	1.15⁻	0.773***	0.784***	0.536***
	Separating accuracy rate (%)	84.103	84.113	82.926	84.156	83.188	82.843	1.52⁻	0.821***	0.766***	0.821***
	Household electricity usage (natural logarithm)	7.733	7.814	8.099	7.724	7.777	7.938	26.04***	0.883***	0.830***	0.780***

[a] Population statistic.
[b] Sample statistic.
*** $p < 0.01$.
⁻ $p > 0.1$.

relationships between electricity use and the explanatory variables in the form:

$$electricity_{it} = \beta_0 + \beta_1 classifying_{it} + \beta_2 envir\_convern_{it} + \beta_3 com\_affinity_{it} + \beta_4 income_{it} + \sum_{k=1}^{2} \gamma_k year_{kit} + \sum_{k=1}^{2} \delta_k classifying_{it} * year_{kit} + \sum_{m=1}^{5} \theta_m classifying_{it} * \boldsymbol{X}_{mit} + \alpha_i + \varepsilon_{it}$$

In this model, $electricity_{it}$, $envirconcern_{it}$, $comaffinity_{it}$ and $income_{it}$ respectively represent electricity usage, environmental concern, community affinity and disposable income of household i in year t, $classifying_{it}$ refers to the logarithm of credits, the rate of dumping or separating accuracy, $year_{kit}$ is a dummy variable of year 2015 or 2016 to control the time effect, the vector $\boldsymbol{X}_{mit}$ represents the household characteristics variables, $classifying_{it} * year_{kit}$ represents the interaction terms between household waste separation and the year dummy variables, $classifying_{it} * \boldsymbol{X}_{mit}$ represents the interaction terms between waste-related behaviour and the household characteristics variables, β_0 is the intercept term, β_1 to β_4, γ_1 to γ_2, δ_1 to δ_2, θ_1 to θ_5 are the corresponding coefficients of the independent variables, α_i represents the entity fixed effect and ε_{it} is the random disturbance error.

4. Results

In order to avoid potential bias from multicollinearity and the difficulty in comparing the relative impact of different dimensional determinants within the same regression, all the non-dichotomous variables were standardized before fitting and evaluating the model.[9] Three regressions were used to fit the relationship between the explained and explanatory variables, with the *Rogers* or *clustered* standard errors for coping with heteroscedasticity and autocorrelation in our panel data. Table 4 summarises the results.

Firstly, consistent with H1a, 'classification (separating accuracy)' have a significantly negative relationship with 'electricity', which suggests that the act of separating household waste has a positive spillover effect on reduced electricity consumption when residents receive an environmental education. In addition, consistent with H1b, 'classification (credits)' has a significantly positive relationship with 'electricity', which indicates that households encouraged to separate their waste by monetary inducement are more likely to increase their electricity usage. Secondly, compared with 'classification (separating accuracy)', 'classification (dumping accuracy)' have an insignificantly negative impact on 'electricity', that is, positive spillover only occurs between waste separation behaviour and electricity saving, which supports H2 – that positive spillover resulting from the performance of more difficult initial behaviour, such as waste separation, is stronger. Thirdly, the value of the interaction term shows that 'classifying (credits)*$year_{2015}$' and 'classifying (credits)*$year_{2016}$' have an insignificantly negative relationship with 'electricity', while 'classifying (separating accuracy)*-$year_{2016}$' have a significantly positive relationship with 'electricity'. This indicates that, as H3 expects, positive spillover resulting from education and mobilisation is more likely to reduce over time. Interestingly, however, the weak negative relationship between waste dumping behaviour and electricity use had been declining and turned positive in the third year ($-0.064 + 0.193 = 0.129$).

For the time-variant control variables, the three regressions all indicate a negative relationship between environmental concern and

[9] The value of each variable's *VIF* (Variance Inflation Factor) is below 4, one of the common threshold values over which multicollinearity significantly affect the efficiency of regression estimation (Grazhdani, 2016), in three models (Min = 1.05, Max = 3.13, Mean = 1.81 in Model 1; Min = 1.14, Max = 3.97, Mean = 1.87 in Model 2; Min = 1.15, Max = 3.98, Mean = 2.02 in Model 3), which reflects that multicollinearity did not pose a significant threat to our estimates.

Table 4
Spillover-effect test results.

