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**Working Paper**

## Nudging the adoption of fuel-efficient vehicles: Evidence from a stated choice experiment in Nepal

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Swiss Federal Institute of Technology Zurich

# Nudging the Adoption of Fuel-Efficient Vehicles: Evidence from a Stated Choice Experiment in Nepal

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## Abstract

Addressing hazardous levels of air pollution in densely-populated cities in emerging countries requires concerted efforts to reduce fossil fuel use, especially in the transport sector. Given that motorcycles comprise almost 80% of vehicle sales in Nepal, a viable alternative to reduce air pollution is driving more fuel-efficient electric alternatives. However, their adoption has been limited due to a gamut of market failures and behavioral anomalies. In this study, we collect rich data on preferences, socio-economic factors and biases of more than 2,000 potential motorcycle buyers in the Kathmandu valley in Nepal. Using a stated choice experiment with randomized information treatments, we evaluate the role of specific behavioral anomalies in determining the stated-preference of consumers on whether they would be willing to buy an electric motorcycle. We find evidence to suggest that cognitive/skills limitations, framing of information, and the affect heuristic play a role in determining the stated-preference of respondents. In particular, displaying qualitative information on the air pollution impact of their choices, and “priming” them through impactful photographs and texts could have a positive effect. Furthermore, the results also hint at the importance of gender, health status and cognitive skills in determining the effectiveness of these nudges in promoting the adoption of electric alternatives. Implications of this study relate to policy choice in settings similar to Kathmandu, where fuel-inefficient vehicles are preferred and widely used, and the negative externalities due to air pollution are very stark.

**JEL Classification:** D1, D8; Q4; Q5

**Keywords:** Market failures; Behavioral anomalies; Electric vehicles; Stated-choice experiment; Nepal

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# 1 Introduction

The global energy system is currently dominated by fossil fuels, which has resulted in climate change at a global level, as well as local environmental problems such as air pollution. Climate change is currently one of the biggest threats to the health, livelihoods as well as existence of humanity, especially in developing countries that are more vulnerable to its negative effects, with limited resources available for adaptation ([United Nations Framework Convention on Climate Change, 2017](#)). Local air pollution entails several important social costs, such as deteriorating public health and loss of productive hours for residents. According to data from the World Health Organization Global Ambient Air Quality Database, nine out of ten people breathe polluted air, and it kills seven million people each year, almost all of them in Asia and Africa ([World Health Organization, 2018](#)).

Asian cities are particularly vulnerable: in 2018, the Environmental Performance Index (EPI) of Nepal's air quality ranked 176th out of 180 countries ([Wendling et al., 2018](#)). Kathmandu, for instance, is ranked the seventh most polluted city in the world ([Facts Research and Analytics, 2018](#)). An individual living in Kathmandu can expect to gain up to 4.7 years of life if these concentrations of PM<sub>2.5</sub> are reduced to the WHO guidelines ([Energy Policy Institute at the University of Chicago, 2019](#)). Relatedly, data from the Ministry of Health of Nepal suggests that the main cause of all disease-related deaths in the country was lung disease in 2016-2017 ([Facts Research and Analytics, 2018](#)).

The transport sector is the primary cause of greenhouse gas emissions and local pollution, with vehicle emissions being the main source of pollutants such as the PMs in the Kathmandu Valley, and contributing to approximately 63% of all PM<sub>10</sub> emissions ([Stockholm Environment Institute, 2009](#)). The most sought-after mode of private road transport in Nepal are two-wheelers (including motorcycles, combustion engine-based scooters and electric scooters), which accounted for about 80% of vehicle sales in 2016-17 ([Facts Research and Analytics, 2018](#)). In addition to strengthening public transport systems, a potential solution to the problem of pollution from vehicular emissions is individuals switching to driving more fuel-efficient or electric vehicles (which are likely to produce zero emissions, given the high share of hydropower in electricity generation in Nepal).<sup>1</sup> However, consumers have showed less interest in buying fuel-efficient and environmentally clean two-wheelers in Nepal despite their availability and market potential, even though they do not have significantly higher purchase costs, and generally have lower lifetime costs (defined as the discounted sum of purchase costs and operating costs such as petrol or electricity expenses). Several drawbacks related to availability of energy-efficiency information also exists that likely poses a challenge to rational decision-making of Nepalese consumers. There is inadequate disclosure of fuel-economy information at dealerships, both online and in brochures. There is also no system in place for energy-labels on motorcycles. Finally, electric vehicles are still a relatively new technology in the country and not very well known by Nepalese consumers (the share of electric motorcycles sold annually is very small).

In the scientific literature, this behavior is largely viewed through the lens of the “energy-efficiency gap”, i.e. under-investment by agents in energy-efficient technologies or services,

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<sup>1</sup>Hydropower plants are the source of more than 90% of Nepal's total electricity generation capacity, which implies that they use largely renewable sources of energy in generation. Furthermore, this capacity is expected to increase in the future, with several new hydropower plants in the pipeline ([International Hydropower Association, 2019](#)).

when the benefits and costs of owning the durables (such as appliances and vehicles) or services are distributed unevenly over time (Hausman, 1979; Train, 1985; Jaffe and Stavins, 1994). Energy-efficient technologies despite often having higher upfront costs, generally have lower operating costs, and are thus less expensive to own, especially over a longer time horizon (in addition to their environmental benefits). Some of the first papers to theoretically discuss the energy-efficiency gap argued that the diffusion of energy-efficient technologies among consumers is often “slower than optimal” (Jaffe and Stavins, 1994). Allcott and Greenstone (2012) suggest that government interventions or policies that can stimulate energy-efficiency are thus likely to increase welfare for two reasons, a) by reducing the use of fossil fuels, and b) by mitigating imperfect information that may cause consumers and firms to under-invest in energy-efficient technologies that are privately profitable.

This literature primarily attributes the energy-efficiency gap to two sets of factors, “market” failures and “behavioral” (or non-market) anomalies (Shogren and Taylor, 2008; Gillingham and Palmer, 2014). Market failures include, for instance, environmental externalities, liquidity constraints or capital market failures (Golove and Eto, 1996), principal-agent problems, and imperfect (or asymmetric) information (Anderson and Newell, 2004; Allcott and Taubinsky, 2015). Mullainathan and Thaler (2000) broadly categorize behavioral anomalies based on agents either displaying “bounded rationality”, such as cognitive/skills limitations, framing problems, status-quo bias, loss aversion, limited attention, the affect heuristic, and herd behavior; or displaying “bounded willpower”, such as myopia or present bias.

The literature on the identification of both market failures and behavioral anomalies has thus far largely focused on consumers in industrialized countries. In this study, we focus on the role of behavioral anomalies in determining purchase decisions among motorcycle buyers in the Kathmandu valley. We design information interventions to shed light on some of the behavioral anomalies that we think may be relevant in this context and evaluate their effect on the stated choice of respondents regarding which type of motorcycle they would purchase. Our study thus draws on, and adds to, the literature on the randomized treatment based evaluations of policies to address the energy-efficiency gap in a stated-choice setting (Allcott and Knittel, 2019; Davis and Metcalf, 2016; Newell and Siikamäki, 2014; Newell and Siikamki, 2015).

The choice of a stated preference approach here stems from the fact that electric motorcycles are based on a new technology compared to existing internal combustion engine (ICE) based alternatives, and may not be well known in Nepal. Consumers, for instance, may not have adequate information about the technology and its associated costs and benefits. With several unknowns in this context, choice experiments in a stated-preference setup help to shed light on potential drivers and underlying mechanisms and helps lay foundations for future research.<sup>2</sup>

We focus our attention on three behavioral anomalies that we hypothesize to be important determinants of the type of motorcycles purchased in Kathmandu: cognitive/skills limitations, differences in choices based on the framing of information, and the “affect heuristic”. Potential buyers of motorcycles, for instance, may be unable to evaluate the savings over the lifetime from purchasing more fuel-efficient or electric alternatives due to cognitive/ skills limitations (Allcott, 2013). They may make different purchase decisions when information is “framed” in a different manner (Blasch et al., 2019). Lastly, they may base their purchase decisions purely on

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<sup>2</sup>At times the choice between stated and revealed approaches is also usually motivated by practical factors that aim to balance the risks and rewards associated with use of resources in new research locations and new domains.



emotions (Finucane et al. (2000) referred to this as the affect heuristic). We study the effects of three kinds of treatments, 1) Treatment 1, which provides cost-related information on the two motorcycles, 2) Treatment 2, which provides qualitative information on their respective impact on air pollution (through smiley icons), and 3) Treatment 3, a “priming” experiment, where the respondents are shown a picture of a child wearing a face-mask, and provided brief facts on the mortality effects of air pollution in Nepal.

