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# Moral Licensing—Another Source of Rebound?

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The rebound effect denotes an offset in energy savings that occurs when an individual increases consumption of a good or service following an increase in its efficiency. It has both economic and psychological underpinnings: In addition to the price, income and substitution effects emphasized by economists, psychologists point to the influence of moral licensing, the cognitive process by which individuals justify immoral behavior (e.g., driving more) by having previously engaged in moral behavior (e.g., purchasing a more efficient car). The present review article provides a conceptual and empirical overview of moral licensing, drawing comparisons with economic explanations for the rebound effect. Based on a unifying theoretical model that illustrates how economic and psychological motivations trigger both rebound and moral licensing effects, as well as a review of microeconometric and experimental evidence, we conclude that consideration of moral licensing is warranted for judging the efficacy of policies targeted at energy consumption and the rebound effect.

**Keywords: substitution effect, income effect, scale effect, moral licensing, moral cleansing**

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## INTRODUCTION

Improvements in energy efficiency have often resulted in lower reductions in energy consumption than anticipated (Sorrell, 2007). A key reason for this outcome are rebound effects, which result from behavioral changes in response to energy efficiency improvements. Economists explain the observed outcomes by changes in relative prices and income: when the unit price of a good or service decreases due to an efficiency improvement, people demand more of it. Alternatively, psychologists have identified non-monetary mechanisms leading to rebound effects. In particular, moral licensing, i.e., moral behavior in one domain (e.g., through lower use of energy) may free people to be less moral in other domains (Effron and Conway, 2015).

Irrespective of whether rebound effects derive from economic or psychological motivations, they stymy the effectiveness of policy interventions aimed at lowering the use of resources and emissions, including efficiency standards or subsidies and tax breaks for energy-efficient technology adoption. By increasing the demand for resources, rebound effects can be viewed as a type of negative spillover. By contrast, recent research (Lacasse, 2016; Nash et al., 2017) has pointed out that some actions that reduce resource use in one domain may additionally reduce resource demand in others, resulting in positive spillovers. For example, greater awareness of environmental benefits associated with the use of more energy efficient technologies may lead to higher conservation efforts.

The co-existence of such negative and positive spillovers raises the question of net effects, a topic that has been controversially discussed in the literature, but one for which empirical evidence is scant. Moreover, the discussion surrounding these issues is often diffuse, not least due to varying definitions of the concepts across disciplines.

Recognizing that effective policy interventions require a profound understanding of the mechanisms underlying the observed rebound effects, this review article provides a conceptual and empirical overview of the associated economic and psychological underpinnings. In general, we focus on applications for the energy efficiency domain, but we also draw on related literature from other domains when applications to energy efficiency are missing. A distinguishing feature of our analysis is the presentation of a unifying model that not only captures the key micro-economic mechanisms behind the rebound, but also psychological effects, such as moral licensing. Recent reviews also discuss moral licensing (Blanken et al., 2015; Mullen and Monin, 2016) or, more generally, spillover effects (Nash et al., 2017), but none in the framework of rebound behaviors, and none distinguishing explicitly the economic and the psychological perspective. Finally, based on our review of the state of research, we identify open questions and address methodological issues.

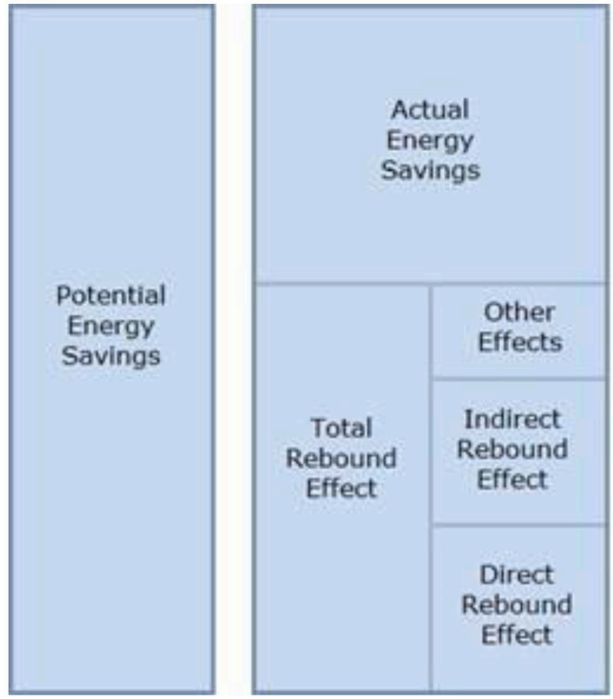


**FIGURE 1 |** Classifying Rebound Effects.

## THE VARIETY OF REBOUND NOTIONS: ECONOMIC CONCEPTS AND EMPIRICAL FINDINGS

The most fundamental definition of the rebound effect (*R*) is given by the relative gap between the *potential* (*PES*) energy savings from an energy efficiency improvement and the *actual* energy savings (*AES*), see **Figure 1**:

$$R = (PES - AES)/PES = 1 - AES/PES.$$

Among the large variety of rebound responses, the economic literature distinguishes between micro-economic rebounds, such as the direct and indirect effect, as well as macro-economic rebound effects (**Figure 1**). A prominent example for direct rebound effects is the adoption of fuel-efficient cars, which lower the costs of transportation services and may thus encourage drivers to employ the car more often, to travel further, to drive faster or to buy a more comfortable (e.g., more spacious) car (Frondel et al., 2008)[1].