Explanatory variable	Explained variable: electricity		
	1(JBL)	2(MLC)	3(MLC)
classifying (credits)	0.352***		
	(0.107)		
classifying (dumping accuracy)		−0.064	
		(0.078)	
classifying (separating accuracy)			−0.272***
			(0.084)
envirconcern	−0.169**	−0.100**	−0.061
	(0.072)	(0.041)	(0.044)
comaffinity	−0.128	−0.080	−0.087
	(0.175)	(0.099)	(0.089)
income	0.097	0.053	0.048
	(0.066)	(0.077)	(0.075)
$year_{2015}$	0.132**	0.218***	0.177***
	(0.064)	(0.061)	(0.042)
$year_{2016}$	0.297**	0.948***	0.944***
	(0.132)	(0.100)	(0.089)
classifying (credits)*$year_{2015}$	−0.137		
	(0.120)		
classifying (credits)*$year_{2016}$	−0.034		
	(0.109)		
classifying (dumping accuracy)*$year_{2015}$		0.054	
		(0.066)	
classifying (dumping accuracy)*$year_{2016}$		0.193**	
		(0.086)	
classifying (separating accuracy)*$year_{2015}$			−0.001
			(0.061)
classifying (separating accuracy)*$year_{2016}$			0.178**
			(0.077)
classifying (credits)*householdsize	−0.133*		
	(0.072)		
classifying (credits)*female	0.002		
	(0.076)		
classifying (credits)*education	0.021		
	(0.144)		
classifying (credits)*elder	−0.085		
	(0.115)		
classifying (credits)*housingarea	−0.043		
	(0.077)		
classifying (dumping accuracy)*householdsize		−0.016	
		(0.087)	
classifying (dumping accuracy)*female		−0.041	
		(0.050)	
classifying (dumping accuracy)*education		−0.044	
		(0.077)	
classifying (dumping accuracy)*elder		0.043	
		(0.100)	
classifying (dumping accuracy)*housingarea		−0.005	
		(0.075)	
classifying (separating accuracy)*householdsize			−0.247**
			(0.124)
classifying (separating accuracy)*female			−0.072
			(0.068)
classifying (separating accuracy)*education			0.129*
			(0.073)
classifying (separating accuracy)*elder			0.157
			(0.104)
classifying (separating accuracy)*housingarea			0.183*
			(0.098)
intercept term	−0.081	−0.351***	−0.313***
	(0.100)	(0.092)	(0.079)
N	171	192	192
R^2	0.523	0.741	0.779
Number of households	57	64	64

Rogers (clustered) standard errors in parenthesis.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

electricity use, which is statistically significant in model 1 and 2, compared with the nonsignificant correlations of community affinity and disposable income to electricity use in the three models. For the interaction terms between household characteristics and classifying performance, only household size in model 1 and 3, housing area and members with at least a high school degree in model 3 have significant interaction effects with classifying behaviour. Meanwhile, two year-dummy variables have a significantly positive impact on the explained variable in the three models. The empirical results are discussed in the following.

5. Discussion

The presence of spillover has been validated by many empirical and experimental studies in distinctive resource conservation fields (e.g. Lanzini and Thøgersen, 2014; Steinhorst et al., 2015; Thøgersen and Ölander, 2003; Tiefenbeck et al., 2013; Truelove et al., 2016). The purpose of the present research is to investigate behavioural spillover related to the external forces of policy measures in environmental domain. Based on a three-year observational study, we found that engagement in household waste separation could guide or impede residents' electricity conservation behaviour. For the first time, this paper provides clear evidence on the existence and availability of the spillover or the behavioural-lever effect in China, the world's largest developing country. In contrast with previous work based on self-reported behaviours, this study also used objective household activity data to overcome possible biases.

We examined how different interventions (environmental versus monetary framed) influenced the direction of spillover. This involved a comparison in behavioural performance between two areas exposed to different forms of waste separation inducement, and revealed that an environmental framed intervention such as a public education campaign could more easily trigger a positive spillover. This finding conforms to the theories of social identity and behavioural consistency and manifests an increase in environmental identity and conservation necessity by special behaviour guidance, and that norm construction can motivate actors to maintain their willingness and engage in other pro-environmental behaviours (Lanzini and Thøgersen, 2014; Truelove et al., 2016). Comparatively, a negative effect on non-targeted behaviour produced by the monetary incentives suggests a rebound effect and erosion of internal attribution caused by financial rewards (Truelove et al., 2014), which corresponds with extant mainstream findings but contradicts the positive findings of Lanzini and Thøgersen (2014). However, the participants of the study consisted solely of college students and behavioural data were all self-reported which, as they themselves observe, reduce the credibility of the findings due to their limited representativeness and potential measurement bias.