Our objective in this paper is two-fold, a) to evaluate whether these behavioral anomalies influence the stated choice of respondents regarding the type of motorcycle they would purchase (electric, or petrol), and on a broader level, b) to assess (heterogeneous) effects of *treating* these individuals with the three randomly allotted information treatments on their stated choice.

By using stated choice experiments with randomized information treatments, we are able to exploit exogenous variation in the kind of information provided to the respondents to elicit the effect that it has on their stated preferences. The random assignment of respondents to treatments assures that any differences in the choices between the different groups are likely to stem from the effects of the information treatments. Nevertheless, there are limitations of stated preferences based approach as compared to a revealed approach, particularly in terms of interpretation of the results.

For this study, we conduct a survey of about 2500 potential motorcycle buyers in Kathmandu, who are looking to purchase a new motorcycle in the next few months. We collect information on their current vehicles (if they have any), their preferences for the new motorcycle, knowledge of fuel prices and fuel economy, as well as information that will enable us to identify whether certain market and behavioral anomalies may have played a role in hindering the adoption of fuel-efficient (or electric) motorcycles. Additionally, we ask the respondents questions to assess their psychological, risk-related and environmental attitudes, as well as collect information on their socio-economic characteristics.

We find that indeed cognitive limitations, framing of information, and the affect heuristic are likely to influence the stated choice of respondents regarding the type of motorcycle they would like to purchase. While a simple comparison of means suggests that all three treatments were effective (namely, the proportion of the respondents in each treatment group who stated that they would buy an electric motorcycle was significantly higher than in the control group), our results from the regression-based analysis suggest that respondents in Kathmandu are more likely to respond to the framing of information, and to priming of emotions, and while their response to the information treatment that provides information on the running costs of the two motorcycle variants is positive, it is weaker than for the other two treatments.

Our contribution to the literature on the energy-efficiency gap is that to the best of our knowledge, this is one of the first studies to evaluate the role of behavioral anomalies in hindering the adoption of efficient two-wheelers in developing countries. Our study is also one of the first, to our knowledge, to examine the effects of the types of information treatments that we consider in this study, on the likelihood to purchase fuel-efficient motorcycles.

This has important implications for policy-makers in developing countries such as Nepal. It is crucial to identify the role played by market and behavioral barriers in limiting the adoption of energy-efficient (or fuel-efficient) technologies, and given these barriers, to test measures to incentivize consumers to switch to them. While our study adopts a stated-preference approach, it offers interesting and important insights on the factors that are likely to influence

the consumer decision-making process regarding clean mobility in cities such as Kathmandu where consumers (often) have strong preferences for fuel-inefficient vehicles.

The structure of the paper is as follows: Section 2 presents a brief overview of the literature on market failures and behavioral anomalies, Section 3 introduces our data and explains the experimental design, Section 4 presents the results, while Section 5 provides the conclusion and policy implications.

## 2 Previous Literature and Hypotheses

This paper fits in, and contributes to, the strand of economic literature that studies market failures and behavioral anomalies that contribute to the energy-efficiency gap. This literature primarily attributes the energy-efficiency gap to two sets of factors, “market” failures and “behavioral” (or non-market) anomalies ([Shogren and Taylor, 2008](#); [Gillingham and Palmer, 2014](#)). Market failures include, for instance, environmental externalities (which can be both positive and negative), liquidity constraints or capital market failures ([Golove and Eto, 1996](#)), principal-agent problems, and imperfect (or asymmetric) information ([Anderson and Newell, 2004](#); [Allcott and Taubinsky, 2015](#)).

[Mullainathan and Thaler \(2000\)](#) suggest that behavioral anomalies include those that reflect agents displaying what is termed “bounded rationality” (examples include cognitive/skills and information limitations, framing problems, status-quo bias, loss aversion, limited attention, the affect heuristic, and herd behavior) or those that reflect “bounded willpower” (such as myopia or present bias). These are of particular relevance in understanding under-investment in energy-efficient durables.

Bounded rationality is an umbrella term for the cognitive constraints that limit the ability of agents in problem solving, and thus may explain the limited adoption of energy-efficient technologies. Potential buyers of vehicles, for instance, may be unable to evaluate the savings over the lifetime from purchasing more fuel-efficient or electric alternatives due to cognitive/skills limitations ([Allcott, 2013](#)). They may follow the behavior of others, without evaluating the benefits of their decisions for themselves, which [Banerjee \(1992\)](#) first termed “herd behavior” and was later called the “bandwagon effect” ([Corneo and Jeanne, 1997](#)). They may base their purchase decisions purely on emotions (called the “affect heuristic” by [Finucane et al. \(2000\)](#)), or they may make different purchase decisions when varying information is provided to them (framing problems). They may be “loss-averse”, in that are reluctant to buy new technologies. [Heutel \(2019\)](#) finds that loss-averse customers are less likely to invest in energy-efficiency using data from a choice experiment in the US. Thus, they may prefer options that they are familiar with due to the “status-quo bias” or the “endowment effect” (found to be a deterrent towards investing in energy-efficiency using data from a sample of European countries by [Blasch and Daminato \(2020\)](#)). Lastly, consumers may be unaware of the “shrouded costs” of purchasing a vehicle, such as the price of petrol, taxed, maintenance costs etc. due to selective attention or limited salience ([Gabaix and Laibson, 2006](#); [Chetty et al., 2009](#); [Turrentine and Kurani, 2007](#); [Sallee, 2014](#); [Handel and Schwartzstein, 2018](#)).

Bounded willpower refers to the inability of agents to make decisions that are in their long-term interest. For instance, several papers find that individuals being “myopic” or “present-biased”



may be unable to evaluate future petrol cost savings from spending more now to buy an electric or fuel-efficient vehicle ([Frederick et al., 2002](#); [Allcott and Wozny, 2014](#); [Turrentine and Kurani, 2007](#)). [Newell and Siikamäki \(2015\)](#) find that education levels matter greatly in determining discount rates, i.e. more educated individuals have lower discount rates for energy-efficient investments, and that being present-biased has significant implications for studying the under-investment in energy-efficient durables, such as in energy-efficient vehicles.

Of course, given the differences between market failures and behavioral anomalies, one can expect that the choice of optimal policy instruments to address them may also vary. [Kolstad \(1999\)](#) suggests that policies found to be effective in addressing such market failures include Pigouvian taxes, marketable permits, liability rules, mechanism designs, and environmental standards. The set of policy instruments that address the energy-efficiency gap arising due to behavioral anomalies, on the other hand, are not motivated by traditional market failures ([Tsvetanov and Segerson, 2013](#)). Behavior-based policies include mainly regulation instruments such as standards and nudges, that are low-cost interventions which can motivate consumers to modify their behavior ([Allcott and Mullainathan, 2010](#)).

Examples of nudges that have been tested in previous studies include providing energy consumption feedback, catalyzing social approval and norms for adoption of energy-efficient technologies, and encouraging goal-setting and commitments to energy conservation. [Houde et al. \(2013\)](#), for instance, find that real-time feedback can reduce electricity consumption by up to 5.7% among consumers in the US. [Allcott \(2011\)](#) provides an impact evaluation of the OPOWER energy conservation program, also in the US, where letters were mailed to compare a household's energy use to that of its neighbors, and finds an average treatment effect of about 2% on energy use. [McCalley and Midden \(2002\)](#) find that setting a specific goals on energy savings helped survey participants save more energy during washing machine cycles. This relatively nascent literature exploring policy design and effectiveness has largely relied on experimental methods to determine the suitability of different alternatives. As pointed out by [Gillingham et al. \(2018\)](#), randomized controlled trials (or RCTs) have increasingly become the touchstone in the literature to undertake experimental interventions for credible policy evaluation.