Formally, the direct rebound is defined as the efficiency elasticity of energy services, i.e., the proportionate change in energy services consumption due to the proportionate change in energy efficiency (e.g., Sorrell and Dimitropoulos, 2008). Indirect rebound effects are frequently illustrated with the following example: Fuel-efficient cars lower expenditures for gasoline, but these cost savings will be spent on other goods and services whose provision necessarily involves energy use at different stages of their global supply chains (Chitnis et al., 2014).

Finally, typical macro-economic rebound effects evolve if the widespread adoption of fuel-efficient cars lower fuel demand, thereby reducing fuel prices. This, in turn, will encourage increased fuel consumption within national and global energy markets. In addition to these energy market effects, the widespread adoption of fuel-efficient cars may also induce secondary effects, that is, changes in the prices, investment, production and trade of other markets, which may have impacts on the energy consumption of both the national economy and international supply chains. In a broader definition, macro-economic effects may also include technological innovation and diffusion effects (van den Bergh, 2011), where energy efficiency improvements lead to new products, applications or even new industries. Most prominently, radical technology inventions such as James Watt's steam engine, which was much more energy efficient than its predecessors, may lead to an overall increase in energy consumption by fostering the production potential of the society—a phenomenon that is called Jevons' paradox (Frondel, 2004; Sorrell, 2009).

In comparison, psychological approaches also distinguish direct and indirect rebound effects, but, as will be detailed in section Moral Licensing and Positive and Negative Spillover Effects from a Psychological Perspective, the motivations are rooted in an individual's values and identity, rather than in their economic incentives.

### Empirical Findings

The magnitude of direct rebound effects can be quite large. For the example of the adoption of fuel-efficient cars, for instance, Frondel et al. (2008, 2012, 2017) and Frondel and Vance (2013, 2018) find quite robust estimates of the direct rebound effect for

[1]Both these definitions highlight that the rebound effect (in the economics literature) refers to relative, rather than absolute measures. Thus, finding a large rebound effect may be associated with rather small absolute effects.

individual mobility in Germany that range between 40 and 70%, meaning that between 40 and 70% of the potential energy saving from efficiency improvements is lost to increased driving. These estimates are on the higher end of those presented in a recent meta-analysis of 76 studies containing 1,138 estimates, which suggests a direct rebound effect of car travel of about 12% in the short run and 32% in the long run, notwithstanding considerable heterogeneity across countries (Dimitropoulos et al., 2016). Due to data availability, car travel is by far the best studied area, where most studies estimate the direct rebound effect from elasticities of distance traveled with respect to either fuel efficiency, fuel cost per kilometer or fuel prices.

In comparison, few studies have quantified the direct rebound effects of other household energy efficiency improvements. For space heating and water heating, the survey by Azevedo (2014) yields direct rebound effects in the range of 2–60% and 10–40%, respectively. For space heating, Sorrell and Dimitropoulos found estimates of 10–58% for the short run and 1.4–60% for the long run. The size of the direct rebound effect in space heating may also differ by socio-economic and building characteristics, such as energy performance. For example, Galvin (2015) finds the direct rebound effect to be higher for low-income households than for high-income households. Sunikka-Blank and Galvin (2012) observe that, on average, non-renovated dwellings consume less than suggested by their theoretical consumption level. Therefore, due to the lower than expected pre-retrofit consumption level, much less energy is saved when these dwellings are retrofitted than is predicted—a phenomenon that is commonly referred to as prebound.

According to the survey by Greening et al. (2000), the rebound in residential lighting lies between 5 and 12%, but the few studies surveyed employ rather small samples. In contrast, Schleich et al. (2014) and Mills and Schleich (2014) consider bulb replacements for a large representative household sample in Germany. Schleich et al. (2014) estimate the average direct rebound effect for lighting at around 6% on the individual level; the larger part (around 60%) of this rebound results from increases in bulb luminosity, and 40% from longer burn time. These estimates are based on actual improvements of energy efficiency between bulb types. In stark contrast, relying on the long-run price elasticity of lighting demand in the United Kingdom, Fouquet and Pearson (2012) estimate the direct rebound effect at 60%.

Only a few studies have quantified the indirect rebound effect or the combination of direct and indirect rebound effects, arguably because such analyses are methodologically complex. As indirect rebound effects capture how lower unit costs from increased efficiency release income that can be spent on other goods and services, estimates of their magnitude are data intensive, requiring detailed information on expenditures. For example, relying on a household demand model for the United Kingdom, Chitnis and Sorrell (2015) estimate price and expenditure elasticities of 12 different goods and services. They find combined direct and indirect rebound effects with respect to greenhouse gas emissions of 41% for measures that improve the efficiency of domestic gas use, 48% for electricity use, and 78% for vehicle fuel use. The primary source of these rebounds is found to be the increased consumption of the cheaper energy service, described by the direct rebound effect, but the indirect rebound is also of relevance. In fact, Chitnis and Sorrell (2015) conclude that the neglect of the indirect rebound may have led prior research to underestimate the total rebound effect. In the end, although the received empirical evidence has to be taken with caution, at least one firm conclusion can be drawn from this strand of the literature: combined direct and indirect rebound effects may be substantial, even approaching 100%, indicating that one cannot ignore rebound effects when it comes to the evaluation of conservation and climate protection measures that are based on energy efficiency improvements.