Furthermore, the present study confirms that the difficulty of initial behaviour have an important effect on positive spillover. Specifically, we detected positive spillover when residents' waste related behaviours were measured by separating rates, rather than dumping records, which manifests that only households performing more difficult initial behaviour well could be observed to save more electricity. This supports Truelove et al.'s (2014) argument that people are more likely to make decisions according to their experience, an indicator of their self-concept. Generally, when past environmental behaviour needs more time and investment to perform, people will be more likely to infer that they are environmentalists and the environmental identities will be more salient, hence, they are more inclined to act in other altruistic domains than those performing easier alternatives.

Perhaps the greatest contribution of this study is to investigate the changing trend of spillover over time. It was found that positive spillover significantly reduced in the context of environmental framing over years when compared with the long-term negative stability induced by financial incentives. The defensive response and other negative cognitive effects it creates need to be considered to understand this situation. When faced with the high pressured, unitary and almost coercive advocacy mobilisation measure of waste separation adopted in Hangzhou (Xu et al., 2017), recipients are more likely to have a defensive reaction to actions targeted by the authority over time (Schwartz and Howard, 1981; Steinhorst and Matthies, 2016) and perceive they have done their duty (Thøgersen and Crompton, 2009). Consequently, they feel less inclined to accept other appeals such as energy conservation from the government (Weber, 1997). Moreover, a significantly directional shift of the relationship between dumping performance and electricity consumption also suggests that the positive spillover of a less difficult initial behaviour might even become negative over a longer-term, which can be explained as a function of a less salient identity caused by easier initial behaviour and defensive reaction. However, it is still worth exploring why a significant recession occurred in 2016 rather than 2015. Except for the postulated mechanism of defensive reaction, another possible explanation is Hangzhou's substantial temperature fluctuation in 2016 (an average 3.1 °C rise in summer and 0.7 °C drop in winter compared with 2015[10]), which has been controlled statistically in our regressions by means of a year dummy variable, and might increase the difficulty of saving household electricity even for individuals with a high environmental identity. As Truelove et al. (2014) argue, more difficult subsequent behaviour could prevent the occurrence of positive spillover. Conversely, monetary framing would be strengthening external attribution (Truelove et al., 2014) and evidently improving the living standard of recipients with a poor personal ecological norm, as is typical of the current general public in China (Xu et al., 2017), which is associated with less willingness to engage in energy conservation.

Meanwhile, the tests of the control variables produced some unexpected findings. There were no significant effects of either community affinity or income in any of the models. Affinity with the community may mainly focus on such participation in public affairs as community service and other voluntary activities, which does not necessarily lead to an enthusiasm for individual energy conservation. The general measurement of household disposable income due to the difficulty in accessing such private information accurately might be narrowing the difference in disposal income between participants and underestimating its effect, creating a probable bias in evaluating the influence of a resident's income. We also found that larger households displayed a stronger positive spillover (see model 3) and weaker negative spillover (see model 1). It is known that collective environmental action is more likely to fail with an increase in group size and a strong internal identity or perceived norm usually acts as a key to overcoming this dilemma (Ostrom, 1980). Therefore, the better separation performance of larger households could be interpreted as a more salient environmental identity shared by their members, which is also a catalyst for positive spillover. Hence, these larger households are more willing to save electricity in both framings. In addition, housing area had a negative moderating effect on positive spillover. As mentioned above, a highly difficult secondary behaviour is expected to reduce the possibility of positive spillover (Truelove et al., 2014). Residents living in bigger apartments might be likely to use electrical appliances more frequently to cope with indoor lighting and thermal variation (Jones et al., 2015), and find it more difficult to engage in daily energy conservation. Thus, people would be less inclined to save electricity even though they were good at waste separation. Finally, contrary to popular belief, it was found that well-educated families had less positive spillover. There are two possible reasons for this. One is that higher education does not necessarily render a stronger environmental identity (Pakpour et al., 2014). The other is that education with an important enlightenment effect on the public could arouse their critical consciousness and stimulate their desire for liberalism (Kingston et al., 2003; Phelan et al., 1995), which might trigger more suspicion of the

[10] Data source: http://www.weather.com.cn (Retrieved 5 May 2017).

authority and defensive responses to mobilisation measures.