As mentioned before, we focus on three behavioral anomalies that we think may be relevant in this context – cognitive/skills limitations, framing of information, and the affect heuristic. We design information interventions and evaluate their effect on the stated choice of respondents regarding which type of motorcycle they would purchase. Our study thus draws on, and adds to, the literature on the randomized treatment based evaluations of policies to address the energy-efficiency gap in a stated-choice setting ([Allcott and Knittel, 2019](#); [Davis and Metcalf, 2016](#); [Newell and Siikamäki, 2014](#); [Newell and Siikamäki, 2015](#)).

Cognitive/skills limitations have been found to be a significant contributor towards under-investment in energy-efficient technologies, as individuals find it difficult to compare their costs and benefits that are distributed over time. Studies have shown that limited levels of skills (measured by standard indicators of financial literacy, as well as by their knowledge of energy-related matters) may lead to sub-optimal decision-making with respect to investment in energy-efficiency ([Blasch et al., 2017, 2018, 2019](#)). They may play an even more significant role in settings where average levels of literacy or education are low to begin with (such as in developing countries like Nepal). For instance, in a study conducted in the south-eastern lowlands of Nepal, [Filippini et al. \(2020\)](#) found that low levels of computational skills were a key determinant of how rational consumers were in terms of their attitudes regarding replacement

of old and energy-inefficient household appliances.

Framing of information has also been shown to have different effects on behavior and preferences of individuals, depending on what kind of information it brings to the attention (or salience) of consumers. For example, [Blasch et al. \(2019\)](#) show that providing information to Swiss consumers on the expected energy consumption of electrical appliances in monetary terms, rather than in quantity terms, was more likely to lead to them correctly identifying appliances having the lowest costs over their lifespan. [Newell and Siikamäki \(2014\)](#) find that providing respondents in a stated choice experiment with an energy label having information on the monetary value of energy savings was the most factor in determining investment in energy-efficiency, while information on the physical energy use and carbon dioxide emissions was not as important. Thus, the kind of information provided to consumers may play a role in determining their eventual choices.

While cognitive and skills limitations may be important factors determining choices of individuals, it is also straightforward to imagine that emotions could also guide these decisions. While the role of emotions in determining investment in energy-efficient technologies (the affect heuristic) has not been studied to the best of our knowledge, it is recognised that emotions may be pivotal determinants of decision-making and possibly, even of bounded rationality ([Kaufman, 1999](#)). One of the three information treatments (described in details in Section 3) that we consider in this paper (Treatment 3) is based on a priming-based experiment, that is closely linked to the affect heuristic, and the notion of emotions influencing decision-making. Another stream of literature that is thus relevant to our study is that on priming, which drawn on both psychology and behavioral economics.

Priming is the activation or stimulation of different identities of an individual through subtle situational cues, which can be used to measure the psychological impact of primed concepts on judgment and behavior in subsequent tasks. [Akerlof and Kranton \(2000\)](#) introduced the concept of identity into economic theory. They developed a model of how an individual's identity, or sense of belonging to a social group, can influence behavior and economic outcomes. They proposed that individuals have multiple identities (e.g. based on their gender, ethnicity, or occupation) that are tied to identity-specific norms that prescribe how people should behave in particular situations. Identity concerns are thought to affect behavior because deviating from the prescribed behavior (i.e. norms) is psychologically costly. Identities may influence behaviour because individuals experience dis-utility if their behaviour deviates from what their identities prescribe ([Akerlof and Kranton, 2000](#); [Cohn et al., 2014](#); [Kessler and Milkman, 2018](#); [Benjamin et al., 2010, 2016](#)).

Priming literature in economics has built on a large literature in psychology demonstrating that identity is a pliable concept. Specifically, this literature has argued and demonstrated that remarkably small forces (e.g., environmental cues or “primes”) can alter facets of an individual's identity (e.g., as a parent, a woman, etc.), and modify their behavior and attitudes ([Cohn et al., 2014, 2015](#); [Hoff and Pandey, 2014](#); [Benjamin et al., 2010, 2016](#); [Chen et al., 2014](#); [Kessler and Milkman, 2018](#)).

Typical priming techniques include actively prompting subjects to think about specific concepts or recollect past experiences. More implicit approaches include the unscrambling of sentences, background music and images, odors, temperature, and subliminal stimuli ([Cohn and Maréchal, 2016](#)). The key identifying assumption is that priming changes the relative weight individuals

attach to a specific identity (and its associated norms) at a given moment. Random assignment ensures that there are no observable and unobservable differences between the priming conditions. Consequently, any behavioral difference between conditions unveils the primed identity's marginal behavioral effect.

### 3 Data and Experimental Design

Our study is based on a survey of 2,500 respondents in the districts of Kathmandu, Bhaktapur, and Lalitpur in Nepal. The field survey was conducted in the form of computer assisted personal interviews (CAPI) over three weeks during the months of October and November in 2019 in collaboration with a local survey partner.<sup>3</sup> The survey was prepared in English by the research team and translated to Nepali by the survey partner prior to the field run. We prepared the survey questionnaire following an exhaustive review of the literature on market failures and behavior anomalies, particularly in the context of adoption of energy-efficient durables. As a result, our questionnaire draws on, and builds upon survey questions asked in existing studies, such as in [Filippini et al. \(2020\)](#); [Blasch et al. \(2018, 2019\)](#); [Heutel \(2019\)](#); [Allcott and Knittel \(2019\)](#).<sup>4</sup>

The target respondents for the survey were those individuals who expressed intent in buying a new motorcycle, which includes both first-time buyers and existing owners of one (or more) motorcycles. All respondents stated that they were either certain that they wanted to purchase a motorcycle in the next few months, or that they were at least considering it.

The survey participants were sampled at places where one might expect a higher share of potential and existing motorcycle owners, such as at universities, near motorcycle dealerships, public and office parking places. Given the large share of motorcycle ownership in the Kathmandu valley, as well as the opportunities that are available to potential buyers to invest in more efficient vehicles, this region was a natural choice of location for this study. The total survey sample consists of 2,500 respondents of which 1,660 are first-time (potential) buyers and 840 already own at least one motorcycle.

The main objective of the survey was to collect information on attributes that may be relevant to assess the purchase decisions regarding motorcycles, and to evaluate any potential role of various types of market failures and behavioral anomalies in determining under-investment in fuel-efficient motorcycles. The survey also collected respondents' socio-economic and household related information. Some questions were designed to specifically help us ascertain their energy-related knowledge, financial literacy, and awareness on issues related to local air pollution. The survey was designed for the purpose of conducting the stated-choice experiments, as opposed to a revealed preference study. Thus, it was structured in a manner that the stated-preference questions were asked early in the survey, so as to not bias the answers of the respondents.