## Theoretical Model

To capture the various notions of the direct and indirect rebound effects, this section presents a unifying theoretical model that not only captures the key micro-economic mechanisms behind the rebound, but also psychological effects, such as moral licensing. As a motivating practical example, the model employs the replacement of night storage heating by a heat pump and analyses the corresponding change in electricity consumption as the result of price, substitution, income, and scale effects. These effects are familiar from standard micro-economic theory, but have been re-termed in the energy economics literature to emphasize those counteracting effects of energy conservations efforts that have often been ignored.

Night storage heating systems are well-known to be both inefficient and sluggish in ensuring warm homes, as they need about 24 h before they are able to provide for the desired temperature level. Nevertheless, they are widely used in some countries. In Germany, for example, there are still more than 1 million night storage heating systems in operation (FCO, 2010). As heating with a night storage heating system is both uncomfortable and expensive, given that its operation is based on electricity, many German households employ additional heating equipment, for example in the form of wood ovens, to reduce their expenditure for heating and to be more flexible in heating their home.

In our model, replacing night storage heating by a heat pump is captured by a change in a household's heating capital stock $K$, whose operation necessitates electricity and additional fuels, such as wood, to provide for the desired heating service of the level $s := s(s_e, s_f, K)$, where $s_f$ denotes the heating service level achieved by the fuel-based heating technology and $s_e$ the respective level produced by electricity. For the sake of simplicity, we assume that the cost of investing in heating technologies are sunk cost and, hence, are irrelevant for the decision on the heating levels.

The heating service levels $s_e$ and $s_f$ are the results of a cost minimization problem under the restriction that a minimum heating level (e.g., indoor temperature) $\underline{s}$ is ensured:

$$\min_{se,\, sf}(p_e\ s_e + p_f\ s_f) \quad \text{subject to} \quad \underline{s} \leq s(s_e, s_f, K), \qquad (1)$$

where $p_e$ and $p_f$ are the prices of utilizing electricity and fuels, respectively, to provide heating service levels $s_e$ and $s_f$. The service prices $p_e$ and $p_f$ depend on the energy and fuel efficiency, as well as on the purchasing prices of electricity and fuels.

Solving minimization problem (1) yields the optimal levels of heating with fuels and electricity:

$$s_f = s_f(p_e, p_f, s, K), \tag{2}$$
$$s_e = s_e(p_e, s_f, s, K) = s_e(p_e, s_f(p_e, p_f, s, K), s, K), \tag{3}$$

where, without loss of generality, it is assumed that the fuel heating level $s_f$ affects the electricity heating level $s_e$, but not vice versa.

The optimal heating level is the result of a (restricted) utility maximization problem in which the heating level $s$ enters the utility function, together with the amount $x_o$ of the composite of all other goods, and the expenditure for heating and all other goods are subject to the usual budget restriction:

$$I \geq c(p_e, p_f, s, K)s + p_o\ x_{o,} \tag{4}$$

where $I$ denotes household income, $p_o$ the price of the composite of all other goods, and $c$ designates the unit cost function of ensuring the heating level $s$:

$$\begin{aligned} c(p_e, p_f, s, K) :=\ & 1/s[p_e s_e(p_e, s_f(p_e, p_f, s, K), s, K) \\ & + p_f\ s_f(p_e, p_f, s, K)]. \end{aligned} \tag{5}$$

The optimal heating level solves the restricted utility maximization problem described above and is a function of $p_o$, $I$, $K$, and the unit cost function $c\ (p_e, p_f, s, K)$:

$$s := s(c, p_o, I, K) \tag{6}$$

Inserting this term into Equation (3) yields a more comprehensive expression for the optimal level of heating with electricity:

$$\begin{aligned} s_e &= s_e(p_e, s_f, s, K) \\ &= s_e(p_e, s_f(p_e, p_f, s(c, p_o, I, K), K), s(c, p_o, I, K), K), \end{aligned} \tag{7}$$

from which the price, substitution, income and scale effects of the change in heating technologies on the optimal level of heating with electricity can be derived:

$$\begin{aligned} ds_e/dK =\ & \partial s_e/\partial p_e\ \partial p_e/\partial K + \partial s_e/\partial K \\ & + \partial s_e/\partial s_f[\partial s_f/\partial p_e\ \partial p_e/\partial K + \partial s_f/\partial s\ (\partial s/\partial K \\ & + \partial s/\partial c\ \partial c/\partial K)] \\ & + \partial s_e/\partial s(\partial s/\partial K + \partial s/\partial c\ \partial c/\partial K), \end{aligned} \tag{8}$$

where $\partial s_f/\partial K = 0$ is employed, as we assume that heat pumps have no direct impact on the level of heating with fuels, and $\partial p_f/\partial K = 0$, as the implementation of a heat pump does not affect the service price of fuels.