The main limitations of the research are the different measures of waste separation behaviour and the relatively small sample due to the restricted availability of objective data. The study also lacks stricter causal inference of the genesis of spillover and the reasons why it varies. To date, some studies have embarked on testing the psychological factors theoretically involved in spillover by experimentation. For example, Truelove et al. (2016) found that participants with decreased pro-environmental identity displayed less policy support after recycling bottles. Additionally, personal norms and efficacy have been showed to mediate the positive relationship between energy conservation and climate-friendly intention (Steinhorst et al., 2015). Future research, therefore, would benefit investigating this further with a large-sample longitudinal and experimental field study and unified metrics into the underlying psychological mechanisms of the spillover and its changing trend to a fine degree over time.

6. Conclusions and policy implications

Based on a three-year panel study of the activities of two samples of households from the city of Hangzhou, this paper detected a positive spillover when residents received an environmental education, but negative when residents were encouraged by monetary inducement. This difference may be due to the residents' increased environmentalist identity because of exposure to environmental information, and rebound and single-action bias caused by the financial incentive. Moreover, the positive spillover effect was stronger when residents were engaged in more difficult initial behaviour (such as waste separation rather than dumping), which is consistent with the expectation that the performing a more difficult pro-environmental behaviour initially can engender a more salient environmental identity and higher willingness to maintain behavioural consistency. More importantly, positive spillover decreased more significantly over the three-year period than negative spillover − most likely as the result of the defensive response of residents from the longer-term education process involved.

We can also draw some conclusions from the results of our analysis for policymakers in further improving their pro-environment strategies. In principle, the government and social organisations would benefit from a greater understanding of the spillover effect and may learn to apply it to improve environmental governance. This is especially the case in China, where its extensive environmental crises – including the rapid growth of solid waste, resource exhaustion, abnormal climate and air pollution levels – provide a severe threat to the life quality of its population, and with many separate promotion efforts aimed at encouraging the public into profound behavioural change in different environmental domains. The findings of the present research suggest that an improved knowledge of behavioural spillover focusing on the 'wedge' effect of simple and painless steps on far-reaching changes can further enrich the policy package and provide a new approach to environmental challenges (Steinhorst and Matthies, 2016; Thøgersen and Crompton, 2009). As we pointed out, household waste separation is relatively simple and easier to be reshaped by external interventions, which can be considered as one of the effective instruments or levers for transition of energy consumption, habit and lifestyle.

However, it is possible that household behavioural change campaigns could actually backfire and hinder engagement in other pro-environmental behaviours in some contexts, which demands a more thoughtful design of the policy instruments involved to optimize the likelihood of positive spillover (Steinhorst et al., 2015; Thøgersen and Crompton, 2009; Truelove et al., 2016). Public information campaigns by governments or volunteer organisations, and monetary incentives relying on resource markets could be two available methods to encourage public participation in environmental protection (e.g. waste separation). As has been validated by previous studies, monetary incentives are usually perceived as one of the most efficient measures for obtaining desired behaviour improvements (e.g. Owusu et al., 2013; Struk, 2017; Thøgersen and Crompton, 2009), but their rendering unexpectedly negative spillover to other non-targeted pro-environmental behaviours prohibits follow-up altruistic action, in comparison with the strong power of environmental appeals in spurring other non-targeted behaviours Hence, governments and other organisations should prefer pro-environmental appeals over purely financial inducements to encourage pro-environmental behaviour if positive spillover is desired. In other words, an essential and indispensable part of a green campaign is the formation of information strategies focusing on environmental advantages and ecological sustainability (Steinhorst and Matthies, 2016), as these can contribute to the development of identity as an environmentalist, personally internal attribution and perception of the necessity for subsequent actions.