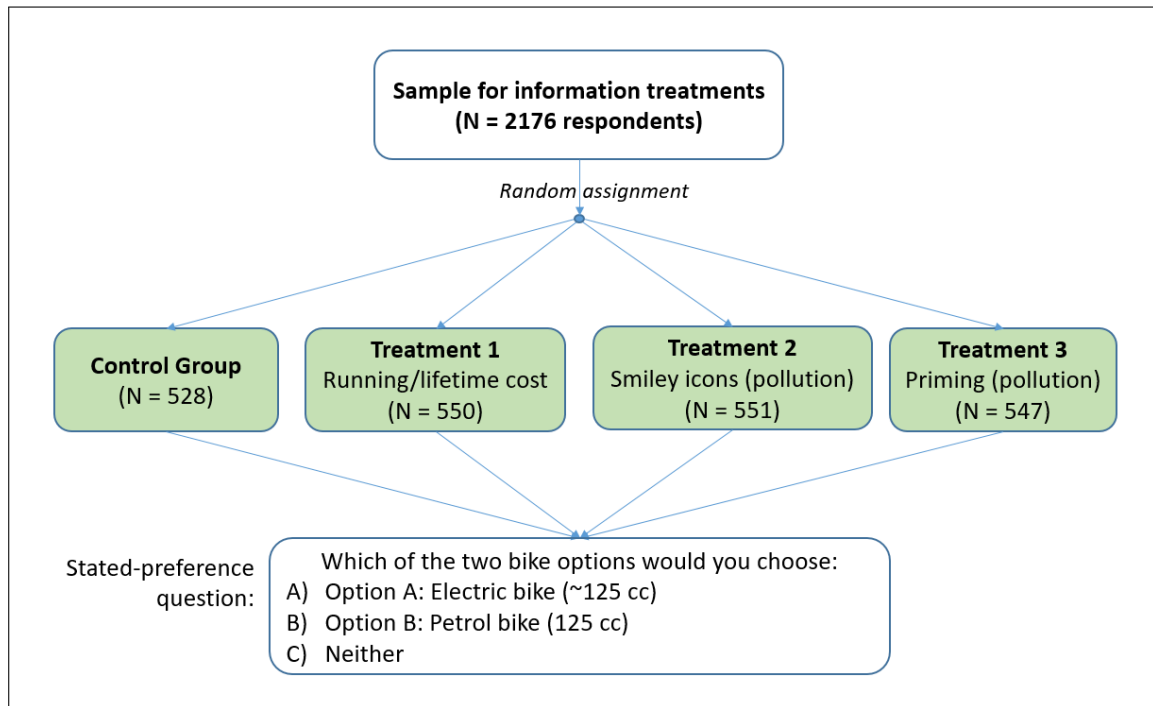
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<sup>3</sup>The survey partner, FACTS Research & Analytics, is a Kathmandu-based marketing and research firm that has several years of experience in conducting field surveys in Nepal.

<sup>4</sup>Prior to the actual field survey, we also conducted a pilot test with 104 respondents, and adapted the questionnaire according to the feedback received, particularly related to reducing the length of the survey. The final questionnaire took about 22 minutes to complete (median duration). At the start of the CAPI-based survey, enumerators informed the respondents about the goals of the study, conditions and incentives for participation, data privacy, and simple instructions on completing the questionnaire.

The respondents were randomly assigned into one of the two experiments during the survey – 2,176 respondents were part of the stated-choice experiment with randomized information treatments that we study in this paper (further described below), and the remaining 324 respondents were part of a second experiment. This second data sample was used for another study, that is entirely independent of the study we focus on in this paper.<sup>5</sup>

We now describe the stated-choice experiment with the randomized information treatments. As a part of this experiment, the respondents were given a hypothetical situation in which they commute 20 kilometres daily by bus, and told that they were considering buying a new motorcycle. They were then asked to state their preference among the two given motorcycle options (one petrol motorcycle, and a comparable electric motorcycle). Respondents were randomly divided into four groups, the **Control** group, the **Treatment 1** group who were provided information on the running costs of the two vehicles, the **Treatment 2** group who were shown smiley-face icons to illustrate the air pollution-related impact of owning these vehicles, and the **Treatment 3** group who were part of a priming-based exercise in which they were provided information on the health impact of air pollution, along with a visual-based prime. Figure 1 depicts the experimental design.<sup>6</sup>



**Figure 1:** Experimental design.

At the crux of our experimental design was the goal to elicit the stated preference of respondents regarding the type of motorcycle that they would purchase (a electric motorcycle versus a comparable petrol motorcycle), in response to the three different treatments. The first treatment, **Treatment 1**, involved informing them about the running costs of a petrol motorcycle, and a

<sup>5</sup>The first experiment looks at respondent's stated-preference of motorcycles in response to randomized information-based treatment (e.g., providing information on running cost, on air pollution, as well as a priming-based intervention) while the second experiment aims to assess herd behavior in the adoption of powerful, fuel-inefficient motorcycles. The two studies are completely independent of one another.

<sup>6</sup>We conducted this experimental component early on in the survey, so as to not bias the answers of the respondents from taking the rest of the survey.

comparable electric motorcycle, and informing them that the total cost of owning a motorcycle is the sum of the purchase cost and the running costs. The second treatment, **Treatment 2** was more qualitative or descriptive in nature, and it illustrated the air pollution impact of owning both kinds of motorcycles with the means of “smiley-face icons” (a “happy” smiley icon for the electric motorcycle, and a “sad” smiley icon for the petrol motorcycle). The third and final treatment, **Treatment 3**, involved a “priming” exercise, where we presented some facts on the mortality and health effects of air pollution in Nepal (and in Kathmandu). In addition, we utilized an image-based priming technique, where we showed the respondents an image of a child wearing a mask in order to trigger a (possibly strong) emotional response in the respondents that may potentially influence their decision.<sup>7</sup>

The respondents were asked about their preferred motorcycle choice (electric versus petrol) after the treatment information was presented to them. Figure 2 presents the information in the form that it was shown to the respondents in each of the four groups in the survey.

For the analysis in the following sections of this paper, we restrict the data sample to those respondents who state that they are the main decision-makers in the household with respect to the purchase of durables such as motorcycles, and to those that state they are the main users of the motorcycles (if they already own one). Moreover, we exclude observations that were collected on two CAPI devices (out of the 25 devices that were used by the survey-collectors) because of data quality concerns with the information collected on these devices.<sup>8</sup> This data cleaning reduces the sample size to 1965 observations (out of a possible 2176 observations).

In order to further test for the quality of randomization, Table 1 includes information on the balance of a set of important covariates across the four groups in our data sample. We report the means and standard deviations of these variables, as well as the computed T-tests for conducting a comparison of means (and testing whether the difference in means of the variable over control and the respective treatment groups is significant). We find that the means of the variables considered ‘one at a time’ across the treatment groups are more or less similar to those of the control except for a few deviations.<sup>9</sup> In addition, the test for joint orthogonality of these sampling variables is satisfied for each of the three treatments at the 1% level, using an F-test.<sup>10</sup>

Given this result, and the fact that we are randomizing the information treatments, a simple comparison of the mean values of the share of respondents who stated that they would prefer the electric motorcycle between treatment and control groups should suffice to evaluate the impact

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<sup>7</sup>The affect heuristic involves a reliance on feelings, good or bad, generated after experiencing some type of stimulus, in making judgements or evaluations which need to be quick. Affect-based judgments are more pronounced when people do not have the resources or time to reflect (Finucane et al., 2000). By priming the respondents with the photograph as well as the text, we are trying to elicit whether they are responsive to such stimuli, and in which direction exposure to such stimuli makes their decisions tilt.

<sup>8</sup>The two devices were used to collect information on a total of 211 respondents (105 on one and 106 on the other).

<sup>9</sup>Deviations are mainly observed with respect to household size (across all treatment groups), age (only in Treatment 1), bachelors and masters education (in treatment 1), and household income less than Rs. 30,000 (in Treatment 2) and above Rs. 75,000 (across all treatment groups). We are unable provide a systematic explanation for these deviations, as the respondents were randomly grouped using the built-in randomization of the CAPI survey software. Moreover, we also dropped observations on respondents surveyed using two specific devices where there appeared to be differences in treatment allocation. Nonetheless, we note that the absolute differences appear to be rather small, and are unlikely to affect the main results in this paper.

<sup>10</sup>These results can be provided on request.

Let's assume a hypothetical situation, where you commute about 20 kms by bus on a daily basis. You are considering buying a new bike. Let us assume that you need to choose among one of the two options shown in the table below.



	Option A 	Option B 
Fuel type (power)	Electric (~125cc)	Petrol (125cc)
Purchase Price (Rs.)	2,35,000	2,24,900

\*Fuel prices in Kathmandu: Petrol = Rs. 110/lt. & Electricity = Rs. 10/kwh

(a) Control Group

Let's assume a hypothetical situation, where you commute about 20 kms by bus on a daily basis. You are considering buying a new bike. Your friends who already own a two-wheeler tell you that the **total cost = purchase price + running cost** where the running cost depends upon kms/day, price of fuel and the lifetime of a motorcycle.





Let's assume that you need to choose among one of the two options shown in the table below.