The first term on the right-hand side of Equation (8), $\partial s_e/\partial p_e$ $\partial p_e/\partial K$, captures what is commonly termed the direct rebound effect in the economic literature (e.g., Frondel et al., 2008): heating with an energy efficient heat pump reduces the price of utilizing electricity for heating purposes and this reduction in the service price $p_e$ may increase the level of heating with electricity (own-price effect).

In addition to this own-price effect, cross-price effects may also be at work, as implementing a heat pump reduces the relative price of heating with electricity and, hence, heating with fuels may be partly substituted by heating with electricity. This substitution effect is captured by the terms in the second row on the right-hand side of Equation (8). There is a direct substitution effect reflected by $\partial s_e/\partial s_f$ $\partial s_f/\partial p_e$ $\partial p_e/\partial K$, which is triggered by the diminished price of heating with electricity, and thereby negatively affects the level of heating with fuels.

Additionally, there is an indirect substitution effect that originates from two sources of scale effects: first, the unit cost of the household's heat production shrinks due to the reduced price of heating with electricity, thereby triggering an increase in real income that may increase the heating level $s$ (income effect): $\partial s/\partial c$ $\partial c/\partial K$. This scale effect arises, for example, if the rise in real income leads to higher indoor temperatures.

Second, there might be an immediate scale effect of using a heat pump on the heating level: $\partial s/\partial K$. This immediate scale effect may arise because the knowledge about operating cost reductions alone, irrespective of the awareness about the concrete amount of cost reduction due to the use of a heat pump, may lead to an increase in the heating level $s$. This effect may be termed the economic licensing effect: it is the sheer knowledge about energy cost reductions that may license increases in the demand for energy services.

Both these mechanisms are also at work when it comes to changes in the level $s_e$ of heating with electricity due to increases in the heating level $s$: $\partial s_e/\partial s$ (see the third row of the right-hand-side of Equation 8). Specifically, the term $\partial s_e/\partial s$ $\partial s/\partial c$ $\partial c/\partial K$ partly reflects what is called the indirect rebound effect in the economic literature: it is likely that the increase in real income due to decreasing heating cost shifts the consumption of electricity beyond the minimum level that is theoretically reachable due to the efficiency improvement.

Lastly, if the term $\partial s_e/\partial K$ emerging from the first row of Equation (8) is positive, it captures within-domain moral licensing effects, which are discussed in detail in section Moral Licensing and Positive and Negative Spillover Effects from a Psychological Perspective: Investing in the environmentally benign heat pump provides the investor with the moral license to consume more electricity for heating purposes.

In addition to the indirect rebound effect that potentially increases the level $s_e$ of heating with electricity, it is likely that the increase in real income due to decreasing heating cost increases the consumption $x_o := x_o(c, p_o, I, K)$ of the composite of all other goods:

$$\begin{aligned} dx_o/dK =\ & \partial x_o/\partial c[\partial c/\partial s\ \partial s/\partial K + \partial c/\partial K + \partial c/\partial p_e\ \partial p_e/\partial K] \\ & +\ \partial x_o/\partial K > 0, \end{aligned} \tag{9}$$

where use is made of Equation (5), which shows that cost function c is a function of $K$, the service prices $p_e$ and $p_f$ and the heating level $s$. The first expression on the right-hand side of Equation (9) reflects what is commonly called the indirect rebound effect: The increase in real income due to cheap heating with a heat pump allows for an increased consumption of other goods and services that require energy. Not least, cross-domain moral licensing effects, as captured by the term $\partial x_o/\partial K$ may also occur, reflecting the (cross-domain) moral license to consume more of other goods (assuming $\partial x_o/\partial K$ is positive), such as water or road fuels, just as a consequence of the investment in the environmentally benign heat pump technology. These effects lie at the heart of the following sections.

# MORAL LICENSING AND POSITIVE AND NEGATIVE SPILLOVER EFFECTS FROM A PSYCHOLOGICAL PERSPECTIVE

The starting point for a psychological analysis of rebound effects related to energy efficiency improvements, or to improvements in resource efficiency in general, is the observation that an efficiency increase induces individuals to change their behavior in the same or another domain. In this section, we firstly focus on disentangling relevant definitions and concepts, secondly summarize the theoretical state of research, and thirdly give an overview of relevant empirical findings with an overall focus on the psychological literature (Peters and Dütschke, 2016).