Moreover, the transience of positive spillover also shows that the risk of defensive reactions in a long-term environmentally framed intervention, such as the application of the conventional command-and-control approach widely used in China (Mol and Carter, 2006). Therefore, it is very important for society to increase the diversification of policies and continually foster personally ecological norms and pro-environmental values, which have been demonstrated to be helpful in triggering positive spillover and avoiding defensive reactions (Steinhorst and Matthies, 2016; Thøgersen and Ölander, 2003). For example, school education needs to take responsibility as early as possible to signal active commitment to environmentalism in order to facilitate the internalization of children's pro-environmental values (Thøgersen, 2004). Besides, policymakers should also make the most of such *nudging* measures as setting the *default* to a pro-environmental option or designing *opt-out* strategies for strengthening societal norms and general pro-environmental motivations (Steinhorst and Matthies, 2016).

Another implication is the importance of the characteristics of targeted behaviour, and that the higher degree of behavioural difficulty predicts more chance of positive spillover (Truelove et al., 2014). Therefore, policy implementation also needs to involve raising the difficulty of targeted behaviour suitably during the later period of a campaign (e.g. requiring the more accurate separation rather than merely correct dumping). Above all, an important consideration for governments and campaigners is an urgent need to involve spillover into the general system of environmental policy performance appraisal. Government needs to evaluate net environmental impact increasingly after accounting for the direct and indirect behavioural effects of one policy (Truelove et al., 2014). For example, although economic rewards do produce substantial improvements in waste separation, they can also be a counterproductive investment in leading to severely excessive energy consumption and increased GHG emissions.

Acknowledgements

This project was supported by the National Social Science Foundation of China [grant numbers 15BZZ066]. We are grateful to the anonymous reviewers for their valuable comments of an earlier version of the manuscript. We would also like to thank Wenwen Wu and other research assistants for their work in data compilation.

References

Abrahamse, W., Steg, L., Vlek, C., Rothengatter, T., 2005. A review of intervention studies aimed at household energy conservation. J. Environ. Psychol. 25, 273–291.
Ajzen, I., 2002. Residual effects of past on later behavior: habituation and reasoned action perspectives. Pers. Soc. Psychol. Rev. 6 (2), 107–122.
Allcott, H., Mullainathan, S., 2010. Behavior and energy policy. Science 327, 1204–1205.
Arellano, M., 1993. On the testing of correlated effects with panel data. J. Econom. 59 (1–2), 87–97.
Ariely, D., Norton, M.I., 2008. How actions create – not just reveal – preferences. Trends Cogn. Sci. 12 (1), 13–16.
Austin, A., Cox, J., Barnett, J., Thomas, C., 2011. Exploring catalyst behaviours: executive summary. A Research Report Completed for the Department for Environment, Food.