	Option A 	Option B 
Fuel type (power)	Electric (~125cc)	Petrol (125cc)
Purchase Price (Rs.)	2,35,000	2,24,900
Cost per km (Rs./km)*	0.30 – 0.40	1.80 – 2.20

\*Fuel prices in Kathmandu: Petrol = Rs. 110/lt. & Electricity = Rs. 10/kwh

(b) Treatment 1

Let's assume a hypothetical situation, where you commute about 20 kms by bus on a daily basis. You are considering buying a new bike. Let's assume that you need to choose among one of the two options shown in the table below.

	Option A 	Option B 
Fuel type (power)	Electric (~125cc)	Petrol (125cc)
Purchase Price (Rs.)	2,35,000	2,24,900
Air pollution		



\*Fuel prices in Kathmandu: Petrol = Rs. 110/lt. & Electricity = Rs. 10/kwh

(c) Treatment 2

Air pollution kills 600,000 children every year worldwide, and it shortens the expected lifespan of children. In Kathmandu, a child can expect to gain up to 4.7 years of life if the WHO guidelines for PM2.5 concentrations are met. (Source: Air Quality Life Index)



Now, let us assume a hypothetical situation, where you commute about 20 kms by bus on a daily basis. You are considering buying a new bike. Let's assume that you need to choose among one of the two options shown in the table below.

	Option A 	Option B 
Fuel type (power)	Electric (~125cc)	Petrol (125cc)
Purchase Price (Rs.)	2,35,000	2,24,900

\*Fuel prices in Kathmandu: Petrol = Rs. 110/lt. & Electricity = Rs. 10/kwh

(d) Treatment 3

Figure 2: Information slides used in the randomized experiment.



**Table 1:** Balance of basic attributes across the control and treatment groups

	Control group N=477	Treatment 1 N=500		Treatment 2 N=493		Treatment 3 N=495	
	Mean (Std. Dev.)	Mean (Std. Dev.)	T-test	Mean (Std. Dev.)	T-test	Mean (Std. Dev.)	T-test
Whether owns a motorcycle	0.323 (0.468)	0.370 (0.483)	(-1.548)	0.339 (0.474)	(-0.525)	0.289 (0.454)	(1.149)
Female	0.287 (0.453)	0.306 (0.461)	(-0.642)	0.329 (0.470)	(-1.396)	0.311 (0.463)	(-0.813)
Age	28.161 (6.997)	29.352 (7.581)	(-2.547)***	28.708 (6.941)	(-1.221)	28.398 (7.025)	(-0.526)
<i>Level of education</i>							
High school or below	0.423 (0.495)	0.450 (0.498)	(-0.835)	0.477 (0.500)	(-1.665)*	0.430 (0.496)	(-0.215)
Professional education	0.029 (0.169)	0.046 (0.210)	(-1.363)	0.030 (0.172)	(-0.098)	0.046 (0.496)	(-1.394)
Bachelors	0.463 (0.499)	0.382 (0.486)	(2.579)***	0.426 (0.495)	(1.170)	0.434 (0.496)	(0.907)
Masters	0.084 (0.277)	0.122 (0.328)	(-1.959)***	0.067 (0.250)	(0.998)	0.089 (0.285)	(-0.279)
Whether a student	0.270 (0.445)	0.234 (0.424)	(1.312)	0.254 (0.435)	(0.598)	0.269 (0.444)	(0.062)
Whether married	0.403 (0.491)	0.452 (0.498)	(-1.563)	0.454 (0.498)	(-1.632)*	0.370 (0.483)	(1.050)
Household size	4.998 (1.370)	5.206 (1.556)	(-2.215)**	5.215 (1.530)	(-2.326)***	5.307 (1.776)	(-3.032)***
<i>Monthly household income</i>							
Less than Rs. 30,000	0.217 (0.413)	0.197 (0.398)	(0.769)	0.167 (0.373)	(1.943)**	0.189 (0.392)	(1.049)
Between Rs. 30,000 – 50,000	0.432 (0.496)	0.382 (0.486)	(1.535)	0.422 (0.494)	(0.304)	0.428 (0.495)	(0.134)
Between Rs. 50,000 – 75,000	0.268 (0.443)	0.305 (0.461)	(-1.240)	0.286 (0.452)	(-0.615)	0.240 (0.428)	(0.948)
More than Rs. 75,000	0.083 (0.277)	0.117 (0.321)	(-1.682)*	0.126 (0.332)	(-2.092)**	0.143 (0.350)	(-2.851)***

Note: The table reports the means and standard deviations (in parentheses) for some of the main sampling variables across the four groups, as well as the T-statistics for testing the difference in means between the control group and the respective treatment groups for these variables. Due to 114 missing observations for the income variable (respondents who didn't know their income or chose not to answer the question), the number of observations for this variable are 456, 463, 462 and 470 across the groups. 'Rs.' refer to Nepali Rupees (Rs. 114.5 = 1 USD on 29.01.2020).

\*, \*\* and \*\*\* respectively denote significance at 10%, 5% and 1% levels.

of the treatments. However, for the sake of completeness, we also estimate probit models to compute the average treatment effects on the treated, incorporating several explanatory variables.

Next, we present information on the summary statistics for these modeling variables used in our analysis. We provide these summary statistics for the regression sample that is used in our estimations (1965 observations) and the overall survey sample (2,500 respondents) in Table 2. About one-third of the sample already own motorcycles. 30% of the respondents are female, and in general, the respondents are young (the average age is about 28 years). Likewise, about 25% of respondents in our sample are students. About 42% of the respondents are married, with the average size of the household being roughly about 5 members.

The highest level of formal education attained by the respondent in our data sample can be categorized as high school or below (45%); professional (or vocational) education (4%); having a Bachelors degree (42%); and having a Masters degree (9%). Almost half of the respondents in the sample thus have a relatively low level of education. Likewise, the measure of monthly household income is captured across four broad categories: below Rs 30,000 (20%); between Rs. 30,000 – 50,000 (about 42%); between Rs. 50,000 – 75,000 (about 27% in our regression

**Table 2:** Summary statistics for the overall survey sample and the regression sample

	Overall Survey		Regression Sample	
	<i>Mean</i>	<i>Std. Dev.</i>	<i>Mean</i>	<i>Std. Dev.</i>
Whether owns a motorcycle	0.336	0.472	0.330	0.470
Female	0.296	0.457	0.308	0.462
Age	28.478	7.083	28.661	7.152
<i>Level of education</i>				
High school or below	0.452	0.498	0.445	0.497
Professional education	0.035	0.183	0.038	0.192
Bachelors	0.419	0.494	0.426	0.495
Masters	0.094	0.292	0.091	0.287
Whether a student	0.242	0.429	0.256	0.437
Whether married	0.416	0.493	0.420	0.494
Household size	5.169	1.573	5.183	1.569
Whether a member of any club or society	0.288	0.453	0.303	0.460
<i>Monthly household income</i>				
Less than Rs. 30,000	0.195	0.397	0.192	0.394
Between Rs. 30,000 – 50,000	0.404	0.491	0.416	0.493
Between Rs. 50,000 – 75,000	0.256	0.436	0.274	0.446
More than Rs. 75,000	0.145	0.352	0.117	0.322
Whether household receives remittances	0.202	0.401	0.206	0.405
Whether self/family member known to have a respiratory disorder	0.088	0.283	0.090	0.286
Would prefer to buy latest innovations	0.567	0.496	0.556	0.497
Whether someone owns an electric motorcycle in social circle	0.283	0.450	0.308	0.462
Whether got a math grade higher than 80% in high school	0.081	0.273	0.076	0.266
Whether got an overall grade higher than 80% in high school	0.086	0.280	0.088	0.283

*Note:* The overall survey sample comprises 2,500 observations, whereas the regression sample comprises 1965 observations. The number of observations for the income-related variables are 2349 in the overall sample and 1851 in the regression sample respectively, due to missing values of this variable. Age varies from 17 to 58, and household size from 1 to 17. All other variables are dichotomous.

sample); and above Rs. 75,000 (12% in our regression sample).<sup>11</sup> This information is missing for about 6% of the total observations, i.e. 151 respondents in the overall sample did not disclose their income.<sup>12</sup>

In addition to these socio-economic variables, we also utilize some other variables in our models that we hypothesize may play a role in determining the choice of the respondents. For instance, we believe that social influence, and opinions of others in the social circle, may be a factor determining the stated choice of respondents. We find that about 30% of the respondents in our regression sample are members of some type of clubs or societies (such as neighborhood associations, student clubs, political associations, environmental groups, etc.). Moreover, about 31% of respondents state that they know someone in their social circle who already owns an electric motorcycle. About 56% of respondents in the sample state that they would like to buy the latest innovations (such as an iPhone), even if they didn't need it. This also points to the role that fads may play in determining the decisions of consumers in this context.