## Definition and Differentiation of Concepts

From a psychological point of view, the acquisition of a more energy efficient product (e.g., a new top-labeled washing machine, an electric vehicle or home insulation) can be regarded as an intervention that interrupts previous routines and thereby leads to behavioral change in how the relevant product or service is used. If this behavioral change occurs in a way that leads to a higher use of energy and other resources than expected, this is termed rebound effect. However, there is also a stream of literature that reports reverse findings (Truelove et al., 2014), i.e., an increase in conservation behavior. If this increase in conservation occurs in the same domain, this is called sufficiency behavior (Seidl et al., 2017). If it occurs in a different domain, the term positive spillover is applied. Negative spillover effects are conceptually identical to the concept of indirect rebound effects (Nash et al., 2017). While all of these effects have been empirically identified in the literature, their existence and magnitude varies extensively and depends on the good or service in question. Schleich et al. (2014), for example, find that some individuals show no behavioral effect following an efficiency increase in lighting while others show rebound behavior and a third group sufficiency behavior.

This leads to the question about which factors explain the diversity in behavioral responses beyond the monetary factors thoroughly studied in the economics literature. In particular, a small but growing conceptual and empirical literature relying on concepts from social-psychology and behavioral economics highlights the role of moral licensing. Following the seminal work by Monin and Miller (2001), moral licensing "occurs when past moral behavior makes people more likely to do potentially immoral things without worrying about feeling or appearing immoral." Similarly, according to Merritt et al. (2010)(p. 344) "past good deeds can liberate individuals to engage in behaviors that are immoral, unethical, or otherwise problematic, behaviors that they would otherwise avoid for fear of feeling or appearing immoral." Analogously, further literature also deals with cross-domain moral cleansing, where the perception that "you are less moral in one domain makes you more moral in another" (Ho et al., 2016, p. 319)[2]. After summarizing the state of research on moral licensing, the potential contributions that this research could make to explaining positive and negative spillovers, as well as rebound effects, is the subject of the next sections.

## Evidence for Moral Licensing

A meta-analysis by Blanken et al. (2015) of 91 studies that all included a licensing condition with a control condition identifies a consistent small-to-medium moral licensing effect (see Effron and Conway, 2015 for a similar conclusion). Moral licensing has been observed in various domains, including racism, dieting, and purchases of luxury or environmental goods, but has hardly been studied with respect to energy issues. For example, Monin and Miller (2001) find that choosing an African American in a job selection task in the first round increases the propensity to discriminate against African Americans in the second round. Similarly, Effron et al. (2009) find that individuals expressing support for Barack Obama in a first question were more likely to make a prejudiced job task decision in a second question. Fishbach and Dhar (2005) find that dieters, after having exercised, choose the more self-indulgent option of a chocolate bar, rather than an apple. Similarly, the study by Khan and Dhar (2006) shows that individuals are more prone to purchasing luxury goods (designer jeans), rather than necessities (a vacuum cleaner), after having committed to a virtuous act (donating for a charity). While most empirical analyses of moral licensing rely on small-sample laboratory experiments, typically with students, Hofmann et al. (2014) recruited a large, demographically and geographically diverse sample ($N > 1{,}200$) of adults from Canada and the United States. They find that committing a moral act decreases the propensity of subsequently committing a moral act, and increases the propensity of committing an immoral act.

### Socio-Psychological Underpinnings of Moral Licensing

There is broad consensus that moral licensing is a relevant behavioral aspect when sequences of behaviors are analyzed (Blanken et al., 2015; Dolan and Galizzi, 2015), yet different approaches for underlying psychological mechanisms have been proposed and empirically analyzed. A theme that consistently emerges across various studies relates to the question "of whether a connection is established between one's behavior (initial or target) and one's values and identity" (Mullen and Monin, 2016, p. 370) and, if so, whether consistent behavior (e.g., to avoid cognitive dissonance) is more likely than moral licensing (or compensation)[3].

[2]Related concepts from the literature also comprise moral compensation (where people try to make up for past bad behavior by morally good behavior) and moral consistency [where people act in line with prior (good) behavior], (cf. Joosten et al., 2013).

[3]Consistent savings behavior would be reflected by a negative sign of $\partial x_o/\partial K$ in Equation (9).

Identity theory discusses two basic rationales of how identity underpins behavior (Nash et al., 2017). Social identity theory proposes that socially available categorizations, e.g., group membership, are integrated with the self-concept to provide self-reference (Tajfel and Turner, 1986). These categorizations have two functions, the first of which is to simplify information processing and to reduce uncertainty by prescribing how to behave. Secondly, they contribute to self-worth through enabling affirming experiences. For example, perceiving oneself as a green consumer can simplify shopping in the supermarket by focusing on organic vegetables. Receiving support for this behavior from peers could contribute to perceived self-worth. In contrast, self-perception theory (Bem, 1972) proposes that people draw on observations of their past behavior to infer their attitudes, emotions and also future behavior. In case of the green consumer this would mean that someone would choose to buy organic because she remembers she did so last time.

With regard to moral self-regulation, the socio-psychological literature has proposed two models to explain self-licensing: the moral credits model and the moral credential model (Monin and Miller, 2001; Merritt et al., 2010; Miller and Effron, 2010; Mullen and Monin, 2016). The moral credits model postulates that individuals accumulate credits in a metaphorical moral bank account that can be used to buy out of positive behavior or offset negative behavior. By contrast, the moral credentials model assumes, similar to self-perception theory (Bem, 1972), that the initial behavior serves as a lens through which subsequent behavior is interpreted. Mullen and Monin (2016) see this as a likely mechanism in case of ambiguity, i.e., when individuals need to judge whether a behavioral choice has a moral dimension.