Climate Research Brook Lyndhurst for Defra, London, pp. 1–15.
Baca-Motes, K., Brown, A., Gneezy, A., Keenan, E.A., Nelson, L.D., 2013. Commitment and behavior change: evidence from the field. J. Consum. Res. 39 (5), 1070–1084.
Bamberg, S., Möser, G., 2007. Twenty years after Hines, Hungerford and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour. J. Environ. Psychol. 27 (1), 14–25.
Bem, D.J., 1972. Self-perception theory. Adv. Exp. Soc. Psychol. 6, 1–62.
Berger, I.E., 1997. The demographics of recycling and the structure of environmental behavior. Environ. Behav. 29 (4), 515–531.
Berkhout, P., Muskens, J., Velthuijsen, J., 2000. Defining the rebound effect. Energy Policy 28, 425–432.
Burger, J., Caldwell, D., 2003. The effects of monetary incentives and labeling on the foot-in-the-door effect: evidence for a self-perception process. Basic Appl. Soc. Psychol. 25 (3), 235–241.
Cialdini, R.B., Trost, M.R., Newsom, J.T., 1995. Preference for consistency: the development of a valid measure and the discovery of surprising behavioral implications. J. Pers. Soc. Psychol. 69 (2), 318–328.
Cohen, J., Cohen, P., West, S.G., Aiken, L.S., 2003. Applied Multiple Regression/correlation Analysis for the Behavioral Sciences, 3rd ed. Lawrence Erlbaum, Mahwah, NJ.
Cornelissen, G., Pandelaere, M., Warlop, L., Dewitte, S., 2008. Positive cueing: promoting sustainable consumer behaviour by cueing common environmental behaviors as environmental. Int. J. Res. Mark. 25 (1), 46–55.
DEFRA, 2008. A Framework for Pro-environmental Behaviours. Available at: http://www.defra. gov.uk/publications/files/pb13574-behaviours-report-080110.pdfs.
De Groot, J.I.M., Steg, L., 2007. Value orientations to explain beliefs related to environmental significant behavior: how to measure egoistic, altruistic, and biospheric value orientations. Environ. Behav. 40 (3), 330–354.
Du, L., Guo, J., Wei, C., 2017. Impact of information feedback on residential electricity demand in China. Resour. Conserv. Recycl. 125, 324–334.
Evans, L., Maio, G.R., Corner, A., Hodgetts, C.J., Ahmed, S., Hahn, U., 2013. Self-interest and pro-environmental behaviour. Nat. Clim. Change 3 (2), 122–125.
Freedman, J.L., Fraser, S.C., 1966. Compliance without pressure: the foot-in-the door technique. J. Pers. Soc. Psychol. 4 (2), 195–202.
Freeman, R., Yearworth, M., Preist, C., 2016. Revisiting Jevons' paradox with system dynamics: systemic causes and potential cures. J. Ind. Econ. 20 (2), 341–353.
Gillingham, K., Kotchen Matthew, J., Rapson, D.S., Wagner, G., 2013. The rebound effect is overplayed. Nature 493, 475–476.
Gneezy, A., Imas, A., Brown, A., Nelson, L.D., Norton, M.I., 2012. Paying to be nice: consistency and costly pro-social behavior. Manag. Sci. 58 (1), 179–187.
Grazhdani, D., 2016. Assessing the variables affecting on the rate of solid waste generation and recycling: an empirical analysis in Prespa Park. Waste Manag. 48, 3–13.
Gu, B.X., Wang, H.K., Chen, Z., Jiang, S.Q., Zhu, W.M., Liu, M.M., Chen, Y.Q., Wu, Y., He, S., Cheng, R., Yang, J., Bi, J., 2015. Characterization, quantification and management of household solid waste: a case study in China. Resour. Conserv. Recycl. 98, 67–75.
Guagnano, G.A., Dietz, T., Stern, P.C., 1994. Willingness to pay for public goods: a test of the contribution model. Psychol. Sci. 5 (6), 411–415.
Heath, Y., Gifford, R., 2006. Free-market ideology and environmental degradation: the case of belief in global climate change. Environ. Behav. 38 (1), 48–71.
Joireman, J., Truelove, H.B., Duell, B., 2010. Effect of outdoor temperature, heat primes and anchoring on belief in global warming. J. Environ. Psychol. 30 (4), 358–367.
Jones, R.V., Fuertes, A., Lomas, K.J., 2015. The socio-economic, dwelling and appliance related factors affecting electricity consumption in domestic buildings. Renew. Sustain. Energy Rev. 43, 901–917.
Kingston, P.W., Hubbard, R., Lapp, B., Schroeder, P., Wilson, J., 2003. Why education matters. Sociol. Educ. 76 (1), 53–70.
Klöckner, C.A., Nayum, A., Mehmetoglu, M., 2013. Positive and negative spillover effects from electric car purchase to car use. Transp. Res. Part D Transp. Environ. 21 (2), 32–38.
Kunreuther, H., Weber, E.U., 2014. Aiding decision making to reduce the impacts of climate change. J. Consum. Policy 37 (3), 397–411.