We also control for some other factors that may be important, such as whether the household receives remittances from family members working abroad (about 21% state that they do), and whether they themselves, or any family member of the respondent, are known to suffer from a respiratory disorder (9% of respondents stated that this was the case). Lastly, we find that about 8% of the respondents secured a grade higher than 80% in their high school math exams (self-reported), which we categorize as a high grade, whereas 9% received an overall grade higher than 80% (averaged over all the subjects that they took in high school). This information captures cognitive skills of the respondents, and is used to compute heterogeneous treatment effects later in the paper.

## 4 Methodology and Results

### 4.1 Main Results

In order to analyze the impact of the different treatments on the outcome variable, namely the likelihood of stating that they would choose an electric motorcycle over a similar petrol alternative, we first calculate the proportion of respondents in each group (control, and treatments 1, 2 and 3) who state that they would opt for the electric motorcycle, and compare the means across these groups. Secondly, we also provide regression-based results, where we are able to incorporate socio-economic and other relevant controls in the models, and report the coefficients of these estimations, as well as the marginal effects. The results for the comparison of means across groups are reported in Table 3, while the regression-based results are provided in Tables 4 and 5.

Table 3 presents statistics on the proportion of respondents in each group who stated that they would choose the electric motorcycle. While the percentage in the control group was about 16.35%, it was 21% in the group for Treatment 1, 26% for Treatment 2, and the share

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<sup>11</sup>These shares appear reasonable – the average monthly household income in urban areas of Nepal in 2015 was Rs. 32,336 according to the available statistics from CEICDATA and Nepal Rastra Bank ([www.ceicdata.com/en/country/nepal](http://www.ceicdata.com/en/country/nepal), accessed 29.01.2020).

<sup>12</sup>The number of missing observations for the income variable is 114 in the regression sample. This reduces our final regression sample to 1851 observations, out of 1965 observations.

was roughly 25% for respondents in the Treatment 3 group. The proportion of respondents choosing an electric motorcycle in each treatment group, compared to that in the control group, are significantly different from each other (at the 5% level in the case of Treatment 1, and at the 1% level for Treatments 2 and 3) using one-sided T-tests. These findings suggest that, compared to the control group, the treatments are likely to have had a positive effect on the likelihood of respondents stating that they would choose an electric motorcycle.

**Table 3:** Treatment Effects: Comparison of means

Group	Control	Treatment 1	Treatment 2	Treatment 3
Proportion opting for the electric bike	16.35 (0.017)	20.60 (0.018)	25.96 (0.020)	24.65 (0.019)
Observations	477	500	493	495

*Note:* The table reports the means and standard errors (in parentheses) for the outcome variable (whether the respondents selected the electric motorcycle in the stated-choice question) across the four groups. The total sample size for this analysis is 1965 respondents, including those who stated that they are the main decision-makers with respect to the purchase of durables (such as motorcycles) in their household, as well as the main users of the motorcycle. This sample excludes observations that were collected on two tablets (out of the 25 tablets that were used for data collection), tablet numbers 9 and 24, on which the distribution of observations across the control and treatment groups appeared non-random.

Since the respondents were randomly assigned to the treatments, the treatment allocations provide exogenous variation in the information that respondents were provided prior to stating their preference. As anticipated, we can also estimate the effect of the treatment on the likelihood of choosing an electric motorcycle by estimating a probit model of the form:

$$E_i = \alpha_i + \beta D_{i,j} + \delta X_i + \epsilon_i, \quad (1)$$

where  $E_i$  is dichotomous and denotes whether respondent ' $i$ ' chose the electric version of the motorcycle,  $D_{i,j}$  is an indicator for whether respondent  $i$  was treated by Treatment ' $j$ ' ( $j = 1,2,3$ ),  $X_i$  denotes the set of respondent-specific socio-economic controls,  $\alpha_i$  denotes the intercept and  $\epsilon_i$  denotes the residual. This model is estimated using Huber-White robust standard errors that are heteroscedasticity-consistent. We are interested in estimating the average treatment effects on the treated, namely the parameter  $\beta$ .<sup>13</sup> We estimate this model separately for each of the three treatments ' $j$ ', and also a model combining the three treatment indicators in one model. These results are provided in Table 4.

The results of regression-based models to identify the effect of the treatments on the stated choice of type of motorcycle are presented in Table 4, which includes the coefficients from these estimations. Columns (1), (2) and (3) present the results of Treatments 1, 2 and 3 respectively, taking one indicator at a time. Lastly, in the results of column (4), we include all three treatment indicators simultaneously (since treatment assignment was random, we expect there to be no correlation across these three indicators).

From the results of column (1) and (4), we find that while Treatment 1 had a statistically insignificant effect (at the 10% level) on the likelihood of respondents stating that they would

<sup>13</sup>In our context, the risk of selection (either on observables or on unobservables) is minimal, as the respondents were randomly allocated across treatment and control groups by the survey-collectors. However, given that the population comprises the control group and three different treatment groups, the coefficients capture the average treatment effect on the treated, rather than the average treatment effect.

**Table 4: Regression Results**

Model Column	Treatment 1 only (1)	Treatment 2 only (2)	Treatment 3 only (3)	All three treatments (4)
Treatment 1	0.135 (0.100)			0.157 (0.099)
Treatment 2		0.313*** (0.099)		0.297*** (0.098)
Treatment 3			0.280*** (0.099)	0.294*** (0.097)
Whether owns a motorcycle	0.111 (0.110)	0.111 (0.107)	0.158 (0.112)	0.085 (0.075)
Female	0.234** (0.116)	0.227** (0.109)	0.399*** (0.110)	0.280*** (0.076)
Age	0.012 (0.009)	0.011 (0.009)	-0.005 (0.009)	0.006 (0.007)
<i>Level of education</i>				
Professional education	-0.078 (0.265)	0.154 (0.289)	0.121 (0.239)	0.047 (0.171)
Bachelors	-0.278*** (0.114)	-0.18* (0.106)	-0.343*** (0.108)	-0.260*** (0.075)
Masters	0.069 (0.166)	-0.016 (0.184)	-0.290 (0.189)	-0.094 (0.121)
Whether a student	-0.103 (0.139)	-0.286** (0.134)	-0.152 (0.129)	-0.069 (0.092)
Whether married	-0.025 (0.141)	-0.132 (0.134)	0.084 (0.134)	-0.091 (0.095)
Household size	-0.014 (0.038)	0.026 (0.035)	-0.033 (0.031)	-0.005 (0.023)
Whether a member of any club or society	-0.081 (0.111)	0.053 (0.110)	-0.162 (0.112)	-0.029 (0.077)
<i>Monthly household income</i>				
Between Rs.30,000 – 50,000	0.496*** (0.150)	0.452*** (0.147)	0.612*** (0.165)	0.545*** (0.107)
Between Rs.50,000 – 75,000	0.639*** (0.165)	0.431*** (0.160)	0.765*** (0.184)	0.601*** (0.118)
More than Rs.75,000	0.239 (0.235)	0.055 (0.219)	0.726*** (0.222)	0.440*** (0.146)
Whether household receives remittances	-0.266** (0.133)	-0.021 (0.124)	0.188 (0.125)	-0.022 (0.087)
Whether self/family member has a respiratory disorder	0.063 (0.182)	0.438*** (0.152)	0.157 (0.175)	0.247** (0.114)
Whether prefers to buy latest innovations	-0.441*** (0.101)	-0.334*** (0.098)	-0.379*** (0.099)	-0.390*** (0.067)
Whether anyone in social circle owns an electric motorcycle	0.238** (0.114)	0.169 (0.108)	0.195* (0.116)	0.194*** (0.076)
Observations	919	918	926	1851

*Notes:* This table reports the coefficients of the models. The probit methodology is used for these estimations. Dependent variable in columns (1) to (4) is a dummy variable for whether the respondent stated that he or she would choose an electric motorcycle in the stated choice experiments. The regression sample of 1851 observations in column (4) includes only those respondents who are the main decision-makers in the family regarding purchase of durables, as well as the main users of the motorcycles (if they already own one), and excludes observations that were collected on two devices for which the distribution of observations across the control and treatment groups appeared non-random, as well as those observations for which the income is missing. The coefficient on the constant has not been reported.