A narrative review by Mullen and Monin (2016) summarizes the theoretical approaches that have been presented as potential frameworks to explain the emergence of licensing effects. These authors organize the literature on moderators of moral consistency vs. licensing effects, extracting several conceptual themes: construal level, identification and value reflection, progress vs. commitment, and ambiguity. *Construal level* refers to the way that people regard their own initial behavior. If this behavior is considered to be reflective of underlying values, consistent moral behavior should be more likely than licensing. Licensing is expected in case of lower construal levels, which refer to a mindset focusing on "how," i.e., more concretely on specific actions and their consequences. Similarly, approaches referring to *identity* predict licensing in case the relevant behavior is not perceived as salient or relevant for the self-identity. This refers to both the initial as well as the later behavior ("*value reflection*").

Attributional explanations look at licensing effect through the lens of goals. If individuals perceive the initial action as an indicator for *commitment* toward a certain goal, consistent behavior is more likely. However, if the initial action is regarded as *progress* or even completion of the relevant goal, licensing is more likely. More specifically: If eating a salad is perceived as seeing oneself as a person that pursues a healthy lifestyle, it is more likely that no dessert will be ordered. However, if the salad triggers the conclusion that healthy food has been consumed, vitamins been taken in etc., a dessert becomes a justifiable option.

Finally, the notion of *ambiguity* assumes in this context that if the initial behavior is perceived as imposed or triggered by external stimuli (e.g., payment) it is less likely to be perceived as an expression of personal values and thereby loses its power to license later behavior. On the contrary, if the later behavior is ambiguous on moral terms, licensing should be more likely, i.e., short term gains are more likely to be collected.

Mullen and Monin (2016) also review the empirical evidence, but no clear conclusions emerge. While some empirical support is found for the reasoning behind all of these approaches, studies tend to more often predict or trigger consistent behavior, rather than licensing behavior. Taken together, the reviewed approaches suggest that the likelihood of moral licensing decreases if the relevant behavior is performed more consciously and if it is of higher personal relevance. Conversely, a focus on short term gains paves the way for licensing. This is also in line with Joosten et al. (2013), who find that people are more likely to act immorally if their mental resources are depleted, i.e., leaving less resources for higher level processing.

The meta-analysis by Blanken et al. (2015) focusses on possible moderators that determine the existence and strength of a moral licensing effect as detected across empirical studies. They find that published studies tend to report stronger effects than unpublished ones. Otherwise, no significant effect sizes could be established across studies on (a) whether the inducing behavior preceding the moral licensing situation relates to single actions or stable traits of the person under study, (b) whether the relevant behavior potentially subject to licensing is real or hypothetical, (c) whether this behavior is within the same or a different behavioral domain as the inducing behavior, and (d) whether the control condition aimed at negative effects (i.e., morally good behavior) or morally neutral behavior. It is important to note that this does not necessarily allow for the conclusion that these aspects are not moderators of moral licensing, as their influence might be dependent on further contextual variables.

## Moral Licensing in Relation to Pro-environmental Behavior: Empirical Findings

A screening of recent studies shows that some also present empirical evidence for moral licensing related to pro-environmental behavior, i.e., behaviors intended to minimize negative environmental impacts in general (Nash et al., 2017), or to contributing to the provision of a public good (e.g., via a charity). In contrast to the research summarized so far, these studies less often include an additional condition aiming at triggering consistent behavior. Thus, there is a stream of empirical literature on moral licensing that looks into similar phenomenon as the literature on rebound and spillover.

### *Laboratory and classroom experiments/surveys with stated behavior/small-scale field experiments*

Geng et al. (2016) aimed at eliciting licensing behavior according to the progress vs. commitment principle (Mullen and Monin, 2016) in a laboratory setting with student samples. Participants were made to choose from fictitious shopping lists with a higher or lower share of green products. Participants who chose more green products reported lower intentions to subsequently engage in pro-environmental behavior and also used more water in a towel washing task. In a second experiment, participants were first reminded either of goal progress or goal commitment for a range of behaviors (including pro-environmental behavior). Then they were asked to indicate their intentions to engage in pro-environmental behaviors. The findings suggest that licensing effects are stronger for the goal progress group than for the goal commitment group. Similarly, participants in an experiment by Sachdeva et al. (2009) contributed less to pollution abatement measures after being primed by writing a self-referential story with positive traits. Employing a quasi-experimental field study, Meijers et al. (2015) find that donating to charity subsequently lowers intentions to behave in an environmentally friendly manner. In the experiment of Mazar and Zhong (2010), participants were more likely to cheat and to steal when they had purchased in an environmentally conscious store rather than in a conventional store in an earlier stage of the experiment. Based on their findings from a classroom experiment, Clot et al. (2016) conclude that moral licensing effects from donating to an environmental organization are more likely to occur among intrinsically motivated individuals when the preceding virtuous act (time dedicated to an environmental program) is mandatory. Similarly, non-intrinsically motivated individuals are more likely to show licensing effects when they had voluntarily chosen to act virtuously in the first stage of the experiment.