Lanzini, P., Thøgersen, J., 2014. Behavioural spillover in the environmental domain: an intervention study. J. Environ. Psychol. 40, 381–390.
Leiserowitz, A., 2006. Climate change risk perception and policy preferences: the role of affect, imagery, and values. Clim. Change 77 (1–2), 45–72.
Lubell, M., 2002. Environmental activism as collective action. Environ. Behav. 34 (4), 431–454.
Ministry of environmental protection of the people's republic of China, 2016. Annual Report on Prevention and Control of Pollution by Solid Wastes in Large and Medium Cities. [in Chinese]. Available at: http://trhj.mep.gov.cn/gtfwhjgl/zhgl/201611/P020161123507795479700.pdf.
Marian, L., Chrysochou, P., Krystallis, A., Thøgersen, J., 2014. The role of price as a product attribute in the organic food context: an exploration based on actual purchase data. Food Qual. Preference 37, 52–60.
Merrill, R., Sintov, N., 2016. An affinity-to-commons model of public support for environmental energy policy. Energy Policy 99, 88–99.
Mol, A.P.J., Carter, N.T., 2006. China's environmental governance in transition. Environ. Polit. 15 (2), 149–170.
Myers, David G., 2009. Social Psychology, 10th ed. McGraw-Hill Higher Education, New York.
Ostrom, E., 1980. Governing the Commons: the Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, New York.
Owusu, V., Adjei-Addo, E., Sundberg, C., 2013. Do economic incentives affect attitudes to solid waste source separation?: Evidence from Ghana. Resour. Conserv. Recycl. 78, 115–123.
Pakpour, A.H., Zeidi, I.M., Emamjomeh, M.M., Asefzadeh, S., Pearson, H., 2014. Household waste behaviours among a community sample in Iran: an application of the theory of planned behaviour. Waste Manag. 34, 980–986.
Phelan, J., Link, B.G., Stueve, A., Moore, R.E., 1995. Education, social liberalism, and economic conservatism: attitudes toward homeless people. Am. Sociol. Rev. 60 (1), 126–140.
Poortinga, W., Whitmarsh, L., Suffolk, C., 2013. The introduction of a single-use carrier bag charge in wales: attitude change and behavioural spillover effects. J. Environ. Psychol. 36 (4), 240–247.
Sachdeva, S., Lliev, R., Medin, D.L., 2009. Sinning saints and saintly sinners: the paradox of moral self-regulation. Psychol. Sci. 20 (4), 523–528.
Schneider, F., 2010. The Jevons paradox and the myth of resource efficiency improvements. J. Clean. Prod. 18 (6), 600–602.
Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J., Griskevicius, V., 2007. The constructive, destructive, and reconstructive power of social norms. Psychol. Sci. 18 (5), 429–434.
Schwartz, S.H., Howard, J.A., 1981. A normative decision-making model of altruism. In: Rushton, J.P., Sorrentino, R.M. (Eds.), Altruism and Helping Behavior. Lawrence Erlbaum Associates, Hillsdale, pp. 189–211.
Scott, C.A., 1977. Modifying socially-conscious behavior: the foot-in-the-door technique. J. Cons. Res. 4 (3), 156–164.
Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. J. Environ. Psychol. 29 (3), 309–317.
Steg, L., Dreijerink, L., Abrahamse, W., 2005. Factors influencing the acceptability of energy policies: a test of VBN theory. J. Environ. Psychol. 25 (4), 415–425.
Steinhorst, J., Matthies, E., 2016. Monetary or environmental appeals for saving electricity? Potentials for spillover on low carbon policy acceptability. Energy Policy 93, 335–344.
Steinhorst, J., Klöckner, C.A., Matthies, E., 2015. Saving electricity – for the money or the environment? Risks of limiting pro-environmental spillover when using monetary framing. J. Environ. Psychol. 43, 125–135.
Stern, P.C., 2000. Toward a coherent theory of environmentally significant behavior. J. Soc. Issues 56 (3), 407–424.
Struk, M., 2017. Distance and incentives matter: the separation of recyclable municipal waste. Resour. Conserv. Recycl. 122, 155–162.
Sturmer, S., Simon, B., Loewy, M., Jorger, H., Sturmer, S., 2003. The dual-pathway model of social movement participation: the case of the fat acceptance movement. Soc. Psychol. Q. 66 (1), 71–82.
Suh, E.M., 2002. Culture, identity consistency, and subjective well-being. J. Pers. Soc. Psychol. 83 (6), 1378–1391.
Tajfel, H., Turner, J.C., 1979. An integrative theory of intergroup conflict. In: Worchel, S., Austin, W.G. (Eds.), Social Psychology of Intergroup Relations. Brooks-Cole, Monterey, CA, pp. 33–47.