The reference category for the level of education is high school or below, and for the monthly household income is income less than Rs.30,000.

\* \*\* and \*\*\* respectively denote significance at 10%, 5% and 1% levels. Huber-White heteroscedasticity-consistent standard errors are reported in parentheses.

buy an electric motorcycle, compared to the control group, the positive coefficient suggests that it may have increased the likelihood of respondents selecting the electric motorcycle, at least for some categories of respondents.<sup>14</sup> The magnitude of the coefficients of Treatments 2 and 3 on the likelihood of choosing an electric motorcycle are larger (and significant at the 1% level) than those of Treatment 1, as the results of columns (1), (2) and (3) suggest.<sup>15</sup> However, when we use testing to see whether the coefficients are different from one another in the results of column (4), we find that while the dummies for Treatments 2 and 3 are significant at the 1% level, they are not statistically different from one another in magnitude even at the 10% level (or even statistically different to the coefficient on the Treatment 1 dummy). Note that in estimating and interpreting these results, we assume that conditional on the covariates, there are no unobservable differences between respondents in the treatment and control groups.

We also find consistent evidence to suggest that the probability of respondents choosing the electric motorcycle is significantly higher if they are female (a result which holds across all models in Table 4), while their age is found to be an insignificant determinant of this decision. Regarding the role of the level of education of the respondents, it is interesting to note that respondents having a Bachelors degree had a significantly lower likelihood of choosing the electric motorcycle, compared to a respondent in the group with the lowest level of education (i.e. high school or below). We do not observe a similar effect for those with professional education or a Masters degree. We hypothesize that this may partially be driven by a significantly higher share of students in the group having a Bachelor's degree, compared to the group of those having a high school diploma.<sup>16</sup>

Likewise, we find that higher levels of income are a positive determinant of this likelihood, even though the effect is insignificant for the highest income group (with monthly income greater than Rs. 75,000) in columns (1) and (2). Thus, one can assume that higher income levels may play a role in the decision to adopt electric motorcycles. However, we also find some evidence to suggest that respondents who receive remittances from abroad are less likely to choose an electric motorcycle (the variable is only significant in the results of column (1), with a negative coefficient, though).

We find an insignificant role for socio-economic factors such as whether the respondents are married, household size, and whether they are members of some kind of clubs or societies (through which information flows may be stronger), across models. Moreover, whether the respondent already owns a motorcycle is also an insignificant determinant of their decision to choose an electric alternative.

Respondents who stated that either they themselves, or a family member, had a respiratory disorder, were more likely to choose the electric motorcycle, as the results of columns (2)

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<sup>14</sup>We explore this further in the next section of the paper.

<sup>15</sup>The results of column (3) are validated when we include a control for whether the respondents were emotionally aroused after seeing the information in the text and photo in Treatment 3, instead of the treatment indicator. Immediately after being shown the information as part of the treatment 3, respondents were asked "How emotionally aroused do you feel now?". The response on a five-point Likert scale varied from 'Not at all' to 'To a very high degree'. This control is a dichotomous variable, which is set to 1 for all those who chose 'To a high degree' or 'To a very high degree' (about 54% of respondents in the Treatment 3 group). This finding is in line with the hypothesis that the effect of priming on decisions such as choice of motorcycles is more likely to work through the emotional trigger it generates in the respondents.

<sup>16</sup>Students have a lower likelihood of choosing electric motorcycles than non-students in our sample (with the difference being significant at the 10% level).



and (4) suggest. This is expected, given that electric motorcycles are not polluting, and thus unlikely to be the cause of any respiratory ailments. Moreover, respondents who stated that they knew someone in their social circle who owned an electric motorcycle, were also more likely to choose the electric motorcycle, suggesting that word-of-mouth, or social learning may also play a role in their decision to choose the electric version.

Another interesting result to emerge from these findings is that those individuals who stated that they are likely to buy the latest innovations (such as iPhones), even if they don't really need them, are less likely to buy an electric motorcycle. This may partially reflect the preferences of younger respondents towards petrol-based motorcycles having larger engine sizes (and the existence of a "fad" for such motorcycles), as well as the possibility that electric motorcycles may not necessarily be viewed as technological innovations in this context.

**Table 5: Marginal effects**

	Treatment 1	Treatment 2	Treatment 3
Average marginal effect	0.041 (0.026)	0.083*** (0.027)	0.082*** (0.027)

*Note:* The table reports the average treatment effects on the treated (the marginal effects corresponding to the coefficients on the treatment dummies in Table 4, calculated at the means of the independent variables) and standard errors (in parentheses). The results correspond to the coefficients from the probit estimation in column (5) of Table 4 that includes all three treatments and uses 1851 observations.

\*, \*\* and \*\*\* respectively denote significance at 10%, 5% and 1% levels.

Lastly, we derive the average marginal effects following the probit model estimation results provided in Table 4. For this purpose, we consider the model in column (4) that includes all three treatments. Table 5 reports the effect of each of the treatments on the probability of opting for the electric motorcycle, compared to the control group (at the means of the independent variables). Each of the three treatments appears to have had a positive effect on the stated choice of the respondents. While the marginal effect of Treatment 1 is found to be insignificant, the marginal effects of Treatment 2 (8.3 percentage points) and Treatment 3 (8.2 percentage points) are found to be strong, and highly significant compared to the control group. These average marginal effects can be interpreted as average treatment effects on the treated in our context, given that they evaluate the effect of each of the three treatments on the likelihood of choosing the electric motorcycle, compared to the control group.

## 4.2 Heterogeneous Effects

In Table 6, we present the results of the estimation of heterogeneous marginal effects for the three treatments, over the dimensions of gender, health and education. In our opinion, these are relevant and interesting variables over which we can compute the conditional average treatment effects on the treated.

Both the psychology and economics literature, for instance, have established that women are likely to display emotion more openly than men, and also feel emotion more intensely

(Harshman and Paivio 1987; Croson and Gneezy 2009). Women also report more intense nervousness and fear than men in anticipation of negative outcomes, and are thus also more likely to be risk-averse than men (Fujita et al. 1991; Croson and Gneezy 2009). In the context of our study, this implies that women are likely to respond more positively in response to the priming treatment than men, as women are more likely to be affected by the emotional cues, and we believe, thus more likely to choose the environmentally-friendly electric motorcycle.

Likewise, salience of information has been known to influence decision-making in the economics literature. Studies have found that individuals can make context-dependent choices, based on attribute-weighting (Chetty et al. 2009; Köszegi and Szeidl 2013; Gabaix and Laibson 2006). We can thus expect that individuals with known respiratory disorders, or with family members known to have them, are more likely to respond positively to be shown information on the air pollution-related impact of electric and petrol motorcycles, because this form of an informational nudge is likely to bring their health status to their attention, and is thus likely to play a role in determining their choice.

Lastly, education has been found to have an important role in determining the level of cognitive skills of individuals, as well as in determining their economic rationality in decision-making (Kim et al., 2018). Individuals with stronger cognitive skills also exhibit fewer behavioral biases (Oechssler et al., 2009), and are thus more likely to process information related to the lifetime costs of durables (Blasch et al. 2019; Filippini et al. 2020; Blasch et al. 2018). We thus hypothesize that individuals with higher levels of education, as well as those who have achieved higher grades in their high school exams (a proxy for their cognitive skills), are more likely to choose electric motorcycles, in response to the informational nudges that they are provided. Moreover, we expect that this effect should also be strong for individuals in the Treatment 1 group, given that they are provided information on lifetime costs of the two motorcycles.