#### *Field experiments and observed market behavior*

Relying on a large dataset of observed food purchases in supermarkets across the UK, Panzone et al. (2012) find that consumers purchase less organic food once they have shown their environmental sensitivity in other domains such as shares of bottled water, total meat, red meat or online food shopping. Jacobsen et al. (2012) analyze changes in electricity consumption in a field experiment in Memphis, Tennessee where participants could choose to purchase one or more blocks of green electricity in a voluntary utility-sponsored green-electricity program (i.e., electricity generated from renewable sources). They find a measurable increase in electricity consumption of 2.5% for households participating at the minimum level of one block, but no change for households purchasing more blocks of green electricity. Yet, this "buy-in-effect" is not large enough to offset the environmental benefits of the program. In contrast, using data from the purchases by loyalty card holders of a Danish retailer, Juhl et al. (2017) find evidence for positive behavioral spillover, i.e., a tendency to buy organic products in an increasing number of product categories over time, thus increasing behavioral consistency over time.

Harding and Rapson (2017) employ billing data from a large-scale field experiment where a major utility in California offered a program to offset customers' electricity-related CO2 emissions at an additional cost. On average, the 748 customers who enrolled in the program were estimated to have increased electricity consumption by 1–3% compared to 13,449 control group households. The authors attribute this finding to a behavioral rebound effect. Arguably, carbon offsets allow some customers' to alleviate their guilt about emitting CO2 at affordable costs, while they continue or even increase a non-virtuous activity.

Ho et al. (2016) use a contingent valuation framed field experiment in an online-survey to explore how peer information inducing culpability (measured as a participant's carbon footprint compared to others') affects participation in a green electricity program (i.e., provision of a public good). The culpability effect is larger when the information makes participants feel good (i.e., their carbon footprint is lower than their peers', corresponding to moral licensing) compared to when this information makes them feel guilty (corresponding to so called moral cleansing)[4]. Their findings also point to the importance of recognizing heterogeneity across individuals: those individuals who were more inclined to act pro-socially mostly drive the effect of culpability.

Similarly, the results of the surveys by Klöckner et al. (2013) among buyers of electric and conventional vehicles in Norway suggest that buyers of electric cars use their vehicle more often for their everyday activities.

Finally, Tiefenbeck et al. (2013) conduct a field experiment in which residents in one building were exposed to information campaigns about water saving measures. Residents in a similar building served as the control group. This campaign reduced water consumption by about 6% on average. At the same time, residents in the treatment group increased electricity consumption by 5.6%, thus suggesting a negative spillover effect across the domains of water and electricity, possibly induced by moral licensing[5].

By better reflecting real life situations, these field experiments have a higher external validity than the laboratory experiments. However, while their findings are consistent with the predictions of moral licensing and moral cleansing, these mechanisms are not rigorously tested impact (cf. Truelove et al., 2014). Thus, moral licensing is only claimed to explain the observed behavior. Using the definitions provided in this paper, most of these studies (with exception of Ho et al., 2016) are in fact studies into spillover or rebound *behavior* without actually exploring the underlying mechanisms.

### Connecting Moral Licensing as a Mechanism With Rebound and Spillover

Research into the rebound effect and its underlying mechanisms can be regarded as following the claim by Dolan and Galizzi (2015 p. 1) that "no behavior sits in a vacuum and we need to consider the possible spillover effects from one behavioral response to the next." To explain the emergence of rebound or spillover behaviors, similar concepts as for moral licensing have been proposed (Thøgersen, 2012; Nash et al., 2017): They assume that positive spillover is more likely to occur if (i) pro-environmental goals and values underpin the behavior, (ii) the behavior is more relevant to identity, (iii) relevant skills

[4] Sachdeva et al. (2009) also find a moral cleansing effect. In their study, participants contributed more to pollution abatement measures after being primed by writing a story with negative trait.

[5] As pointed out by Truelove et al. (2014), the empirical evidence for this conclusion is not very strong though. The difference in electricity use between treatment and control group is only significant for a one-tailed $t$-test, but not for a two-tailed $t$-test.

and knowledge are accessible, and (iv) in case of higher self-efficacy, i.e., the individual feels able to actually show the relevant behavior. Similarly, it can be assumed that in these cases rebound effects are less likely to occur if the efficiency increase is motivated or in line with salient pro-environmental goals and values and/or perceived as more closely connected to self-worth and -identity. However, this might not apply if choosing the more efficient product or service is more strongly motivated by other goals, e.g., cost saving, safety, or comfort. Lacasse (2016) point to these related paths in their study when they find a negative effect of reduced guilt and a positive effect by an increased/more salient environmental self-identity on environmental attitudes following a manipulated recollection of past pro-environmental behaviors.

It is important to note that licensing as a mechanism refers to the moral dimension of behavior, that is, underlying assumptions about right or wrong in relation to values, norms or societal consensus. If a rebound occurs due to access to higher financial means or lack of knowledge, it lacks this moral dimension. Thus, applying the concept of moral licensing to the rebound mainly adds an additional mechanism, but cannot be the only one considered. What is most attractive about drawing on the licensing literature is that it enables a deeper conceptualization to capture the variation in rebound effects due to its relationship with concepts like moral consistency.