Thøgersen, J., Ölander, F., 2003. Spillover of environment-friendly consumer behaviour. J. Environ. Psychol. 23 (3), 225–236.
Thøgersen, J., Crompton, T., 2009. Simple and painless? The limitations of spillover in environmental campaigning. J. Consum. Policy 32 (2), 141–163.
Thøgersen, J., Noblet, C., 2012. Does green consumerism increase the acceptance of wind power? Energy Policy 51 (6), 854–862.
Thøgersen, J., 1999. Spillover processes in the development of a sustainable consumption pattern. J. Econ. Psychol. 20 (1), 53–81.
Thøgersen, J., 2004. A cognitive dissonance interpretation of consistencies and inconsistencies in environmentally responsible behavior. J. Environ. Psychol. 24 (1), 93–103.
Thøgersen, J., 2006. Understanding repetitive travel mode choices in a stable context: a panel study approach. Transp. Res. Part A: Policy Prac. 40, 621–638.
Tiefenbeck, V., Staake, T., Roth, K., Sachs, O., 2013. For better or for worse? Empirical evidence of moral licensing in a behavioral energy conservation campaign. Energy Policy 57, 160–171.
Truelove, H.B., Carrico, A.R., Weber, E.U., Raimi, K.T., Vandenbergh, M.P., 2014. Positive and negative spillover of pro-environmental behavior: an integrative review and theoretical framework. Glob. Environ. Change 29, 127–138.
Truelove, H.B., Yeung, K.L., Carrico, A.R., Gillis, A.J., Raimi, K.T., 2016. From plastic bottle recycling to policy support: an experimental test of pro-environmental spillover. J. Environ. Psychol. 46, 55–66.
Van der Werff, E., Steg, L., Keizer, K., 2013. I am what I am, by looking past the present: the influence of biospheric values and past behavior on environmental self-identity. Environ. Behav. 46 (5), 626–657.
Vandenbergh, M., Carrico, A., Bressman, L.S., 2011. Regulation in the behavioural era. Minn. L. Rev. 95 (3), 715–781.
Wan, C., Shen, G.Q., Yu, A., 2015. Key determinants of willingness to support policy measures on recycling: a case study in Hong Kong. Environ. Sci. Policy 54, 409–418.
Wang, J., 2010. Garbage siege. Available at: http://dhscape.com/projects/garbage-siege-garbage-landscaping.
Weber, E.U., Lindemann, P., 2007. From intuition to analysis: making decisions with our head, our heart, or by the book. In: Plessner, C., Betsch, C., Betsch, T. (Eds.), Intuition in Judgment and Decision Making. Lawrence Erlbaum, Mahwah, NJ, pp. 191–208.
Weber, E.U., 1997. Perception and expectation of climate change: precondition for economic and technological adaptation. In: Bazerman, M.H., Messick, D.M., Tensbrunsel, A., Wade-Benzoni, K. (Eds.), Psychological Perspectives to Environmental and Ethical Issues in Management. Jossey-Bass, San Francisco, pp. 314–341.
Weber, E.U., 2006. Experience-based and description-based perceptions of long-term risk: why global warming does not scare us (yet). Clim. Change 77 (1–2), 103–120.
Whitmarsh, L., O'Neill, S., 2010. Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. J. Environ. Psychol. 30, 305–314.
Willis, M.M., Schor, J.B., 2012. Does changing a light bulb lead to changing the world?: Political action and the conscious consumer. Ann. Am. Acad. Polit. Soc. Sci. 644,

160–190.
Wooldridge, M., 2003. Introductory Econometrics: a Modern Approach, 2nd. ed. South Western Publishers, Ohio, USA.
Xu, L., Ling, M.L., Lu, Y.J., Shen, M., 2017. External influences on forming residents' waste separation behaviour: evidence from household in Hangzhou, China. Habitat Int. 63, 21–33.
Zeng, C., Niu, D., Li, H., Zhou, T., Zhao, Y., 2016. Public perceptions and economic values of source-separated collection of rural solid waste: a pilot study in China. Resour. Conserv. Recycl. 107, 166–173.
Zhang, S., Zhang, M., Yu, X., Ren, H., 2016. What keeps Chinese from recycling: accessibility of recycling facilities and the behavior. Resour. Conserv. Recycl. 109, 176–186.
Zhong, C.B., Liljenquist, K., Cain, D., 2009. Moral self-regulation: licensing & compensation. In: de Cremer, D. (Ed.), Psychological Perspectives on Ethical Behavior and Decision Making. Information Age, Charlotte, NC, pp. 75–89.
Zhou, S., Teng, F., 2013. Estimation of urban residential electricity demand in China using household survey data. Energy Policy 61, 394–402.