In order to compute the conditional average treatment effects on the treated, we estimate a probit model of the type in column (4) of Table 4, including all three treatment indicators. This model takes the following form:

$$E_i = \alpha_i + \beta D_{i,j} + \gamma H_i + \lambda H_i * D_{i,j} + \delta X_i + \epsilon_i, \quad (2)$$

where  $H_i$  now denotes a variable over which heterogeneous effects are calculated. The rest of the notation remains unchanged from expression (1). We are interested in estimating the parameter  $\lambda$ , and thus evaluating whether the coefficient on the interaction term differs from that on the main effect, given by  $\beta$ , i.e. whether there are heterogeneous effects over different subgroups of the population.

We estimate different models for each variable  $H_i$  that we are interested in evaluating heterogeneous effects over, namely gender of the respondent, whether the individual or a family member has a respiratory disorder, and three variables related to education (highest level of education attained, whether the respondent received a high math grade in the high school exams (higher than 80%), and whether the respondent received a high overall grade in the high school exams (again, higher than 80%)).

Table 6 presents the marginal effects of these estimations, evaluated at the means of the

independent variables.<sup>17</sup> These marginal effects are calculated with respect to the control group. We find that female respondents in the Treatment 3 group have a positive likelihood of stating that they would adopt an electric motorcycle, whereas the effect of Treatment 3 is insignificant for male respondents. On the other hand, male respondents have a significantly higher likelihood of stating that they would opt for the electric motorcycle in response to Treatment 2, compared to the control group (whereas we do not find that this effect holds for female respondents treated by being shown the smiley-face icons).

**Table 6:** Heterogeneous marginal effects

Variable	Categories	Treatment 1	Treatment 2	Treatment 3
Gender	Male	0.044 (0.029)	0.091*** (0.032)	0.045 (0.030)
	Female	0.034 (0.052)	0.068 (0.052)	0.173*** (0.056)
Health	Self/family member not known to have a respiratory disorder	0.050** (0.027)	0.069*** (0.028)	0.085*** (0.028)
	Self/family member known to have a respiratory disorder	-0.063 (0.100)	0.197** (0.104)	0.042 (0.105)
Level of Education	High school or below	0.036 (0.042)	0.059 (0.042)	0.091** (0.044)
	Professional education	-0.020 (0.138)	0.079 (0.162)	0.204 (0.154)
	Bachelors	0.034 (0.036)	0.109*** (0.038)	0.072** (0.036)
	Masters	0.099 (0.088)	0.067 (0.102)	0.007 (0.092)
	Math score in high school exams	0.033 (0.0273)	0.068** (0.028)	0.065*** (0.028)
	> 80%	0.136* (0.080)	0.289*** (0.111)	0.283*** (0.088)
Overall score in high school exams	< 80%	0.025 (0.027)	0.066*** (0.028)	0.059** (0.028)
	> 80%	0.213*** (0.084)	0.300*** (0.102)	0.329*** (0.087)

*Note:* The table reports heterogeneous marginal effects calculated over variables related to gender, health and education. These marginal effects are calculated based on a probit estimation similar to that in column (5) of Table 4 using 1851 observations, with the main effects as well as interaction effects of the treatment dummies included. These marginal effects (calculated at the means of the independent variables) are to be interpreted as conditional average treatment effects on the treated. Huber-White standard errors are reported in parentheses.

\*, \*\* and \*\*\* respectively denote significance at 10%, 5% and 1% levels.

Intuitively, we also find that the marginal (positive) effect of respondents known to have respiratory disorders (either themselves, or their family members), in response to Treatment 2, is significantly larger than those that have no known respiratory disorders. Being shown qualitative information on the air pollution impact of the two motorcycles, and thus bringing the health implications of their choice to salience, is more likely to nudge individuals who are already known to have (or whose family members are already known to have) some type of respiratory disorder in the direction of choosing the cleaner alternative.

Lastly, we find that there are no significant differences across levels of education with the exception of individuals belonging to the Treatment 2 and 3 groups and having a Bachelors degree, who are significantly more likely to choose the electric motorcycle, compared to respondents in the control group (likewise for individuals having a high school degree or below, in response to Treatment 3).<sup>18</sup> However, evidence on the importance of cognitive skills can

<sup>17</sup>The coefficients can be provided on request.

<sup>18</sup>While in Table 4, we observed that respondents with Bachelors degrees were significantly less likely to state that they would choose an electric motorcycle compared to those whose educational attainment was having a high school diploma or less at the overall level (i.e. irrespective of treatment allocation), the results of Table 6 tell us that on average, respondents in the Treatment 2 and 3 groups who have Bachelors degrees may be reacting in a more positive manner to these treatments, compared to respondents in the control group.

be discerned from the marginal effects over the variables for the grades in the high school exams. The marginal effects are not only significantly different to those of the control group if individuals had high grades (achieved more than 80% either in math, or in their overall grade), but they are also much higher in magnitude compared to the marginal effects for individuals having 'low' grades.

The results for Treatment 1 are particularly interesting; as we found in Tables 4 and 5, the overall treatment indicator for Treatment 1 was insignificant, whereas these results suggest that Treatment 1 can have a positive impact on the likelihood of choosing an electric motorcycle (compared to those individuals in the control group), if individuals have high levels of cognitive skills to be able to process the information on running costs that is provided to them. It can be expected that respondents who scored well in their high school math exam (and are thus likely to have higher computational abilities) are more likely to be able to understand the concept of lifetime costs, and compare them over the petrol and electric motorcycles.

We are of the opinion that these results have important implications pertaining to designing as well as targeting of policies so as to ensure their effectiveness. Informational nudges are likely to have heterogeneous effects across different subgroups of the population, and our results suggest that these effects may be particularly strong for some segments.

## **5 Conclusion and Policy Implications**

Our study evaluates the magnitude of some of the behavioral anomalies that we hypothesize to be relevant in determining the choice of motorcycles of consumers. We collect rich data on stated preferences, socio-economic factors and biases of potential motorcycle buyers in the Kathmandu valley, a region with rampant air pollution. Using a stated choice experiment with randomized information treatments, we evaluate the role of three specific behavioral anomalies in determining the stated preference of consumers for an electric alternative.

Firstly, we find some evidence to suggest that cognitive/skills limitations, framing of information, and the affect heuristic can play a role in determining the stated choice of respondents regarding whether they would like to buy an electric motorcycle. Relatedly, we find that providing information to respondents on the running costs of comparable electric and petrol motorcycles, displaying qualitative information on the air pollution impact of their choices, and “priming” them through impactful photographs and text may have a positive effect on their likelihood of opting for the electric motorcycle. In particular, the role of using simple heuristics like smiley icons to denote the air pollution impact of each type of motorcycle, and priming the “caretaker” identity of the respondents (and providing information to them on the effects of air pollution on mortality) seem to have a strong impact on this likelihood. Furthermore, the results also hint at the importance of gender, health status and cognitive skills in determining the effectiveness of these nudges in promoting the adoption of electric motorcycles.

These findings have important consequences for policy choice in settings similar to Kathmandu, where social norms and engine power are important determinants of personal mobility choice, and the negative externalities due to air pollution are very stark. Absence of energy-labels and a lack of up-front disclosure of information on fuel-economy and pollution are likely to pose a challenge to rational decision-making of Nepalese consumers. While addressing cognitive

or skills limitations is an important solution to ameliorate the energy-efficiency gap in many such settings, we show that other approaches guided by psychological and emotional triggers may also be useful to this end. While our study is one of the first to shed light on the role that behavioral anomalies may play in contributing to the energy-efficiency gap in developing countries, the paper adopts a stated-preference approach. As pointed out by [Davis and Metcalf \(2016\)](#), stated choices in a controlled experimental setup may not necessarily translate to actual choices in real-world settings as these choices entail real financial implications. This poses limitations particularly in terms of interpretation of the results and actual impact of the treatments. Nevertheless, in the context of adoption of new energy-efficient technologies like electric motorcycles, stated-preference setups allow us to investigate potential drivers and underlying decision mechanisms and helps lay foundations for future research.

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