## SUMMARY AND CONCLUSIONS

This paper has provided conceptual insights and empirical findings on rebound effects in response to resource efficiency improvements, thereby distinguishing microeconomic from psychological mechanisms, notably moral licensing (see **Figure 2**).

We have developed a unifying theoretical model framed around the example of replacing inefficient night storage heating by a more efficient heat pump that illustrates how economic and psychological mechanisms trigger both rebound and moral licensing effects.

As our review of the empirical literature highlights, the received micro-econometric evidence suggests that while the magnitude of the rebound effect varies depending on the service in question, it may be substantial, particularly for energy services. Most studies have focused on quantifying the direct rebound effects, which describe the increase in the demand for a service following from a decrease in its unit cost through an efficiency improvement. These direct effects tend to fall below 10% for services such as space heating and lighting, but may exceed 60% for services such as water heating and mobility. Evidence on indirect rebound effects, which result when cost savings from an efficiency improvement are spent on both the same service and other goods and services, are more difficult to come by. Nevertheless, failure to recognize these effects may result in substantially underestimating the total rebound effect, which conceivably approaches 100% in some cases.

Evidence on the rebound effect from the psychological literature yields a somewhat murkier picture, for two reasons. First, while psychological theory points to a moral licensing effect, which would increase the rebound when people feel free to engage in "immoral" behavior by increasing their energy consumption, this response may not be universal.

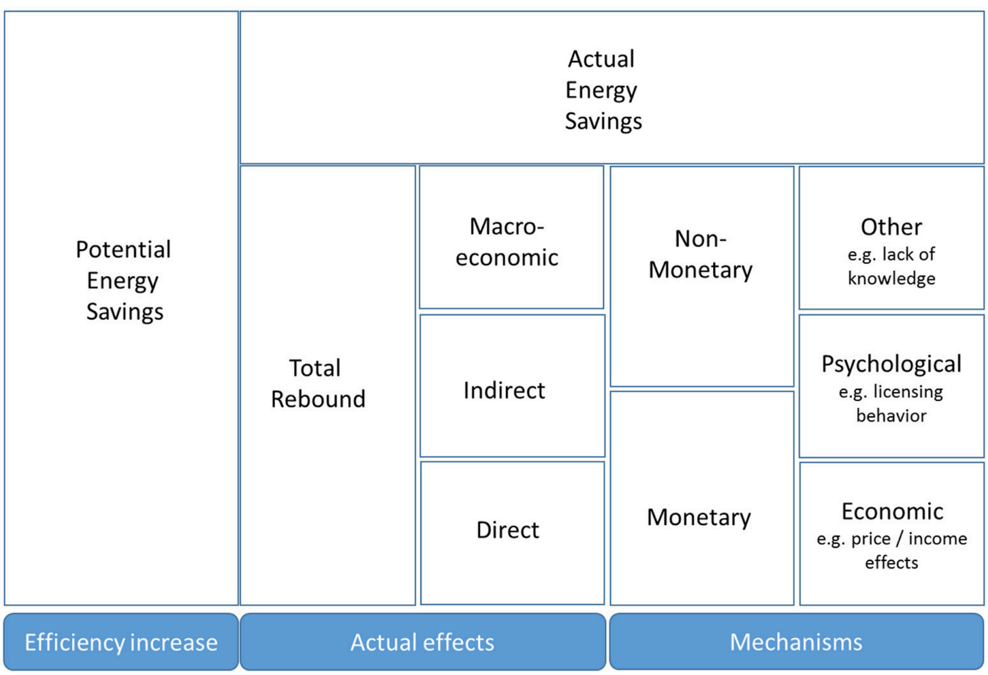


**FIGURE 2 |** Overview on rebound effects and underlying mechanisms.

Alternative mechanisms may have the opposite effect, as when people strive to maintain consistency in their behavior so as to adhere to an underlying set of values. Second, whatever impulse predominates—whether cashing in on good behavior or, conversely, committing to its continuation—the underlying cognitive process makes empirical identification very difficult. While studies may be designed that reveal behavior consistent with a particular psychological explanation, establishing a rigorous cause-effect relationship poses a vexing empirical problem.

Nevertheless, from a policy perspective, additional empirical work quantifying the effects resulting from moral licensing (within and across domains) is warranted. In addition, distinguishing micro-economic rebound and moral licensing effects seems imperative. For example, individuals having purchased an electric vehicle may drive more because costs per kilometer have declined (economic explanation of the rebound effect), or because they perceive purchasing an electric vehicle as a virtuous act (moral licensing), or both. Yet, microeconomic rebound and moral licensing have very different policy implications. For example, a tax on electricity is expected to address the direct rebound effect, but not necessarily moral licensing. Thus, if the observed rebound is triggered by moral licensing, rather than micro-economic mechanisms, traditional policy recommendations to mitigate the rebound may have only a muted effect. Empirically disentangling moral licensing from the microeconomic rebound is consequently important for policy guidance.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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